

## Reliability of ICDAS to Detect Occlusal Caries among Master's Degree students of Dentistry

### Confiabilidade do ICDAS para Detectar Cárie Oclusal Entre Mestrandos de Odontologia

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Recebido em: 04/01/2019

Aprovado em: 05/04/2019

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#### Abstract

The objective of this study was to investigate the reproducibility of the International System for the Detection and Evaluation of Caries (ICDAS) for the diagnosis of caries by students of the Master's Degree in Dentistry (n = 25). The occlusal surfaces of human third molars (n = 14) were evaluated by twenty-five (n = 25) students using the ICDAS index and later a questionnaire was applied on demographic and professional context data. The dental crowns were sectioned in mesial to distal direction to obtain slices of 1mm in thickness which were observed in a stereomicroscope (40X) to identify the greatest extension of caries lesion. Data were analyzed by the Chi-Square, Fisher's Exact and Spearman's Correlation Coefficient at a significance level of 5%. There was an influence in the diagnosis of caries among students and teeth, where the majority of those who declared themselves to be safe missed the diagnosis. There was variability between the diagnosis and the proposed treatment for caries, with a better diagnosis for tooth VII and less for X; greater fit for treatment of teeth XIII, XIV and lower for IV, VI. The histological cut showed that the teeth were more affected by caries than the ICDAS. It was concluded that the ICDAS reproducibility was partially satisfactory when the occlusal surface was evaluated by the master's degree students.

**Keywords:** Dental Caries. Diagnostic Techniques and Procedures. Therapeutics.

#### Resumo

Este trabalho teve o objetivo de investigar a reprodutibilidade do Sistema Internacional de Detecção e Avaliação de Cárie (ICDAS) para o diagnóstico da cárie, por estudantes de curso de Mestrado em Odontologia (n=25). As superfícies oclusais de terceiros molares humanos (n=14) foram avaliadas por vinte e cinco (n=25) estudantes, utilizando o índice ICDAS, e posteriormente foi aplicado questionário sobre dados demográficos e de contexto profissional. As coroas dentárias foram seccionadas no sentido médio distal para obter fatias de 1 mm de espessura, que foram observadas em estereomicroscópio (40X) para identificar a maior extensão da lesão de cárie. Os dados foram analisados pelos Testes Qui-Quadrado, Exato de Fisher e Coeficiente de Correlação de Spearman, em nível de significância de 5%. Houve influência do grau de instrução dos estudantes no diagnóstico da cárie em relação ao dente avaliado e a maioria que se declarou segura errou o diagnóstico. Houve variabilidade entre o diagnóstico e o tratamento proposto para a cárie, com maior acerto para diagnóstico do dente VII e menor para o X; maior acerto para tratamento dos dentes XIII, XIV e menor para IV, VI. O corte histológico mostrou que os dentes estavam mais comprometidos pela cárie que o ICDAS. Concluiu-se que a reprodutibilidade do ICDAS foi satisfatória quando a superfície oclusal foi avaliada pelos mestrandos.

**Palavras-chave:** Cárie Dentária. Técnicas e Procedimentos Diagnósticos. Terapêutica.

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## 1 Introduction

Epidemiological studies recognize the inclusion of caries development as one of the priority diseases to be evaluated at national level, in view of their chronic relevance, even with the rapid technological change of that time<sup>1</sup>. New analyzes show that the burden of dental caries increases throughout life, to the point of the World Health Organization<sup>(WHO)</sup> 2 in 2015 estimate that the oral diseases are the fourth most expensive disease to treat in industrialized countries besides presenting a global prevalence of 35% for all combined ages<sup>3,4</sup>. Furthermore, according to the evaluation by the Global Burden of Disease<sup>(GBD)</sup> 5 in 2013, the oral conditions affect 3.9 billion

people, being the untreated caries in permanent dentition, the most prevalent condition<sup>4</sup>.

National public health programs should incorporate the oral health promotion and disease prevention based on the common approach of risk factors<sup>6</sup>. Caries is the most common of all chronic diseases in most low income and industrialized countries<sup>3</sup>. It is often called a multifactorial condition, since the caries process involves multiple causal factors<sup>7,8</sup>. Change in the approach of these etiological factors has emphasized the influence of diet on the caries<sup>9,10</sup>. There are several scientific evidences<sup>1,11</sup> that free sugars are the primary factors necessary for its development<sup>1</sup>. Thus, previous preventive measures

have clearly failed, and now it is necessary to reassess the reason for the growing of caries index with age and what can be done to limit individual and social burden of this disease<sup>6</sup>.

The future of research, clinical practice and education in the area of Karyology, depends on a comprehensive approach of caries and the adoption of a universal system for measuring the different stages of progression of lesions during their development process<sup>12</sup>. A shift in the policies of health promotion and prevention is needed to correct the disparity between what is taught in schools of dentistry in the area of clinical karyology and what is done in private and public oral health<sup>13</sup>. This conflict is due to the lack of consensus on the use of apparently similar terms as Prevention, Early Diagnosis and Preventive Intervention and its correction could improve the impact of training courses in the resolution of oral health problems arising from caries<sup>14,15</sup>.

The International System of Detection and Caries Assessment is a tool for visual inspection, scientifically proven regarding the effectiveness of early detection of caries lesion<sup>16</sup>. ICDAS is standardized and internationally recognized, developed in order to provide a numerical classification of the health status of a tooth, from a more detailed visual evaluation<sup>15</sup>. Thus, the sensitivity of the visual inspection is improved, and the subjectivity of the examiners is minimized<sup>17</sup>. This method makes it possible by electronic means a package of educational software - E-Learning program<sup>18</sup> to assist to professionals in its use. Constituted by a course of 90 minutes, updates and familiarizes the new users about the subject<sup>19,20</sup>.

There is difficulty standardizing the assessment of caries lesions by different methods. Many are used only to detect caries, but they do not detect certain stages of the lesion, neither their activity as ICDAS does. Among them is the histological method, considered by many authors as the gold standard for validating the detection of caries in vitro studies<sup>21-23</sup> and the histological sectioning is the preferred medium to validate the depth of the caries process. However, this method prevents clinical studies by destroying the study sample, which may be carried out only on pulled out teeth<sup>21</sup>.

Considering the above, an investigation "in vitro" was carried out on the reproducibility of the ICDAS method to test the hypothesis that: 1) There is no variability between the diagnosis and the treatment proposed for the caries in occlusal surface among the dentistry students using ICDAS; 2) The degree of reproducibility of the ICDAS method to detect lesions of occlusal caries in permanent teeth by students of dentistry is similar to histological sections.

## 2 Material and Methods

After approval of the project by the Committee for Ethics in Research (811,736), 14 human third molars affected by caries at different levels, without sealant or restorative treatment, were included in the sample.

The teeth were disinfected for 7 days in a solution of chloramine-T (Vetec Química Fina Ltda.; Rio de Janeiro, Rio de Janeiro, Brazil) to 0.5% in water at 4°C; cleaned by means of root scraping using periodontal curettes (McCall; Hu-Friedy Mfg. Co., LLC; Chicago, USA) and polished with pumice stone, associated with the brush of Robson coupled in low speed turbine Konzept (Factory KaVo Brazil Ind. Com. Ltda, Joinville, Santa Catarina, Brazil) for the removal of debris and soft tissue. The clean teeth were stored in glass jars containing ultrapure water (Elga; PurelabOption-Q DV25; São Paulo; Brazil) and subsequently included based on acrylic resin and encoded in a random manner from I to XIV The set was kept moist, in ultrapure water throughout the study not to dehydrate.

### 2.1 Analysis of reproducibility

To constitute the control group for the score of the ICDAS scores in each evaluated tooth, three researchers were calibrated according to the criteria of the method of ICDAS visual inspection (Table 1). The training occurred in a single step, by electronic means (www.icdas.org), where the method itself offers a package of educational software - E-Learning program<sup>18</sup>. Immediately after the training, the teeth were cleaned by prophylaxis with pumice and water for 60 seconds(s), rinsed and dried for 5s with threefold syringe and arranged in individual benches so that their occlusal surfaces were visually inspected by researchers independently. In case of disagreement on the score of the score, the criterion of consensus was adopted.

**Table 1** - Visual description assigned to the scores of the ICDAS and histological methods.

Scores	ICDAS	Histological Sections
0	Healthy - Intact tooth surface.	No demineralization.
1	Visible initial alteration in enamel restricted to the base of pits and fissures.	The enamel demineralization is limited to 50 % of the external surface of the enamel.
2	Clearly visible alteration in enamel as lesion of a white or brown spot.	Demineralization (brown discoloration) involving between 50 % of the enamel and 1/3 of the dentin.
3	Interruption of the enamel surface without visible dentin (micro cavitation).	Demineralization (brown color), involving the middle third of the dentin.
4	Clear shading of the underlying dentin to the cavitated enamel or not, without visible dentin.	Demineralization (brown color), involving the third internal of the dentin.
5	Clear cavity in enamel with visible dentin, involving less than 50% of the evaluated area.	
6	Clear extense cavity in enamel with visible dentin, involving less than 50% of the surface.	

Source: Research data.

In the next phase, 25 Dentistry students at master's degree level, were invited to participate in the research. Initially they were trained to use the ICDAS method by the same educational program of 90 minutes adopted to enable researchers. Before the electronic training, the students were asked about demographic data and professional context (Table 2). After the training, the teeth were arranged in individual benches for visual inspection of the occlusal surfaces by the students.

**Table 2** - Questionnaire on demographic data and professional context.

Student's name:		
Age: _____ years.		Nationality:
Gender:	1 - ( ) Male. 2 - ( ) Female.	1) Graduation Year: _____
The name of the institution of education where you graduated:		
Specialty in which you operate?		
Sector of professional performance:		
1 - ( ) Private. 2 - ( ) Public. 3 - ( ) Both.		
Area of expertise:		
1 - ( ) Urban. 2 - ( ) Rural.		
Do you feel secure in detecting the carious lesions in its various levels of involvement of the disease?		
1 - ( ) Yes. 2 - ( ) No.		
What resources do you use during the implementation of the method of visual inspection?		
1 - ( ) Turbine BR + Robson. 2 - ( ) Threefold Syringe. 3 - ( ) Explorer probe. 4 - ( ) Spherical Tip Probe.		
Do you know the international system for detection and evaluation of dental caries (ICDAS)?		
1 - ( ) Yes. 2 - ( ) No.		
Do you have interest in taking part in a training on the ICDAS.		
1 - ( ) Yes. 2 - ( ) No.		

Source: Research data.

For the visual inspection of the occlusal surfaces, the requirement of prior cleaning of the surface and drying for 5 seconds was followed. Between each assessment the teeth were moistened with water from the threefold syringe not to dry out. After the assessment, the students established a diagnosis for caries, using ICDAS. The first digit of the code was zero for all teeth of the study, as they were free from sealant and restoration according to inclusion criteria. The second digit was established according to the visual inspection of each student. The treatment proposed for each stage of the disease dental caries was determined by the individual experience of each master's degree student and was categorized into: 1 - Educational; 2 - preventive and 3 - restorative. The data on the diagnosis and the treatment proposed for each evaluated tooth were recorded in individual sheets and subsequently tabulated.

## 2.2 Section of the teeth

Each tooth was sectioned lengthwise in the mesio-distal

direction in 5 equidistant sections of 1mm thick, passing through the main groove of the occlusal surface; with the aid of a cutting disc by diamond Extec 12205 (Erios, São Paulo, São Paulo, Brazil) coupled to a cutting machine model 1000 ISOMET (Buhler Ltd., Lake Bluff, IL, USA) at a speed of 200 revolutions per minute (rpm) under constant cooling with distilled water. Therefore, the crowns were separated from the roots through another cut perpendicular to the long axis of the tooth, at the height of the cement enamel junction. The 4 sections obtained from each sample were wrapped individually in a container with a lid containing 2 ml of ultrapure water.

## 2.3 Histological Analysis.

The histological sections were analyzed in dental optical stereoscope Bel Photonics (Bel Microimager Analyzer, Monza, Italy), with magnification of the original in 40 X and by means of a Microscope Eyepiece Camera 3.1 MP (ToupTek Photonics Co.,Ltd; Hangzhou, Zhejiang, China), coupled to the stereoscope, both sides of each section were photographed and the digital images obtained by software (ToupView Photonics Co.,Ltd; Hangzhou, Zhejiang, China) were expanded on a computer monitor. The degree of involvement of each tooth by the carious injury, was determined by the most profound extension of the demineralization and the change of color found in the sample in comparison with the healthy tissue. They were analyzed by 3 independent researchers to determine the score of the lesion, according to the histological criteria described in table 1. Before the evaluations, the images were adjusted in relation to the size and exposure and processed in batch processing with the software, viewing and editing of images Digital Photo Professional (Canon, Canon Inc., Tokyo, Japan). In case of disagreement on the score of the score, the criterion of the researchers' consensus was adopted. Thus, the control group was constituted for the histological slice.

## 2.4 Statistical Analysis

The ordinal categorical data were compiled in Microsoft Office Excel 2010 and transported to the program Statistical Package for Social Sciences (SPSS), version 20.0. To express the reproducibility between ICDAS methods and histological cut the Kappa index was used (k). To test possible associations and correlations among the variables the Chi-square test, Fisher's exact test and Spearman's Correlation Coefficient were used. The significance level was fixed in 5%.

## 3 Results and Discussion

In the study sample, there was a greater proportion of students who were female (56%) who studied in private school (60%), with more than 5 years since graduation (52%) and with a specialization course (56%) in dentistry. Of the students who work in the profession (68%), all work in an urban area, being

that 52% work in the private sector and 16% in the public sector. When asked about the caries detection, 80% said they have security in detecting lesions in their different stages and 72% of the students did not know the ICDAS method, but all agreed to receive training on the method.

The reliability analysis showed that the correlation among the researchers in the ICDAS method ( $k = 0.70$ ) was significant and the histological section ( $k = 0.92$ ) was almost perfect. In relation to the master's degree students, the analysis showed that there was a concordance. The association among the independent variables and the diagnosis of caries lesions that were significant, are represented in Table 3. It was observed that having a specialization influenced the students to know more the diagnosis in the tooth VIII ( $p = 0.49$ ). The sector where the professional performs his or her functions influenced the diagnosis of the teeth IX (0.044) and XIII (0.043), because students who work in the public sector have hit over the diagnosis of tooth IX, while students who do not act in the profession have hit over the diagnosis of tooth XIII. Of the 20 students who claimed to have security in detecting lesions, 85% wrong diagnosis, while that of the 5 insecure students only 1 missed. Regarding the proposed treatment no variable influenced the result.

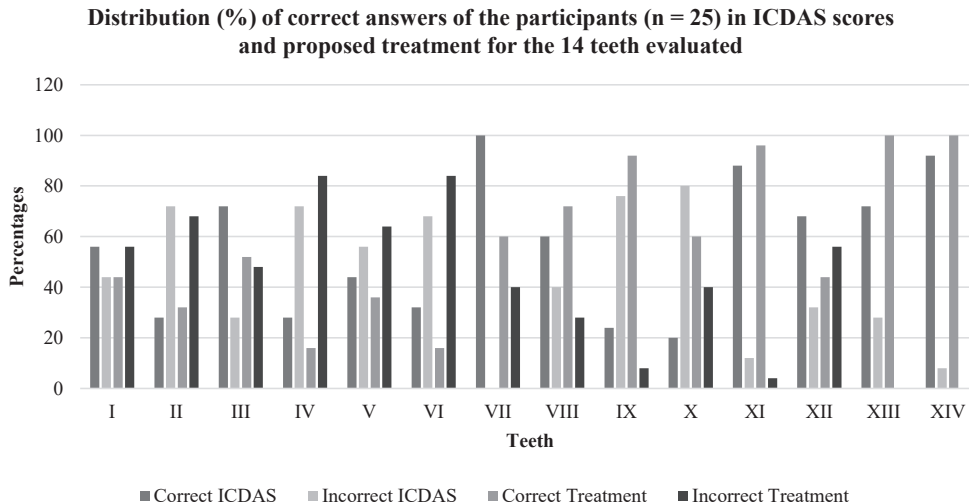
**Table 3** - Result of the evaluation of the ICDAS teeth in relation to the proposed treatment

Teeth	ICDAS Scores		Proposed treatment		$p^f$
	Correct	Incorrect	Correct	Incorrect	
	N (%)	N (%)	N (%)	N (%)	
I	14 (56)	11 (44)	11 (44)	14 (56)	<b>0.017</b>
II	7 (28)	18 (72)	8 (32)	17 (68)	<b>0</b>
III	18 (72)	7 (28)	13 (52)	12 (48)	<b>0.03</b>
IV	7 (28)	18 (72)	4 (16)	21 (84)	1
V	11 (44)	14 (56)	9 (36)	16 (64)	0.208
VI	8 (32)	17 (68)	4 (16)	21 (84)	1
VII	25 (100)	0 (0)	15 (60)	10 (40)	-----
VIII	15 (60)	10 (40)	18 (72)	7 (28)	1
IX	6 (24)	19 (76)	23 (92)	2 (8)	1
X	5 (20)	20 (80)	15 (60)	10 (40)	0.358
XI	22 (88)	3 (12)	24 (96)	1 (4)	0.12
XII	17 (68)	8 (32)	11 (44)	14 (56)	1
XIII	18 (72)	7 (28)	25 (100)	0 (0)	-----
XIV	23 (92)	2 (8)	25 (100)	0 (0)	-----

Source: Research data.

The percentage of correct responses of the participants ( $n = 25$ ) for each evaluated tooth (Graph 1), both for the ICDAS scores as well as for the proposed treatment was greater in teeth VII (100%) and XIII, XIV (100%) and was lower in teeth X (20%) and IV, VI (16%), respectively.

**Figure 1** - Distribution (%) of correct answers of the participants ( $n=25$ ) for the ICDAS scores and the proposed treatment to 14 evaluated teeth.



Source: Research data.

In the analysis of correlation between the diagnosis and the treatment proposed by the students for each evaluated tooth (Table 3), there was a significant difference for the tooth I ( $p = 0.017$ ), because the 14 students that have hit the diagnosis, 11 erred treatment; while the 11 who err the diagnosis 8 hit the treatment; for the tooth II ( $p = 0.000$ ), because of the 7 students that have hit the diagnosis all hit the treatment, while the 18 who have done wrong the diagnosis 17 erred treatment and for the tooth III ( $p = 0.030$ ), because of the 18 students that have hit the diagnosis 12 hit the treatment being that the 7

who have done wrong diagnosis, 6 hit the treatment.

The histological test revealed that the teeth III and VII were free from dental caries; the remaining teeth had caries lesions which stretched up to the dentin; no tooth presented a carious injury restricted to the enamel.

The association among the independent variables and the diagnosis of caries lesion, showed that having or not specialization influenced the finding in the tooth VIII ( $p = 0.49$ ) and the sector of the professional practice influenced the finding of the teeth VIII (0.043) and IX (0.044). Regarding

the proposed treatment no variable influenced the result.

The percentage of correct responses of the participants ( $n = 25$ ) for each evaluated tooth (Graph 1), both for the ICDAS scores as well as for the proposed treatment was greater in teeth VII (100%) and XIII, XIV (100%) and was lower in teeth X (20%) and IV, VI (16%), respectively.

In the analysis of correlation between the diagnosis and the treatment proposed by students for each tooth evaluated (Table 3), there was a significant difference for the teeth I ( $p = 0.017$ ), II ( $p = 0.000$ ) and III ( $p = 0.030$ ).

The early detection of early signs of caries is a challenge to the surgeon-dentists, due to the subjectivity of the conventional methods adopted by the clinician and the multifactorial trait of the disease<sup>1,7,8</sup>. In this work the detection of caries on the occlusal surface of human teeth and treatment proposed by students of the Master's degree Course in dentistry was made with the ICDAS, a promising trend method to detect and assess caries lesions<sup>15</sup>.

In this study considerable agreement inter observer was observed for the assessed parameters, with the ICDAS method. However, a single training<sup>18</sup> was not enough to reduce the variability between the diagnosis and the treatment proposed for the caries lesions. So, the first study hypothesis was rejected.

In a previous study<sup>24</sup>, sixteen graduate students evaluated the occlusal surfaces of 67 deciduous teeth exfoliated after a single training and found a kappa value = 0.78, like the evaluations in our study ( $k = 0.70$ ). The difference among the studies is in the way that the training of postgraduate students was held. In our study, they were trained by electronic means and on the other, they were trained by means of phantom. In the study of Zandoná, *et al.*<sup>25</sup>, the researchers compared three groups of participants with different levels of clinical experience, on the use of the ICDAS on occlusal surfaces. Thirty participants, among them professors, graduate and post-graduate students, examined 60 occlusal surfaces, after electronic and practical training. They concluded that previous clinical experience does not seem to play a significant role in learning ICDAS, because there was no significant difference among the groups evaluated for intra and inter-examiner concordance.

In this study, upon assessing the influence of some demographic variables and professional context in the variation between detection and institution of treatment for dental caries using ICDAS, the time of the students' formation also did not influence the assessment of the teeth with the ICDAS, as well as in the study of Al-Khatrash *et al.*<sup>14</sup>. However, the professional performance in the public sector influenced the assessment in the tooth IX, because the participants have hit more the diagnosis. While students who do not act in the profession have hit over the diagnosis of tooth XIII. This might be justified by the familiarity of the professionals who work in the public sector with the method

of visual inspection.

Another variable that influenced the results of this study was the participants to have specialty in any area of dentistry, because they hit the diagnosis better in the tooth VIII. Just as in the previously mentioned study<sup>14</sup>, where the participants' specialty was the only factor that had an effect on the diagnosis and treatment of occlusal caries, because the participants with specialty in restorative dentistry had a tendency to underdiagnose caries lesions in enamel, while the general practitioners and other specialists tended to the treatment of dental caries in enamel.

In the study of Al-Khatrash, *et al.*<sup>14</sup> half of the participants did not diagnose the presence of dental enamel when in fact it was present. The same error happened in the teeth with caries that stretched to the dentin. More than two-thirds of participants diagnosed the teeth as without dental caries or limited to the enamel. In this case only four teeth were evaluated by 156 graduates and specialists in dentistry. The variability in the diagnosis of dental caries lesion raises the issue of the underdiagnosis and on treatment of disease and reinforces the importance of addressing the origin of this variation, in order to improve the clinical decision making<sup>20</sup>.

Another interesting result in this study was that of 20 (80%) master's degree students that stated to be sure in detecting carious lesions in their different stages, 16 (85%) erred in finding in the tooth IV. This suggests that a single training was not enough to calibrate the students regarding the use of the ICDAS or that there was failure in correct understanding or partial parameters of the method, since the evaluation of occlusal surfaces of the teeth was performed immediately after the end of the training. But it was enough to awaken the interest of students in improving their detection method of carious lesions and that a thorough visual examination can influence the method accuracy. In addition, it decreased the variability between diagnosis and treatment proposed for caries, in only three teeth (I, II, III) of 14 teeth evaluated by the participants.

Concerning the histological method, the reliability analysis showed almost perfect agreement, corroborating the results found in previous studies<sup>17,19,20</sup> and reaffirming the condition of gold-standard method to detect caries lesions.

To decrease the variability existing between the detection of occlusal caries and institution of treatment, it is necessary to train the professionals since their formation to use efficient methods as the ICDAS. In addition to considering the risk factors to which the individual is exposed before proposing a treatment to avoid the underdiagnosis and on treatment of caries lesions.

#### 4 Conclusion

It was concluded that the ICDAS reproducibility was partially satisfactory when the occlusal surface was evaluated by the master's degree students.

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