Reproducibility of caries diagnosis in permanent teeth according to WHO, ICDAS-II and Nyvad criteria

Priscila Florentino Silva[1], Franklin Delano Soares Forte[2], Ana Maria Barros Pereira Chaves[3], Isabela Albuquerque Passos Farias[4], Kaline Silva Castro[5]

[1]Graduate Program in Dentistry, Master's Degree Program in Preventive and Pediatric Dentistry, Federal University of Paraíba, João Pessoa, Brazil

[2]PhD, Graduate Program in Dentistry, Master's Degree Program in Preventive and Pediatric Dentistry, Federal University of Paraíba, João Pessoa, Brazil

[3]PhD, Graduate Program in Dentistry, Master's Degree Program in Preventive and Pediatric Dentistry, Federal University of Paraíba, João Pessoa, Brazil

[4]Professor, Department of Restorative Dentistry, Federal University of Paraiba, João Pessoa, Brazil

[5]Graduate Program in Dentistry, Master's Degree Program in Preventive and Pediatric Dentistry, Federal University of Paraíba, João Pessoa, Brazil

Abstract

Aim: To assess inter-examiner reproducibility in the detection of 20 occlusal caries in permanent teeth using three diagnostic codes and criteria: WHO (1997), Nyvad and ICDAS-II. **Methods:** Three graduate students (G) and two undergraduate dental students (UG) without previous experience in the use of Nyvad and ICDAS-II were trained by a reference examiner. Examiner validity was assessed by consensus agreement between the investigators. Two cutoff points were used for ICDAS-II and Nyvad to represent reproducibility values: the A- lesion, B- cavity lesion. **Results:** According to the examiners consensus, the kappa values ranged from 0.71 to 0.85 for G group and from 0.85 to 0.95 for UG group (ICDAS-II). For the Nyvad index values varied from of 0.77 to 1.00 (G) and from 0.65 to 0.74 (UG), for the WHO index, values obtained ranged from 0.66 to 1.00 (UG) and 1.00 (G). Using a cutoff A, interexaminers reproducibility (ICDAS-II) ranged from 0.73 to 0.87 (G) and 1.00 (UG). According to Nyvad criteria, the kappa value ranged from 0.78 to 1.00 (G) and from 0.70 and 0.90 (UG) when compared to the consensus. The kappa values using the cutoff point B ranged from 0.66 to 1.00 (G), 0.76-0.89 (UG) in ICDAS-II and the in Nyvad criteria varied from 0.87 to 1.00 (G) and from 0.65 to 0.88 (UG). **Conclusions:** Reproducibility values ranged from good to perfect. The reproducibility revealed precise answers in the occlusal caries lesions diagnosis according to the criteria used. The best use of reliability tools for examiner training was important regardless of the examiners being undergraduate or graduate students.

Keywords: dental diagnosis, tooth decay, reproducibility.

Introduction

In recent years, the prevalence of dental caries in children and adults has declined and changed both in industrialized and in developing countries like Brazil[1-2]. The international epidemiological criteria used in Brazil, the WHO standard, do not register lesions caries in pre cavitations stages, such as white spot

lesions[3]. Thus, the progress of non cavitated caries lesions in populations it is an important evidence of using new indices in a public with new dental profile.

Treatments that emphasize prevention need diagnostics that reveal the real stage of carious process, from the subtle demineralization changes to the cavitations itself, monitoring the individual routine[4]. The development of new criteria for detecting initial carious lesions process are followed by studies[5-6]. Among the new caries detection systems are Nyvad et al. (1999)[7] and International Caries Detection and Assessment System II (ICDAS-II) created in 2002[8].

Proposed by Nyvad et al. (1999)[7], the Nyvad criteria includes initial manifestation of caries in the pre-cavitary stages differencing active and inactive caries in both levels cavitated and non-cavitated. Three stages of severity related to the depth of penetration are considered in Nyvad index: intact surface, descontinuous surface and cavity in enamel or dentin, avoiding use of an explorer unless the visual examination is not sufficient to choose lesion as active or inactive.

The ICDAS-II is another set of criteria for non-cavitated caries diagnosis. It recommends the direct visual examination on clean teeth, followed by careful drying of the of the lesion surface preceding the exam, identifying the state of teeth using an ordinal scale from the health surface to cavitated caries. According to studies, epidemiological surveys using these new indices are possible with acceptable reliability in Brazil[9-10] and other countries[11-13].

Reproducibility is recognized as the ability to obtain similar results on several examination and has been considered of great importance when evaluating a particular method of validation, ensuring uniformity of caries criteria interpretation[14-15].

The aim of this study was to assess the reproducibility of visual examination of occlusal caries lesions in human permanent teeth using the WHO diagnostic criteria (1997), Nyvad and ICDAS-II. Graduate and undergraduate students of Dentistry course at the Federal University of Paraíba were selected as examiners for this study.

Material and methods

This research was approved by the Ethics Committee of Lauro Wanderley Hospital, Federal University of Paraíba, under protocol #458/10. The procedures for this research complied with the guidelines and regulations involving human subjects, approved by Resolution No. 196 of 10 October, 1996 - National Council of Health[16].

Three graduate students (G) and two undergraduate students (UG) concluding the Dentistry course were selected as examiners and were trained in WHO (1997), ICDAS-II and Nyvad indexes.

The examinations were performed in a clinical setting with access to triple syringe and artificial light. Approach to other tests performed previously with other codes and criteria was not allowed, also tests performed by another examiner. The dental mirror and WHO periodontal probe were used without pressure on tooth surface, only to precise questions

arising from the visual diagnosis. The teeth were kept immersed in 10% neutral formaldehyde preventing changes in their appearance. Drying the tooth was permitted.

The examiners were trained with SB Brasil 2010[15] methodology using the consensus method. According to this method, the prevailing consensus of the examiners was used as gold standard. Initially, the activities consisted of a lecture of codes and criteria to be used in the subsequent examination, digital pictures of the teeth with occlusal caries lesions were presented and theoretical exercises were performed. The examiners also practiced on ICDAS e-learning[17] electronic program with images of dental caries according to the scores and theoretical exercises.

Clinical Training

The training phase consisted of clinical examination of 10 teeth with several situations, from healthy teeth, white spot, enamel fracture, cavitation in dentin to teeth with extensive destruction. The examiners reviewed the examination register in their files and discussed disagreements to reach a consensus.

Following the training methodology, 20 teeth were examined. All examiners completed the tests, recorded the results in their files, discussed to obtain consensus and a common consent filled was used to calculate the kappa coefficient of sample. Tests with other criteria were conducted after 1 week to reduce the influence of one system in subsequent examination. The last criteria assessment was OMS (1997)[3].

Cutoff

Two criteria cutoff points were used to analyze the Nyvad and ICDAS-II results. Thus, the cutoff A (lesion) for Nyvad and ICDAS-II criteria considered caries lesion all present demineralization at enamel or dentin, excluding score "0" (without demineralization). The cutoff B (cavity lesion) classified carious lesions those with discontinuous surface (ICDAS-II scores 3, 4, 5 and 6, and Nyvad scores 2, 3, 5 and 6), the other scores 0, 1W, 1B, and 2B, 2W (ICDAS-II) and 0, 1 and 4 (Nyvad) were considered as "not decayed". Interexaminer agreement was expressed by weighted Kappa coefficient. The recommended values for agreement were superior to 0.65 (the same adopted in SB 2010[15] Brazil methodology).

Results

The Kappa results of inter-examiner reproducibility tests obtained from the Cohen's Kappa index and classified according to Landis and Koch[18] are presented (Table 1). The interexaminer reproducibility verified according to the consensus ICDAS-II ranged from 0.71 to 0.85 for G and 0.85 to 0.95 for UG, Nyvad from 0.77 to 1.00 (G) and 0.65-0.74 (UG), OMS value 1.00 was obtained for G group and from 0.66 to 1.00 for UG group.

For a cutoff A, the reproducibility according to consensus (ICDAS-II) ranged from 0.73 to 0.87 for G and 1.00 for UG.

Table 1 - Inter-examiner reproducibility exam for the contents ICDAS-II Nyvad, Cohen's Kappa index

CRITERIA	Ex*2 x cs‡	Ex3 x cs	Ex4 x cs	Ex2 X Ex3	Ex2 X Ex4	Ex3 X Ex4
			Reproducibility PG†			
ICDAS-II	0.85	0.71	0.79	0.61	0.73	0.70
NYVAD	0.77	0.93	1.00	0.72	0.77	0.93
OMS	1.00	1.00	1.00	1.00	1.00	1.00
			Reproducibility G¥			
CRITERIA	Ex2 x cs	Ex3 x cs	Ex2 X Ex3			
ICDAS-II	0.95	0.85	0.78			
NYVAD	0.74	0.65	0.45			
OMS	0.66	1.00	0.66			

†Graduate student
*Examiner
‡ Consensus file
¥ Undergraduate student

Table 2 - Inter-examiner reproducibility exams using cutoff A in ICDAS-II and Nyvad index, Cohen Kappa.

CRITERIA	Ex*2 x cs‡	Ex3 x cs	Ex4 x cs	Ex2 X Ex3	Ex2 X Ex4
			Reproducibility PG†		
ICDAS-II	0.87	0.73	0.76	0.57	0.87
NYVAD	0.88	0.78	1.00	0.68	0.88
			Reproducibility G¥		
CRITERIA	Ex2 x cs	Ex3 x cs	Ex2 X Ex3		
ICDAS-II	1.00	1.00	1.00		
NYVAD	0.70	0.90	0.60		

†Graduate student
*Examiner
‡ Consensus file
¥ Undergraduate student

Table 3 - Inter-examiner reproducibility exams using cutoff B in CDAS-II and Nyvad index, Cohen Kappa.

CRITERIA	Ex*2 x cs‡	Ex3 x cs	Ex4 x cs	Ex2 X Ex3	Ex2 X Ex4	Ex3 X Ex4
			Reproducibility PG†			
ICDAS-II	1.00	0.66	0.87	0.66	0.87	0.56
NYVAD	0.87	1.00	1.00	0.87	0.87	1.00
			Reproducibility G¥			
CRITERIA	Ex2 x cs	Ex3 x cs	Ex2 X Ex3			
ICDAS-II	0.89	0.76	0.66			
NYVAD	0.65	0.88	0.56			

†Graduate student
*Examiner
‡ Consensus file
¥ Undergraduate student

Table 4 - Percentage distribution of diagnostic disagreements among examiners.

Disagreement (%)		Cavitated	Non-cavitated	Active	inactive
		Disagreement involving occlusal caries lesions			
PG†	5.0	33.3	66.6	58.3	41.6
G¥	20.0	68.8	31.3	40.0	60.0

†Graduate student
¥Undegraduate student

For Nyvad criteria, the kappa value ranged from 0.78 to 1.00 (G) and for G group was 0.70 and 0.90 (Table 2).

Data obtained from the cutoff point B are presented in Table 3. In ICDAS-II, the kappa value calculated from consensus ranged from 0.66 to 1.00 (G) and from 0.76 to 0.89 (UG), For Nyvad criteria cut off B was 0.87 to 1.00 (G) and from 0.65 to 0.88 (UG). The reproducibility values ranged from good to very good agreement, according Landis and Koch[18].

Table 4 shows the distribution of discordant diagnoses between the graduate and undergraduate examiners. Graduate students disagreed at 15% of examinations and 20% of undergraduate examiners tests was discordant. Among the disagreements, 33.6% involved cavitated lesions and 66.6% involved non-cavitated lesions (41.6% were inactive lesions and 58.3% active lesions). The graduate examiners obtained 68.75% of discordant diagnoses represented by cavitated lesions and 31.25% non-cavitated lesions (40% active and 60% inactive). Disagreement between sound surfaces and non-cavitated lesions was 40% of undergraduate discordant diagnoses and 36% of graduate discordant diagnoses.

Discussion

An accurate and reliable exam of dental caries is an essential stage of epidemiological surveys, which will contribute to the overall quality and reliability of research, as well as support appropriate interventions[19-20]. The occlusal surface is the most affected by caries among children, adolescents and young adults, due to its complex anatomy, making the detection of non-cavited lesions a difficult task[21-22]. Examiners presented different experience levels as different values of reproducibility has been observed[20-21].

Studies that investigate the relationship between examiner calibration and the reproducibility achieved in the use of new methods for caries detection are necessary in order to validate and refine these systems and epidemiological assessment[22-23].

During data collection, examiner training was important to minimize both the random and systematic error[15,24] mainly because an early stage of caries diagnosis was assessed, increasing the reproducibility and validity problems[12,25]. A substantial decrease of scores values (ICDAS-II) after training sessions was observed either enhance of reproducibility before (0.72) and after (0.78) examination[17]. Careful reading of the codes and criteria combined with images of characteristic lesions in training session[17,25] emphasize learning effectiveness

The enamel caries percentage according to consensus found in the present study confirms the ability of the ICDAS-II and Nyvad criteria to detect early changes in the enamel similar to other studies[5,21]. Several studies have shown examination outcomes related to examiners experience[20], and previous training[17,26]. Detection of early lesions and detailed features is necessary in new indices which monitor the changes in teeth surface related to patient's attitudes.

In the present study, higher reproducibility values were observed while cutoff point A (lesion) was chosen unlike studies in which examiners with little experience achieved

high reproducibility in D3 cut off (cavity lesion)[20]. Braga et al. (2009)[22] reported the use of cutoff points for diagnostic reproducibility not altering the sensitivity, specificity and accuracy. Differentiating active lesions from inactive induced some classification doubt as reported by examiners[7,24], although in this study values ranged from good to perfect when cutoff was not used.

The sensitivity can vary significantly (0.18 to 0.52) between unexperienced and experienced examiners[20], with an increased inter-examiner agreement similar to presented in our study. The sensitivity of graduates emerged in the WHO (1997) index application. The majority of discordant diagnoses between the undergraduate examiners and among the graduate examiners were represented by pre-cavitated active lesions and sound surfaces codes[7,22].

These findings show effectiveness of new criteria to differentiate active lesions from inactive lesions whether cavitated or not cavitated. According to Nyvad et al. (1999)[7] the agreement between examiners for non-cavitated active lesions and inactive non-cavitated lesions were 68.7% and 72.5%. According to Ismail et al. (1992)[27], trained examiners confuse incipient caries 17 times more than cavitated caries surfaces.

The ICDAS-II and Nyvad-II criteria have several scores to demonstrate pre-cavited lesions with respect to depth, and its relation to the activity, allowing the caries development analysis by examiners[22]. This is a positive feature in surveys using these indices where the additional objective is treatment decision planning instead of reporting the prevalence of caries only.

Visual inspection of incipient caries lesions should be performed by trained examiners with new methods and criteria in clean and dry teeth surfaces, increasing sensitivity and specificity apply to epidemiologic surveys.

In conclusion, examiner training according to the methodology proposed in this study, with theoretical discussion, discussion and exercise for proper calibration, makes possible the use of different criteria for caries diagnosis, considering active and inactive, pre-cavitated or cavitated caries lesions.

Acknowledgments

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