Original Article

Performance of dental undergraduate students using International Caries Detection and Assessment system (ICDAS)

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Abstract

Objectives: This study aimed to assess intra- and inter-examiner reliability of International Caries Detection and Assessment System (ICDAS) and modified epidemiology ICDAS (MOD) code by undergraduate dental students with different clinical experiences.

Methods: A total of 150 dental undergraduate students with varying clinical experiences (0, 1 and 2 years of clinical experience) were recruited. Participants received training through a theoretical lecture on ICDAS criteria by an experienced National Benchmark Group (NBG) examiner and underwent e-learning program prior to ICDAS calibration. Visual examination on extracted permanent teeth (N= 45) with different location and stages of caries progression ranging from ICDAS scores 0 to 6, was performed using the ICDAS criteria. The assessments were repeated after one hour. The data were analysed to evaluate inter-examiner and intra-examiner reliability in the form of kappa scores using SPSS 23 Software.

Results: Mean kappa values for intra- and inter-examiner reliability for ICDAS code, were between 0.41 to 0.60, and 0.61 to 0.80 respectively. For MOD code, mean kappa values for intra- and inter-examiner reliability were between 0.61 to 0.80. Good intra-examiner agreement (>0.61) was observed in both ICDAS and MOD code for all groups.

Conclusion: All students performed similar agreement, therefore, clinical experience within 2 years does not influence the performance of visual inspection in detecting caries using ICDAS. The results of the study shows that ICDAS and modified epidemiology ICDAS codes has good reproducibility and is feasible to be used as a tool in clinical practice as well as patient education.

Keywords: ICDAS, caries detection, visual inspection, dental education

Abbreviations: ICDAS (International Caries Detection and Assessment System); MOD (Modified epidemiology ICDAS); NBG (National Benchmark Group)

Introduction

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Conventional caries detection method using Black's caries classification system has been widely used in general practice and teaching institutions since more than 100 years ago. The system uses a visual-tactile inspection aided by a sharp dental probe, relying on surface texture for

presence of caries and recorded cavitated lesion. This method of caries detection has been disproved as a diagnostic technique and shown to be unnecessarily damaging to tooth structure (Ekstrand et al., 1987; Lussi et al., 1993). Caries detection based on the World Health Organization (WHO) index has been used vastly in epidemiological settings but recorded caries at the level of cavitation (Nyvad et al., 2008). The WHO criteria decayed-missing-filled teeth/surfaces (DMFT/S) index neglects enamel non-cavitated caries, thus often lead to underestimation of caries experience and prevalence.

The International Caries Detection and Assessment System (ICDAS) has been introduced to improve the validity and reliability of visual caries detection methods (Ismail et al., 2007). This visual scoring system was developed to standardise caries detection procedures for clinical research, clinical practice, epidemiological surveys and education (Ismail et al., 2007). It relates the detection of lesion severity, assessment of lesion activity and monitoring of lesion behaviour over time (Pitts, 2009). This system combines components of various caries classification systems into one standard system by the use of a six-point scale that ranges from the earliest visible stage of enamel caries to extensive lesions with cavitation exposing dentine in order to describe caries severity stages (Topping et al., 2009).

In the past 30 years, there has been a gradual international shift towards minimal intervention dentistry (Tyas et al., 2000), which has been supported by the Fédération Dentaire Internationale. This approach is in line with the ICDAS since the system is based upon the modern evidence on cariology which enables the concept of caries prevention and monitoring of a lesion. ICDAS has been shown to have acceptable values of sensitivity, specificity and reproducibility for detection of both early and more advanced carious lesions (Ismail et al., 2007; Cook et al., 2007; Jablonski-Momeni et al., 2008, Nogueira et al., 2017).

Diagnosing caries using ICDAS has now been accepted in many countries and is gaining acceptance. The European Core Curriculum in Cariology recommends ICDAS to be included in cariology curriculum in dental school (Pitts et al., 2011). Currently, dental educational institutes all around the world have shown interest in ICDAS within their dental curriculum; this includes dental schools in Europe, North and South America, as well as Asia. The ICDAS method has been shown to be easily adapted by dental students (Diniz et al., 2010; Jablonski-Momeni, 2012).

Malaysia has been slowly adapting ICDAS in dental schools and general clinical practice in the Ministry of Health. Implementation of ICDAS involves a theoretical learning module in the form of pocket lecture and e-learning package available on the International Caries Classification and Management System (ICCMS) website, to assist in the educating of students and clinician. This teaching resources includes the ICDAS protocols for caries detection and an element of testing to promote standardization of the use of the ICDAS codes. The training includes calibration of caries detection in which students or clinicians performed in-vitro examination on extraction teeth.

Our working hypothesis was that caries detection using ICDAS would be influenced by the examiner's clinical experience. The ICDAS caries detection method should

present a different reproducibility and reliability dependent on the examiner's expertise. To test this hypothesis, we aimed to assess intra- and inter-examiner reliability of International Caries Detection and Assessment System (ICDAS) and modified epidemiology ICDAS code by undergraduate dental students with different clinical experiences.

Material and Methods

This study was approved by the committee for Ethics in Research, Faculty of Dentistry, Universiti Teknologi MARA, Malaysia.

Sample selection and training

A total of 150 dental undergraduate students with different clinical experiences were grouped into 3 groups:

Group 1: no clinical experience (n:50)

Group 2: 1-year clinical experience (n:50)

Group 3: 2 years clinical experience (n: 50)

Participants were introduced to ICDAS criteria in the form of lecture during pre-clinical year, underwent 90 minutes e-learning program and revision of ICDAS. Revision of ICDAS includes photograph assessment and discussion prior to the in-vitro extracted teeth assessment (Figure 1). This sequence of ICDAS training has been used to calibrate undergraduate students, dental clinicians and academics in most dental institutions in Malaysia.

Visual examination and assessment

In vitro visual examination extracted permanent teeth (N= 45) with different location and stages of caries progression ranging from ICDAS scores 0 to 6, was performed using the ICDAS criteria. Prior to the calibration, these extracted teeth were
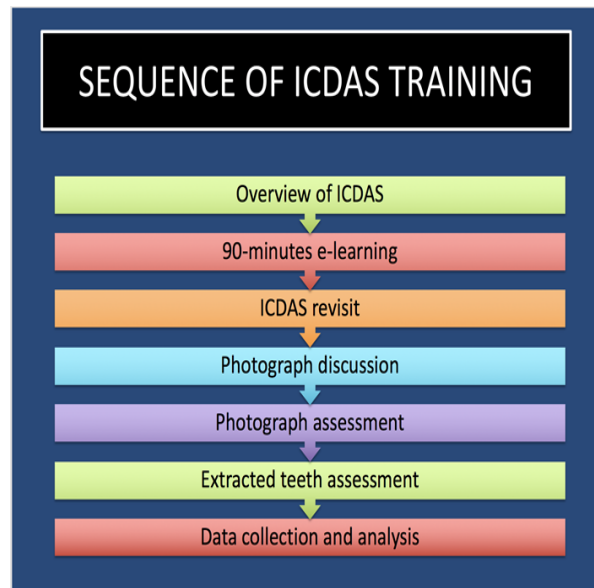

Figure 1: Sequence of ICDAS training. ICDAS training involves a theoretical learning module in the form of lectures and e-learning package, photographic assessment and discussion, in-vitro assessment and data analysis.

labelled and scored accordingly by the National Benchmark Group (NBG) trainers, a consensus between the calibrated NBG trainers was achieved in cases of disagreement. The same sets of extracted was used for each calibration. The examination was guided by black and white photographs of each lesion. A blunt WHO periodontal probe, dental mirror, triple air-syringe, operating light illumination, table of ICDAS codes and a score sheet were provided at each station. The surfaces of each extracted tooth were examined in wet and dry condition. Each examiner was required to score the lesion using ICDAS two-digit code (Table 1) and modified epidemiology ICDAS on the score sheet. Modified epidemiology ICDAS code is a modification of ICDAS caries code 1 and 2, in which it is scored as code A (Table 2). Assessments were repeated one hour after the first calibration to assess the intra-examiner agreement of each individual.

Data management

All data were collected and saved in excel sheets and compared to the scores from NBG. The data were analysed to evaluate inter-examiner and intra-examiner reliability in the form of kappa scores using SPSS 23 Software. Inter-examiner kappa agreement is an agreement between individual and NBG scores, whereas intra-examiner agreement is an agreement between the same individual in the first and second calibration. Both agreement for ICDAS and modified epidemiology ICDAS codes for inter and inter-examiner were calculated.

The inter and intra-examiner kappa agreement were classified into poor, fair,

ICDAS code	Criterion
0	Sound tooth surface: no evidence of caries after 5 s air drying
1	First visual change in enamel: opacity or discoloration (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	Localized 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 1: ICDAS codes and criteria

MOD code	Criterion
0	Sound tooth surface: no evidence of caries after 5 s air drying
A	ICDAS code 1: First visual change in enamel: opacity or discoloration (white or brown) is visible at the entrance to the pit or fissure seen after prolonged air drying
A	ICDAS code 2: Distinct visual change in enamel visible when wet, lesion must be visible when dry
3	Localized 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 2: Modified Epidemiology ICDAS (MOD) codes and criteria

INTERPRETATION OF KAPPA SCORE	
Value	Details
<0.20	poor agreement
0.21-0.40	fair agreement
0.41-0.60	moderate agreement
0.61-0.80	good agreement
0.81-1.00	very good agreement

Table 3: Interpretation of kappa coefficient based on Fleiss and Cohen (1973)

moderate agreement, good and very good agreement (Table 3) based on Fleiss and Cohen (1973) kappa interpretation. Good kappa agreement is achieved when the kappa value is more than 0.61 and moderate agreement is observed when the kappa value is between 0.41 to 0.60.

Results and Statistical Analyses

A total of 150 dental undergraduate students with different clinical experiences (2 years, 1 year and no clinical experience)

underwent ICDAS training and calibration. Students had no experience using ICDAS in vivo for all groups. Each student examined a total of 45 extracted teeth in vitro, 51 surfaces with varying severity of caries lesion ranging from sound to severe caries extension using the two-digit ICDAS and modified epidemiology ICDAS (MOD) code. On examination, 14% (n=7) was sound (ICDAS 0), 24% (n=12) had early enamel demineralisation (ICDAS 1 and 2, MOD code A), 27% (n=14) had moderate caries extension (ICDAS 3 and 4) and 35% (n=18) had severe caries extension (ICDAS 5 and 6).

Inter-examiner agreement was calculated by comparing the results of the benchmark (NBG) scores and the scores of examiners with different levels of experience, using kappa statistics. Inter-examiner agreement for ICDAS code showed moderate agreement with kappa value between 0.41-0.60, in 66% to 70% of students for all groups (Figure 2). Good inter-examiner
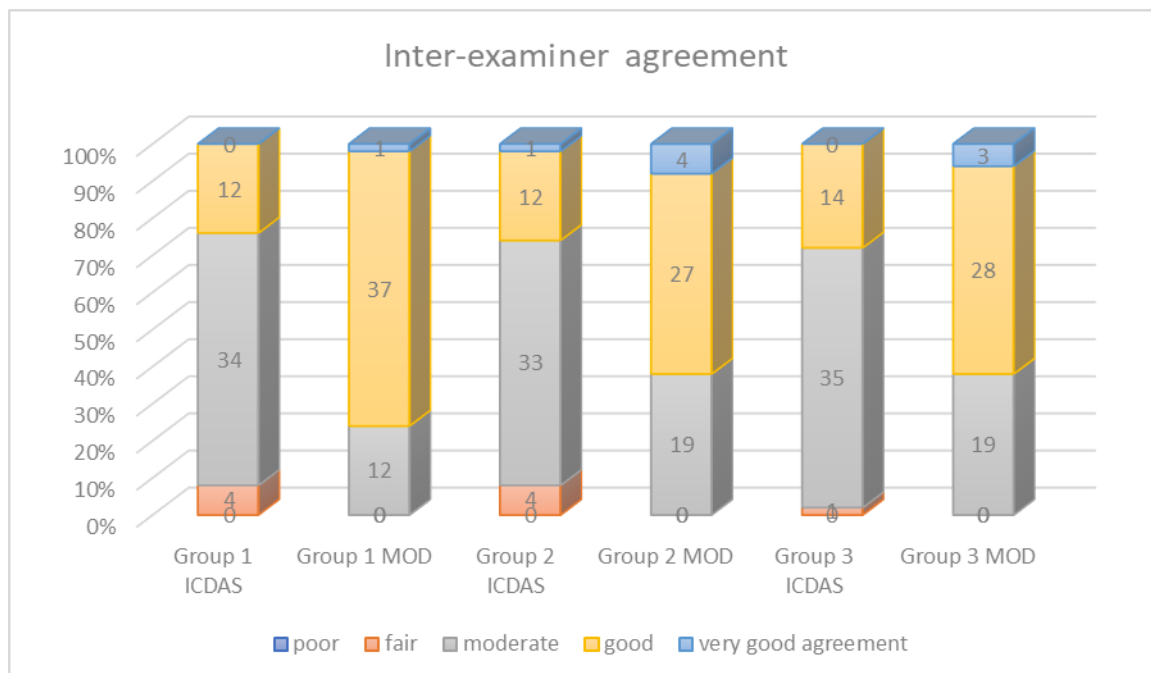

Figure 2: Inter-examiner agreement for ICDAS and Modified Epidemiology ICDAS (MOD)

Mean kappa value for inter-examiner agreement for ICDAS and MOD code were between 0.41 to 0.60 and 0.61 to 0.80 respectively.
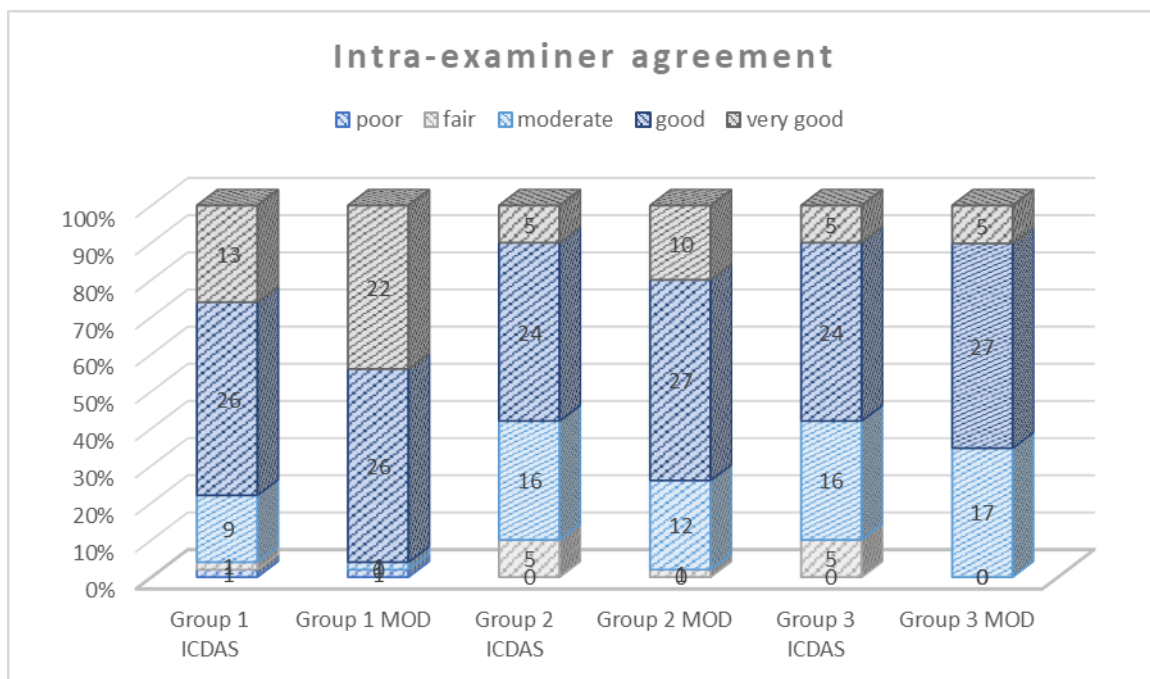
Figure 3: Intra-examiner agreement for ICDAS and Modified Epidemiology ICDAS (MOD). Good intra-examiner agreement with kappa value more than 0.61, was observed in both ICDAS and MOD code for all groups.

agreement (>0.61 kappa value) were reported for modified epidemiology ICDAS code in 76% of group 1 (no clinical experience), 62% of group 2 (1year clinical experience), 62% of group 3 (2 years clinical experience) (Figure 2).

Good intra-examiner agreement was observed in both ICDAS (>58%) and MOD (>74%) codes for all groups. More than 74% students have good agreement in group 3 (2 years clinical experience) and 96% of students with no clinical experience when examining using modified epidemiology ICDAS code (Figure 3). Overall group 1 showed good inter-examiner agreement MOD (76%). Highest percentage of students in group 1 were observed with good intra-examiner agreement in both ICDAS and modified code, 78% and 96% respectively. However, all groups were observed to have moderate agreement (0.41-0.60 kappa value) in detecting caries using ICDAS.

Discussions

Inter-examiner reliability of dental undergraduate students using ICDAS was found to be moderate, kappa value ranged between 0.41 and 0.6. This agreement is slightly lower compared to study reported by Ismail et al. (2007). The reliability of six examiners to classify tooth surfaces by their ICDAS caries status ranged between good to excellent, kappa coefficients ranged between 0.59 and 0.82 (Ismail et al., 2007). A systematic review by Ekstrand et al., (2018) reported reproducibility values were more than 0.60. However, assessment was performed by experienced clinicians in most of these studies.

All groups reported to have moderate agreement using ICDAS, however, good inter-examiner agreement (>0.61 kappa value) was observed when modified ICDAS (MOD) code was used. In modified

epidemiology ICDAS (MOD) code, early enamel caries lesion (ICDAS code 1 and 2) is coded as MOD code A. Students were unable to differentiate ICDAS 1 and 2, when the caries lesion is at enamel level. However, this is acceptable as treatment options for ICDAS 1 and 2 involve preventive or non-operative treatment only. Intra-examiner agreement was higher compared to inter-examiner agreement. Good (0.61-0.80 kappa value) to very good (>0.80 kappa value) intra-examiner agreement was observed for all groups using ICDAS and MOD code. Students who had no prior clinical experience were very consistent in their assessment for both ICDAS and modified epidemiology caries detection.

Overall, mean kappa values for intra- and inter-examiner reliability for ICDAS code, were between 0.41 to 0.60, and 0.61 to 0.80 respectively. Jablonski-Momeni et al. (2012) reported mean kappa values for intra- and inter-examiner reproducibility were between 0.34 and 0.72 for predoctoral dental students. For MOD code, mean kappa values for intra- and inter-examiner reliability were between 0.61 to 0.80. Good intra-examiner agreement (>0.61) was observed in both ICDAS and MOD code for all groups.

Conclusion

Caries detection using ICDAS performed by dental undergraduate students was observed to have moderate reliability for ICDAS codes and good reliability for modified epidemiology ICDAS codes. Good to excellent intra-examiner agreement indicated that this caries detection system has good reproducibility. ICDAS criteria seem to be instinctively understood by students without clinical experience, even though most of these students had never before seen a carious tooth. All students performed similar agreement, therefore, clinical experience within 2 years does not influence the performance of visual inspection in detecting caries using ICDAS. A step by step training and calibration is imperative for students and clinician prior to the use of ICDAS for caries detection in-vivo, on patients. The results of the study shows that the International Caries Detection and Assessment System (ICDAS) and modified epidemiology ICDAS (MOD) code has good reproducibility and is feasible to be used as a tool in clinical practice as well as patient education. This tool can also be used by clinicians with minimal or no clinical experience.

Conflict of Interest/Funding

None declared

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