



## Original Research Article

## Comparison of efficacy of ICDAS, CAST, Nyvad's criteria, SCI and WHO-DMFT in caries identification among six to twelve year old children

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## ABSTRACT

**Aim and Objectives:** The aim of the study was to compare the ICDAS, the CAST, the DMF, the Nyvad criteria and the SCI with respect to their ability in identification of caries in the individuals from six to twelve years of age and also the time required for recording each indices.

**Materials and Methods:** A total of 47 children visiting the hospital were selected and examined. Examination was done in the dental chair with adequate light. Oral prophylaxis was done. Subsequently, examination was performed by the examiner according to DMFT system, ICDAS, CAST, Nyvad's criteria and SCI and the information forms were recorded. Chi square test and one way ANOVA were used for data analysis.

**Results:** In this study, the no statistically significant difference was shown by number of sound teeth. For caries involving enamel, there was statistical difference seen. For caries involving dentin, Distinct/Active Cavity lesions, statistically significant difference was seen. For pulp involvement, statistically significant differences were observed. For, restored teeth, there was statistical difference but missing teeth due to caries did not show any statistically significant difference. The mean time taken to apply the DMF was 1mins 17secs; for ICDAS, 3mins 32secs, for CAST, 3min 30secs, for Nyvad's Criteria, 2mins 34secs and for SCI it took 1min 2secs.

**Conclusion:** A common method for classification of caries identification is ambiguous. DMFT and SCI is the most simple and less time consuming method. ICDAS addresses the all the progressive stages of the caries.

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### 1. Introduction

The basic indication of any diagnostic procedure is to diagnose whether a particular condition is present or not in a subject.<sup>1</sup> Even though incredible changes were noticed about the prevalence and extent of oral health conditions, dental caries pursue to be the most widespread oral disease and major public oral health issue.<sup>2</sup> So, modifications of the preventive and therapeutic approaches are required. Hence, it begins with properly assessing the existence and severity of the lesion.<sup>1</sup> Caries risk patients can be identified when an accurate caries detection and classification is

used and it also helps in identification of enamel lesions detection. According to which a non-operative treatment can be planned.<sup>1</sup>

A various data collection methods have been proposed in recent years to identify caries in individual and group.<sup>1</sup> The methods such as International Caries Detection and Assessment System (ICDAS), Decayed-missing-filled (WHO-DMFT), Caries Assessment Spectrum and Treatment (CAST), Specific Caries Index (SCI) and Nyvad Criteria are used recently and mostly.

The Decayed-Missing-Filled (DMF) is the most common method used for assessing and measuring dental caries prevalence among population. The method was developed by WHO. The diagnostic criteria for the decayed tooth

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component (D/d) in the DMF method is cavitated dentine lesion.<sup>3</sup> The pre-cavitation stages are excluded from the measurement of the caries lesion. The advantage of this method is easy to apply and has a high level of reproducibility.<sup>3</sup>

In 2001, The International Caries Detection and Assessment System (ICDAS) were developed. It allows clinicians to measure different stages of caries lesion. ICDAS II was developed in 2009.<sup>4</sup> The ICDAS is a two digit coding method; for caries, first digit denotes the surface condition and second denotes the caries progression. Treatment needs are not included in this criteria.<sup>5</sup>

The Caries Assessment Spectrum and Treatment (CAST) instrument was developed combining both ICDAS II and WHO-DMFT methods.<sup>6</sup> The CAST method codes for sound teeth, sealant, restoration, and also different stages of caries progression. It is used both surface as well as tooth level. Severity of the lesions determines the code.<sup>7</sup>

The Nyvad Criteria was proposed in 1999.<sup>8</sup> Based on a visual–tactile caries classification, it enables in the detection severity of caries lesions and the activity. The caries is classified into nine stages: Non cavitated to cavitated and sound to active or inactive.<sup>9</sup>

The Specific Caries Index (SCI) was proposed by Acharya in 2006. It is used along with the DMFS index. It is based on the G.V.Black's classification of caries. Quantitative and qualitative data about caries location, prevalence, and type of caries lesion in an individual can be obtained using this method. The SCI score for an individual is calculated by adding the individual tooth scores.<sup>10</sup>

The disadvantage of DMFT is that it underestimates the occurrence of lesions even though it is the fastest method to apply. But, ICDAS is high time consuming criteria; it provides detailed information on severity of caries. CAST can be used to obtain information about disease distribution, lesion severity and preventive.<sup>1</sup> In the study conducted by Acharya, SIC index has shown good reliability and validity.<sup>10</sup>

The previous studies has been conducted either in primary or permanent dentition. Therefore, this study was conducted to compare the ICDAS, the CAST, the DMF, the Nyvad criteria and the SCI with respect to their ability in identification of caries in the individuals from six to twelve years of age and also the time required for recording each indices.

## 2. Materials and Methods

This study was conducted at Department of Paedodontics and Preventive Dentistry at Yenepoya Dental College.

47 children from Mangalore in the age group of 6-12 years visiting department of Pedodontics, Yenepoya dental college was selected. Prior to the commencement of the study, signed consent forms were collected from parents, followed by clearance from the ethical committee (Protocol

number: YEC2/397).

Examinations were performed on a dental unit under adequate light conditions. Before evaluation oral prophylaxis was done in all children to remove calculus and plaque. Then clinical examination was done using a mouth mirror and WHO probe to detect caries lesion. While using ICDAS method, compressed air syringe was used to dry the tooth. For Nyvad Criteria, an explorer was used to assess the lesion surface. Examination began in the following order; first the posterior most right maxillary teeth then left maxillary teeth, and then left mandibular teeth and finally right mandibular teeth. The time spent for each assessment method was calculated, from the first noted code to the last recorded code. The mean time spent for carrying out all examinations of each method were calculated and compared.

For the WHO-DMFT, a tooth was recorded as decayed only if a cavity had a softened floor and wall; all pre-cavitated caries stages were considered sound.

For the ICDAS, the two-digit codes for each tooth surface were recorded: first digit represents the tooth surface condition and the second digit represents, for the caries stage assessment. (Table 1 and Table 2)

For the CAST, among ten codes was recorded. (Table 3)

For the Nyvad Criteria, coding was based on the tooth surface condition. Lesion considered as active when gentle probing of enamel is dull and rough, on the other hand it is considered as inactive when the lesion appears glossy and smooth on probing (Table 4).

For the SCI, all teeth were recorded and were given score from 0 to 6 according to the site of involvement of caries. (Table 5)

All the outcomes were recorded for each caries measurement method of all 48 children in separate recording sheet. Descriptive statistics were calculated. For all analyses, tooth will be considered as the unit. The maximum value recorded per tooth was considered at the surface level.

Examination outcomes were recorded in excel sheet. SPSS was used for statistical analysis. All the data were presented in tabular forms. The statistical comparison of mean difference between the 5 caries measurement methods was done using one-way ANOVA / Chi Square test.

## 3. Result

The sample consisted of 47 children (53.19% males and 46.80% females, age range 6–12 y).

The sample distribution regarding tooth conditions according to the, ICDAS, WHO-DMFT, CAST, Nyvad Criteria and SCI is shown in Table 6. The percentage of sound teeth recorded using the five methods was not statistically significant ( $p > 0.05$ ), with the SCI showing the highest value (75%) and the ICDAS the lowest (69.56%). Statistics regarding distinct/active lesions were compared

**Table 1:** ICDAS codes according to the dental conditions

Code	Code Definition
Code 0	Unfilled and unsealed tooth
Code 1	Sealant applied but all pits and fissures are not covered
Code 3	Sealant applied and all pits and fissures are covered
Code 4	Amalgam restoration
Code 5	Stainless steel crown
Code 6	Porcelain or veneer crown or PFM
Code 7	Lost or fractured restoration
Code 8	Temporary restoration
Code 9	Tooth is missing or has a certain condition
	The tooth surface is not examinable
	<b>96</b> because of poor accessibility or convenience
	<b>97</b> The tooth is lost due to caries
	<b>98</b> The tooth is lost due to reasons other than caries
	<b>99</b> Unerupted tooth

**Table 2:** ICDAS codes for determination of the condition of each individual tooth

Code	Code Definition
Code 0	Sound
Code 1	First visual change in enamel (whitespot seen after 5 seconds of air drying)
Code 2	Distinct visual change in enamel (whitespot seen without air drying)
Code 3	Localised enamel breakdown due to caries with no visible dentin
Code 4	Non- cavitated surface with underlying dark shadow from dentin
Code 5	Distinct cavity with visible dentin
Code 6	Extensive distinct cavity with visible dentin. An extensive cavity involves atleast half of a tooth surface and possibly reaching pulp
Code 7	Tooth extracted because of caries
Code 8	Tooth extracted for reasons other than caries
Code 9	Unerupted tooth

**Table 3:** CAST index codes and criteria

Characteristics	Code	Description
	<b>0</b>	Sound – no visible evidence of a distinct carious lesion is present
<b>Sealed</b>	<b>1</b>	Sealed – pits ad fissures have been at least partially sealed with a sealant material
<b>Restored</b>	<b>2</b>	A cavity has been restored with an indirect restorative material currently without a dentine carious lesion and no fistula / abscess present
<b>Enamel</b>	<b>3</b>	Distinct visual change in enamel. A clear carious related discolouration (white or brown in colour) is visible, including localized enamel breakdown without clinical visual signs of dentine involvement
<b>Dentine</b>	<b>4</b>	Internal caries-related discolouration in dentine. The lesion appears as shadows of discoloured dentine visible through enamel which may or may not exhibit a visible localized breakdown
	<b>5</b>	Distinct cavitation into dentine. No (expected) pulpal involvement is present
<b>Pulp</b>	<b>6</b>	Involvement of pulp chamber. Distinct cavitation reaching the pulp chamber or only root fragments are present
	<b>7</b>	Abscess/ Fistula. A pus containing swelling or a pus releasing sinus tract related to a tooth with pulpal involvement due to dental caries is present
<b>Lost</b>	<b>8</b>	The tooth has been removed because of dental caries
<b>Other</b>	<b>9</b>	Does not match with any of the other categories

**Table 4:** Nyvad's criteria

Code	Code definition
0	Sound
1	Active caries (intact surface)
2	Active caries (surface discontinuity)
3	Active caries (cavity)
4	Inactive caries (intact surface)
5	Inactive caries (surface discontinuity)
6	Inactive caries (cavity)
7	Filling (sound surface)
8	Filling + active caries
9	Filling + inactive caries
X	Extracted because of caries

**Table 5:** SCI

Code	Code definition
0	No carious lesion detected
1	Carious lesion occurring on the occlusal, buccal pits and fissure of molars and premolars and the lingual pits of the anterior teeth
2	Proximal caries affecting the molars and premolars
3	Carious lesion situated on the proximal surface of the anteriors and not involving the incisal edge
4	Carious lesion situated on the proximal surface of the anteriors, involving the incisal edge
5	Carious lesion situated on the cervical region of the tooth
6	Carious lesion situated on the occlusal cusp tips of molars and premolars and on the incisal edge of incisors
6A	Grossly decayed tooth / root stumps indicated for extraction

**Table 6:** CHI-square test

Tooth conditions (n=1104)	DMFT n%	ICDAS n%	NYVAD'S n%	CAST n%	SCI n%	$\chi^2$ p value
Sound	70.61	69.56	70.01	70.2	75	0.98 <sup>^</sup>
Enamel opacity	-	0.27	-	-	-	0.016
Enamel Active	-	0.72	3.17	-	-	0.000
Enamel inactive	-	-	0.90	-	-	0.404 <sup>^</sup>
Active discontinuity	-	7.24	4.52	6.61	-	0.000
Grey shadow	-	2.44	-	2.71	-	0.003
Distinct cavity	21.01	9.05	14.13	9.51	22.28	0.008
Inactive discontinuity	-	-	-	-	-	0.289 <sup>^</sup>
Inactive cavity	-	-	1.26	-	-	0.077 <sup>^</sup>
Pulp involvement	-	4.98	-	5.52	-	0.000
Filling	4.61	3.98	4.8	4.25	-	0.047
Missing teeth	3.71	1.26	-	1.26	2.53	0.207 <sup>^</sup>
Sealants	-	0.27	-	0.45	-	0.520 <sup>^</sup>

<sup>^</sup> - not significant,  $p < \alpha$  – Significant,  $p > \alpha$  – NOT Significant ( $\alpha = 0.05$ )

among, the ICDAS, the CAST, the Nyvad Criteria, the WHO-DMFT and SCI; the values measured using the five methods were statistically significant ( $p < 0.05$ ), with the SCI the highest (21.01%) and the ICDAS and the CAST showing the lowest (9.05% and 9.51%, respectively). Statistically significant differences were observed for lesion involving pulp. Details about fillings showed statistical difference but missing teeth for caries did not show any significant difference. The presence of sealant showed no statistically significant difference among the five methods.

#### 4. Discussion

The goal of Caries scoring method is recording standardized, consistent data by evaluating the tooth condition and it provides information that may be useful for researchers, epidemiologist and clinicians.<sup>11</sup>

Nowadays, carious lesion management is based on a non-operative approach;<sup>12</sup> therefore, the caries detection criteria that include early injuries and non-cavitated lesions will be of greater advantage, especially when it is used in populations with low prevalence of the disease.

**Table 7:** Mean application time

Statistics	DMFT	ICDAS	NYVAD	CAST	SCI
Mean	1mins 17secs	3mins 32secs	2mins 34secs	3mins 30secs	1min 2secs
Standard deviation	17.82secs	34.09secs	25.94secs	28.69secs	12.68secs

With regards to the application time, the fastest method was the SCI, with a mean application time of  $62 \pm 12$ secs, while for the ICDAS it was  $212 \pm 34$ secs, for the CAST  $210 \pm 28$ secs, for the WHO-DMFT  $77 \pm 17$ secs, for the Nyvad Criteria  $154 \pm 25$ secs and for the SCI it was  $62 \pm 13$ secs.

The methods used in this study were proposed for different objective in distinct years and they have different strengths, weakness and used in same context.

WHO-DMFT is the most used and preferable method in epidemiological surveys because of its simplicity and limited time-consuming application.<sup>13</sup> This index has a drawback such as it does not record the early white spot lesions,<sup>14</sup> No specific codes for recording enamel lesions, difficulty in differentiating caries lesions in dentin that can be restored,<sup>15</sup> it doesn't provide any data about the caries stage, restoration used and penetration depth of the tooth. It only reflects a number that denotes the surfaces or teeth which are decayed, missed, or filled.

The ICDAS method has great advantages, which includes high accuracy rate, since the coding is based on the lesion's various stages, it helps the clinicians and researchers to differentiate the different stages of the caries process.<sup>1</sup> It is clinically reliable in permanent teeth and also valid in primary teeth. It was put forward to detect various stages of carious Sequelae. It also proved reliable for use in clinical trials where the effectiveness of carious control agents was evaluated. According to the study conducted by Diniz et al. in 2009 concluded that ICDAS has good precision and reproducibility in detecting occlusal caries.<sup>16</sup> Shoaib et al. 2009 concluded that ICDAS has a reliable validity and reproducibility when used for primary molar teeth.<sup>17</sup>

The CAST applies to all stages of enamel lesions.<sup>18</sup> The only purpose of CAST index is that it is used in epidemiological study. According to the study conducted by De Souza AI in 2014 to investigate CAST index validity and concluded that the cast index can be effectively used in epidemiological studies.<sup>15</sup> Limitation of the CAST is that it does not address the lesion activity.

Nyvad's criteria are the first classification system for determination of lesion activity. Each score depicts assessment of different lesion activity. The Nyvad Criteria method is useful in order to control the activity of the disease in high risk patients and it also helps clinicians to decide the most appropriate treatment plan. The method might be a supportive tool for evaluating and planning population-based preventive programs.<sup>16</sup>

SCI was proposed with an objective provide quantitative and qualitative information about dental caries. It gives data regarding the location and type of caries lesion on clinical examination. It gives the same criteria for caries detection as that of DMF. Drawback of this criterion is its inability to

provide data useful for treatment planning and also, the lack of information for assessing root caries.<sup>10</sup>

Comparing the five methods is not simple, since their different scores regarding both the restoration given and the lesion stage. For example, score for the absence of the lesion (sound tooth), data show a difference in the number but not statistically significant this may be credited to the small population. This result was acceptable, as the WHO-DMFT considers pre-cavitated stages of the caries lesions as sound, while they are considered as affected in the other methods.<sup>6</sup>

Nowadays, the non-invasive procedure is considered as the best clinical treatment for child, so planning at early stage for caries prevention is necessary and the index can provide a valuable source for deciding the plan. Therefore, assessing the lesion only at a dentinal cavitated stage (the WHO-DMFT method) can be prevented.

The caries progression rate is not yet estimated by any method; but, the activity of the lesion is included in Nyvad Criteria, it reflects the demineralisation, which can be used as substitute lesion progression.

According to the application time, ICDAS and CAST were more time-consuming and laborious in nature than other methods. This may be due to the fact that ICDAS was the only methods in which caries lesions were detected in enamel after drying the teeth. The SCI method showed a lesser time may be due to its criteria of noticing the site of the caries only and giving a score to the tooth.

The limitation of this study is that only small population was selected. The age group mostly represented a mixed dentition period, where a false scoring is possible. For instance, a 2<sup>nd</sup> primary molar with caries and pre-shedding mobility in child of age 11 is indicated for extraction, which means it's the 'M' component of DMF index but in other methods it goes for a caries score, which means the caries prevalence will be different if more tooth is present with same findings in different indices used.

One of the strengths of the present study is that it provides an insight into the caries prevalence in the age group of 6-12years using 5 different methods of caries index and also an idea about using of preferred method for different instance.

## 5. Conclusion

From the outcomes of the present study we come to conclusion that a common language for caries detection

is ambiguous especially when the comparison is made and that too in mixed dentition period. A certain amount of similarity is present among all the method. Important factors to be considered by clinician and researchers are severity and activity of caries lesion. A common method in caries identification is important when different methods are compared.

## 6. Source of Funding

None.

## 7. Conflict of Interest

The authors declare no conflict of interest.

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