Original Article

Reliability of Caries Assessment Spectrum and Treatment Tool in the Indian Subcontinent

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ABSTRACT

Background: Accurate diagnosis, reporting of caries and its consequences, is absolute mandate for planning an efficient, effective community health-care program. Literature reports indicate shortcomings of existing caries assessment tools. Caries assessment spectrum and treatment (CAST) is novice caries quantification tool, which quantifies the entire spectrum of carious lesions. This tool records give an insight into the status of restorations along with various progressive developmental stages of dental caries. This instrument has been validated for face, content, and construct by an expert group, and currently, its usage is on the rise. **Aim:** The aim of this study was to report the reliability of this assessment tool with regard to the primary and permanent dentition of school children and adults belonging to a south Indian district. **Materials and Methods:** A cross-sectional study was carried out by two trained and calibrated examiners by examining 192 school children in the age-group between 4 and 6 years and 262 adults between 19 and 69 years. The study sample was reexamined by the same examiners after a gap of 4 weeks. The κ coefficient values and percent of agreement were calculated for the data recorded from the study subjects. **Results:** The analyzed data showed moderate intra-examiner and inter-examiner reproducibility for either of the dentition as revealed by κ coefficient values (0.80–0.89). Inter- or intra-examiner agreement was found to be substantial to almost perfect (percent agreement above 90%) with respect to both the age-groups. **Conclusion:** The CAST tool seems quite promising to be the future for quantifying caries spectrum for a community or an individual.

KEYWORDS: *Caries assessment spectrum and treatment, caries epidemiology, dental caries, reliability studies*

INTRODUCTION

Dental caries has been recognized by the United Nations as a major health concern, as it causes pain, suffering, and affects the quality of life of an individual or a community.[1,2] However, considerable decline in the prevalence and severity of dental caries in many countries, coupled with changes in caries epidemiology, has presented challenges to the diagnosis or detection of carious lesions.[3-6]

In light of these current developments, measuring carious lesions at the dentine level does not hold any credibility and understandably; the decayed missing filled teeth index,[7] which quantifies a decayed tooth at the dentin level, is now considered to be outdated in its approach.

To address the emerging challenges, a new pragmatic and reliable instrument for use in epidemiological

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surveys was developed and named as the caries assessment spectrum and treatment (CAST), which covers the complete range of carious lesions: from no carious lesions to the advanced stages of dental caries.[8,9] The CAST tool has been designed keeping in mind the perceived drawbacks of the International Caries Detection and Assessment System[10] and the pulpal ulcerative fistula abscess index.[11]

The CAST instrument has been validated for face and content by a group of 56 epidemiologists from 24 countries, using the e-Delphi consensus method.[12]

An instrument should be valid and reliable for use in epidemiological surveys. The CAST tool had been validated for face and content by a group of 56 epidemiologists from 24 countries.[13] The reliability of the instrument is dependent on its reproducibility, and it had been assessed by de Souza *et al.*[14] among a Brazilian population with three different age-groups.

The CAST tool had been used by other research groups in the recent past to assess the caries spectrum among those specified groups, with only the intra-examiner variability probed by reexamining approximately 5%–10% of the sample.[15-19]

The need of the hour is that this tool should be reliable with respect to different population subgroups with varying CAST codes, and thus considering the dearth in the literature, this study was devised to assess the reproducibility of the CAST tool among a section of school-going children and adults belonging to a district in the southern part of India.

MATERIALS AND METHODS

The dental public health unit of this institute had recently launched a screening-cum-awareness campaign mainly targeting the adult population and the school-going children in the district of Nalgonda, Telangana, India. The mobile dental services unit had to play a major role in the implementation of this enormous task, which obviously had to be carried out in a systematic and a phase-wise manner. The idea of testing the reproducibility of the CAST tool was feasible due to the very nature of the program. The ethical clearance to carry out this study was obtained from the institutional ethics committee of Kamineni Institute of Dental Sciences, Nalgonda, Telangana, India, and prior approval was obtained from the local health authorities (Ethical Approval Certificate No.: KIDS/IEC/43/B/17) after submitting the details of the screening campaign and the study details. This cross-sectional analytic study was conducted in pragmatic conditions relevant to fulfill its objectives.

The study population consisted of adults and school children in the age-group between 19 and 60 years and 4 and 6 years, respectively, who form the ideal population for recording CAST variables with respect to permanent and primary dentition. As a part of the campaign, two government schools and a local municipality ward of a rural town were selected from the list of schools and wards obtained from municipal authorities using Excel software, Microsoft excel spreadsheet, Office 365, which generated random pairs to be a part of the study. Written consent was obtained from every individual and from the guardians of the school children before the start of the study, by explaining the specifics of this scientific investigation. Unwilling subjects and nonresidents of study area were excluded from the study. The study was conducted in accordance to the guidelines laid down by the World Medical Association and the Declaration of Helsinki.

The CAST tool records the entire caries spectrum from no caries, to restorations, presence of enamel and dentine caries lesions, and the complications of untreated caries as well. The teeth, which are missing due to caries, are also recorded in this assessment. Each tooth in the oral cavity was examined for the presence of these codes, and only a single code was assigned to each tooth.

EXAMINER TRAINING AND CALIBRATION

Two graduate students were chosen to carry out the reliability assessment of the CAST tool [Table 1]. They were initially put through theoretical classes, which highlighted the salient features of the assessment tool. They were encouraged to discuss doubts or any discrepancies that propped up within their minds, which were appropriately addressed. Later on, a set of high-resolution photographs, which corresponded to the various CAST codes, was displayed to these two examiners.

With the training session completed, the onus shifted on to the calibration exercise. The examiners clinically examined a set of 30 school children and adults within the dental clinics of the institute. Care was taken to ensure that these subjects belonged to the very same town, wherein the actual study was carried out. The κ coefficient for the inter-examiner agreement was calculated to be 0.81. On the basis of these values, effect size of 20% (*t* test for κ value differences at 95% confidence interval and 80% power) was determined, and using G*Power software, G Power software version 3.1.9.2, a minimum sample size of 196 per group was ascertained, which was rounded off to 250 per group to account for attrition (20%).

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

Table 1: Codes and description of the caries assessment spectrum and treatment instrument in a hierarchical order[17]

The examination of the school children was carried out within their respective school premises with the help of portal dental chairs and associated diagnostic kits. Mouth mirrors and community periodontal probes were used to ascertain the status of each tooth according to the CAST criteria. A specially designed form was filled up by the assistants to help the examiners for conducting the proceedings in a systematic way. A high degree of emphasis was laid on the disinfection protocol to protect the study subjects and the examiners from cross infection. This very cohort of school children was later reexamined after a gap of 4 weeks by the same examiners.

The oral health campaign aimed at the adult population was carried out in the early hours of the morning so as to include participants in the working age-group and the college-going students. The clinical examination of the adults was carried out in the mobile dental units, with the examination pattern as set out by the CAST criteria. The reexamination of the same set of adults was carried out after 5 weeks.

STATISTICAL ANALYSIS

Data were analyzed using the Statistical Package for the Social Sciences (IBM, Chicago, Illinois) software, version 20.1 for Mac. Descriptive statistics were drawn from collected data. The κ statistics was calculated to determine reliability. For examination and scoring, the mouth was divided into four quadrants—upper right (51–55 for children and 11–18 for adults), upper left (61–65 for children and 21–28 for adults), lower right (81–85 for children and 41–48 for adults), and lower left (71–75 for children and 31–38 for adults). The examiner examined all the teeth and identified the highest score for each quadrant and gave the final score according to CAST instrument. For each case examined, four scores

were generated. Each quadrant was then determined as "non-cavitated" versus "cavitated" (codes 0–3 vs. 4–9) teeth. Score 0 was given for CAST codes 0–3 and score 1 for CAST codes 4–9. Inter- and intra-examiner reproducibility was calculated based on these scoring. Agreement was calculated for CAST codes 0–9 by determining the two sets of categories. The reproducibility of the CAST instrument with the primary and the permanent dentition was assessed with the inter- or intra-examiner consistency test, the percent of agreement, and with the unweighted κ coefficient scores.

RESULTS

Analyzing the data obtained from the primary dentition [Table 2], the prevalence of the enamel carious lesions (code 3) was found to be 0.34%, and the prevalence of the dentin carious lesions (codes 4–6) was found to be 17.95%. With the permanent dentition, the prevalence of enamel carious lesions and dentin carious lesions was 0.35% and 32.23%, respectively. The κ values for the intra-examiner agreement with respect to both the dentitions were greater than 0.80, with a very high percent of agreement observed in between the examiners in either dentitions [Table 3].

DISCUSSION

This cross-sectional study was attempted to assess the reliability factor, which is the consistency or the repeatability of the measurements taken by the tool under consideration. There was a variation in which the data had been analyzed as compared to the earlier work on the reproducibility of this instrument.[14] The mouth had been divided into four quadrants, with each quadrant labeled as cavitated or non-cavitated based on the highest CAST code marked for that respective quadrant.

Table 2: Number of tooth examined with caries assessment spectrum and treatment instrument

CAST code			CAST code		
Primary dentition	**N**	**%**	**Permanent dentition**	**N**	**%**
0	1964	55.79	0	2821	40.79
1	0	0.00	1	0	0.00
2	320	9.09	2	730	10.55
3	12	0.34	3	10	0.35
4	87	2.47	4	123	4.36
5	320	9.09	5	1810	26.17
6	503	1.28	6	702	1.77
7	82	2.32	7	250	3.61
8	232	6.59	8	469	6.78
9	0	0.00	9	0	0.00
Total	3520	100	Total	6915	100

Table 3: Intra- and inter-examiner consistency test of assessing primary and permanent dentition at quadrant level with the caries assessment spectrum and treatment instrument (0–9)

Inter rater reliability	Primary dentition				Permanent dentition			
	N	**κ**	**SE**	**Po (%)**	**N**	**κ**	**SE**	**Po (%)**
Intra-examiner								
Examiner 1	768	0.81	0.06	91.0	1040	0.82	0.12	99.0
Examiner 2	768	0.89	0.08	93.0	1040	0.87	0.15	99.0
Inter-examiner								
Examiner 1 versus 2	768	0.80	0.05	92.0	1040	0.78	0.12	95.0

Po = percent of agreement, SE = Standard error

The κ statistics are primarily used to determine the reproducibility of a diagnostic tool, and this investigation entailed the use of unweighted κ scores as the codes of this tool are categorical in nature. The κ coefficient values are not only affected by the unit of analysis but also on the prevalence of the disease of interest. It is precisely the reason why the κ coefficient values cannot be compared between different population subgroups.[20]

It has been recommended to report the information about systematic disagreements among examiners, homogeneity of the sample, and bivariate symmetry in misclassification along with the κ coefficient values.[21] These recommendations could not be adhered to because of the lack of a gold standard or a benchmark examiner. It would be prudent to recollect the methodology of this investigation, wherein two inexperienced examiners were trained and calibrated to assess the carious spectrum of the sample.

To the best of our knowledge, this is the second scientific study, which has assessed the reproducibility of the CAST instrument on a sizable sample, and probably, the first of its kind in the Indian subcontinent.

Analyzing the results obtained, the strength of agreement within both the examiners and the inter-examiner agreement was found to be almost perfect in the primary dentition. With the permanent dentition, the inter-examiner agreement was substantial, thus calling for a more rigorous calibration exercise for any such examinations in the future.[22]

Reliability is the process that signifies the repeatability of the instrument. Addressed in simpler terms, it is the ability of the tool to harvest similar results at different intervals of time.[23] The proponents of the CAST instrument had initially carried out the reproducibility test on a section of Brazilian children or mothers and concluded that inter- or intra-examiner agreement was substantial to almost perfect with respect to both the age-groups.

At this juncture, the results of both these studies look very promising, but it is precisely at this stage, the extrapolation of the study results hit a roadblock. Analysis of the caries spectrum indicates a low prevalence of dental caries among the study subjects in both these studies, and as stated earlier, the κ coefficient values are dependent on the prevalence of the disease. This could easily be a drawback of this study, although nothing much could be conducted with the design of the study.

CONCLUSION

With inputs from the examiners and from the analysis of the data in this investigation, we can conclude that the CAST tool is a convenient-cum-reliable tool for

assessing the carious spectrum, but a sample with a higher caries experience has to be selected to establish the reproducibility of this tool once and for all.

CONFLICTS OF INTEREST

There are no conflicts of interest.

AUTHORS CONTRIBUTIONS

All the authors of this manuscript have contributed towards this manuscript and have in principle, approved the final contents of this paper to be published. Sreenivas Voruganti: study conception, data collection and interpretation. Praveen B. Haricharan: data analysis, manuscript writing, and data collection. Durga P. Mudrakola: manuscript revision and critical analysis of the content. Neeraja Turagam: manuscript writing and critical analysis of the content.

ETHICAL POLICY AND INSTITUTIONAL REVIEW BOARD STATEMENT

This study has been approved by the Institutional Review Board of Kamineni Institute of Dental sciences (Board approval number: KIDS/IEC/43/B/17) and has been conducted according to the guidelines laid down by the Declaration of Helsinki 1964.

PATIENT DECLARATION OF CONSENT

Appropriate written consent has been obtained from the study subjects prior to the clinical examination. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

DATA AVAILABILITY STATEMENT

The data used to support the findings of this study are available from the corresponding author upon request.

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