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Dental Caries Risk Assessment among Subjects with Congenital Heart Disease Using Cariogram Study Model

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Abstract

Background: The purpose of this study is to assess caries risk and identify related factors among children with CHD, using Cariogram® computer study model.

Materials and Methods: A descriptive cross-sectional study was carried out among 30 children aged 3-12 years who were categorized as cases and controls based on inclusion criteria. Data were collected using the specially designed proforma. For all the study subjects, caries related factors required for building Cariogram® were assessed, followed by individual caries risk assessment (CRA).The collected data was subjected to multiple logistic regression analysis to determine the caries risk factors which were significantly associated in CHD.

Results: According to the Cariogram®, CHD children constituted a high caries risk category compared to age and gender matched controls with an average overall caries risk of 68% and 26% respectively.Plaque amount and diet frequency were found to be the caries risk factors which were significantly associated in CHD children when compared to age and gender matched controls.

Conclusion: Performing CRA, identifies the exact risk factors in CHD children and helps to individualize the prevention and treatment strategies in such children. Using Cariogram® CRA tool, which easily and near accurately evaluates the caries risk profile , it was found in this study that plaque amount and diet frequency were the significant caries risk factors in CHD children thus emphasizing the importance of dietary counseling and oral hygiene maintenance at an early age itself for such children.

Keywords: Caries risk assessment, Congenital heart disease, Cariogram®, *Streptococcus Mutans*

Introduction

Congenital heart disease (CHD) which refers to the structural or functional heart diseases present at birth is the most common group of congenital anomalies in children with an incidence of approximately 6-8 per 1000 live births.[1] Various studies done worldwide have proved that children with CHD are associated with high caries prevalence, more untreated caries, lower frequency of regular dental care and late caries intervention when compared to healthy children.[2] Poor oral hygiene in CHD children may give rise to frequent bacteraemia and also treatment of dental caries is a prerequisite for cardiac surgery.Caries risk assessment tools can aid in the identification of reliable predictors and thus allow dental practitioners, physicians and other non-dental health care providers to become more actively involved in identifying and referring high caries risk children.[3] One such tool Cariogram® is a software program which demonstrates the multi-factorial background of dental caries ,expresses the percentage of risk due to each etiological factor, total risk and offers recommendations for preventive measures that should be adopted to avoid the formation of new caries. The overall increased vulnerability of the cardiac child to stressful dental treatment procedures due to limited cardiac output, increased risk of general anesthesia and risk of prolonged bleeding when on anticoagulants, emphasizes the need for caries preventive strategies. Caries-risk assessment instruments like Cariogram® provides the clinician with an individualized direction to determine appropriate preventive and therapeutic measures.[4] Thus the purpose of this study was to assess and compare the caries risk and related factors among children with and without CHD.

Materials and Methods

Study design and settings: This was a cross-sectional study, in which a group of children with CHD having dental caries was compared to a group of children without CHD having dental caries. A total of 60 children participated in the study. The participants were divided into two groups: a group of 30 children of age 3-12 years diagnosed with CHD who visited the Cardiology outpatient department of MS Ramaiah Medical College, Bangalore, India and a comparison group of 30 age and gender matched healthy children without congenital heart disease having dental caries who visited the Department of Pedodontics of MS Ramaiah Dental College and Hospital, Bangalore, India. Ethical clearance from the institutional ethics committee was obtained prior to the start of the study. Convenient sampling method was used to select the sample group as per the inclusion and exclusion criteria after obtaining the required informed consents.

Inclusion and Exclusion Criteria

In the CHD group, children diagnosed with CHD having Decayed Missing Filled teeth index (DMFT/deft) one or greater than one, who have not undergone any cardiac surgery were included. Children with any other concomitant diseases or syndromes apart from CHD and severely ill children who were not able to cooperate for the examination were excluded.In the control group, age and gender matched children without CHD and with DMFT/deft one or greater than one were included.

Caries risk assessment

Cariogram® was used for caries risk assessment of both groups and the caries related variables were assessed as following:-

1. **Caries experience:** By recording DMFT/dmft-All selected children were clinically examined for dental caries by a single pedodontist utilizing the WHO criteria (1997) for diagnosis of dental caries. The

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examination was carried out using mouth mirrors, CPI probe under natural light/torch as per the guidelines of American Dental Association for Type 3 examination. A trained assistant recorded the findings on data collection forms. Clinical data for caries detection was collected based on the criteria developed by WHO (1997).

2. **Plaque amount:** Plaque index by Silness P and Loe H, 1964 was used to assess plaque amount as instructed in the Cariogram®. Dental examination of all study subjects was carried out by a single pedodontist using mouth mirror and CPI probe.
3. **Related diseases:**The structured interview included questions about any related general diseases other than congenital heart disease.
4. **Salivary secretion:**Unstimulated salivary flow rate per minute was assessed. The subject was asked to relax for a couple of minutes before the saliva collection. To collect unstimulated whole saliva, the patient was asked to sit in bent forward position and to drool saliva passively into the collection tube for 5 minutes (Figure-1).
5. **Salivary buffering capacity:**Buffering capacity of the collected saliva was determined by measuring the pH using electronic pH meter (Figure-2).
6. **Diet Content:**Lactobacilli count, which helps determine the dietary contents, was determined by Rogosa agar culture method.
7. ***Streptococcus mutans* count:** *Streptococcus mutans* count was assessed by culture using Mitis Salivarius Bacitracin (MSB) agar method (Figure-3).
8. **Diet frequency:**Structured interview of the parent/ caregiver included questions on the number of dietary intakes per day which helped determine dietary frequency.
9. **Fluoride programme:** Structured interview also included questions on the modes of fluoride exposure used by the study subjects.

The collected data was entered into a proforma, following which the scores obtained were entered into the Cariogram® computer program for caries risk assessment. The scores of each of these nine factors which ranges from 0 to 3 (Table-1) have to be entered to the Cariogram® computer program to create an individual's caries risk profile .The weighting for the various factors are based on thorough literature searches and evaluation of results of a large number of publications. The Cariogram® calculates the individual risk of future carious lesion development and represents the risk as a pie diagram. Sectors of the diagram are: Red sector representing BACTERIA (plaque amount and mutans streptococci level), dark blue sector for DIET (lactobacillus level and diet frequency), light blue sector for SUSCEPTIBILITY related factors (fluoride programmes, saliva secretion and buffering capacity) and yellow sector for CIRCUMSTANCES (caries experience and medical history). The green sector which is remaining represents the CHANCE OF AVOIDING CARIES. If this sector is small, the caries risk is high, and vice versa. It can vary from 0 to 100% (Figure- 4).

Statistical analysis

Statistical analysis was done by using multiple logistic regression analysis to assess the odds ratio and Pearson index was used to study the correlation between the different variables and overall caries risk.

Results

Out of the 30 study subjects in each group, 12 had primary dentition and 18 had mixed dentition. The mean dmft was significantly more in the primary dentition for CHD group compared to control group and for permanent teeth an increase in mean DMFT was noted for CHD group but the

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result was not statistically significant (Table-2).For subjects with CHD, the average overall caries risk was high (68%) when compared to controls (26%)(Table-3).In both primary and mixed dentition, factors dmft/DMFT and plaque amount had a significant correlation with the overall caries risk (Table-4).In this study, plaque amount and diet frequency were found to be the caries risk factors which were significantly associated in children with congenital heart disease when compared to age and gender matched controls (Table-5).

Discussion

Children with CHD have significantly poorer dental health at a very young age itself than their healthy counterparts and this has been substantiated by a multitude of literature.[3,6,7,8] In this study, children with CHD had significantly more caries (Mean dmft= 5.4) in their primary teeth than the control group (Mean dmft= 2.8).For the permanent teeth, caries experience was more for the cardiac group than controls but the result was not statistically significant which may be due to the reduced number of permanent teeth in this study or due to the decreased exposure time of these teeth to the oral cavity. 84% of CHD subjects had dmft/DMFT>3.Increased plaque accumulation, high levels of caries experience, more untreated dental caries and severe gingival inflammatory conditions have been observed in this special pediatric population.The increased incidence of dental problems in these children may be due to chronic intake of sweetened medications (sucrose containing), increased tooth susceptibility from developing enamel defects, more frequent exposure of these children to sweet snack foods due to parental indulgence, low priority of dental care held by primary attendants, negligence of oral hygiene as a result of a greater concern with cardiac disease and prolonged periods of hospitalization. The intake of medicines like diuretics and digoxin, contributes to the increased caries incidence due to the presence of sucrose and associated xerostomia.[3,6,9] For children with CHD, once caries is established in the early primary dentition, restorative treatment is very difficult and pulpotomies are not indicated because of the risk of infective endocarditis. Preferably, extraction of the pulpally involved primary teeth will have to be carried out to avoid increased risk of odontogenic bacteremia. Dental extractions in these young children, possibly requiring general anesthesia will compound to the problem with additional financial, emotional and physical burdens.[9]The overall increased vulnerability of the cardiac child to stressful dental procedures due to limited cardiac output and cyanosis necessitates it to focus more on caries prevention. Moreover, the increased risk associated with general anesthesia and the risk of prolonged bleeding amongst children indicated for cardiac surgery taking warfarin or other anticoagulants restricts extensive dental procedures and thus emphasizes the need for caries prevention strategies and early diagnosis.In this study, CHD children were found to constitute a high caries risk group and had presented with higher overall caries risk (68%) than the control group (26%).Thus the average actual chance to avoid new cavities was 74% for the control group when compared to 32% for the cardiac group.Plaque amount and diet frequency were the caries risk factors which were significantly associated in children with CHD when compared to age and gender matched controls who had caries. The low dental care index of these patients and parent's or caretaker's negligence to oral health care due to more serious medical problem ,may be the major reasons for increased plaque accumulation and thus plaque amount to be a significant contributing factor. One of the reasons for the lack of regular dental care for these children in the first years of life may be the prolonged periods of hospitalization as a

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result of surgery or illness and dental caries may not be identified until it is well established. Parental unawareness about the importance of oral hygiene maintenance in these children may also have added to the increase in plaque amount in this study. A study done by da Silva in 2002 reported that the guardians' knowledge was not satisfactory in respect of the importance of the maintenance of good oral health for prevention of infective endocarditis.[10]Suvarna et al concluded that parents' knowledge was fair but the oral health attitudes were not very satisfactory and demands improvement.[11]

The next caries risk factor of significance which was deduced from the present study was diet frequency. Regular vomiting, sometimes induced by drug-related nausea or reduced gastric capacity, is a well-recognized problem in children with CHD. To compensate for the increased metabolic requirements and limited caloric intake, they have to eat more frequently than healthy children with food enriched with nutrients and energy. Parental indulgence and the over protective nature to their medically compromised child results in more frequent providing of snacks and sweetened food items which also accounted to increased diet frequency contributing to caries in CHD children. The increased intake of sweetened medications may also attribute to dietary frequency being a risk factor when it is most often coupled with poor oral hygiene practices. Moreover, an increased frequency of fluid intake is often advised for these children due to longer periods of infections that they have, compared to normal children. Depending on the type of fluid intake and time of intake (for eg: at night time- lower salivary protection), this factor may influence dental caries.Although not statistically significant, related general diseases were also found to be a specific caries risk factor for children with CHD. 26 out of 30 CHD diagnosed children examined had history of respiratory infection in past one year and were on medications for the above also. Hemodynamic causes like alterations in pulmonary mechanics further lead to areas of atelectasis and ventilation perfusion mismatch, ultimately leading to hypoxia and immunodeficiency like reduction in total T-cell percentage and helper T-cells, immunoglobulins (IgG and IgA) and complement C3 and C4 observed in CHD children have been considered responsible.[12]When interviewed most parents reported regular intake of respiratory medications by their CHD affected children. Thus respiratory infections and medication consumed for the above may also be an additional unexplored caries risk factor in these children.

Non-significantly higher levels of *Streptococcus mutans* ($4.8x\ 10^4$) were found in the study group compared to the age and gender matched controls ($7.2x10^3$) in the present study. A higher meal frequency, changes in salivary secretion and composition due to cardiac medications like diuretics and use of antibiotics coupled with the confounding effect of sucrose found in these medications favorsbacterial colonization[13,14] Thus increase in Streptococcus mutans levels is also major caries risk factor in children with CHD.Cariogram® is considered one of the most reliable models as reported by many authors for predicting caries risk in an individual because it is an objective, quantitative method that uses a computer program to calculate the data, with results that can be printed out and saved. It also makes a series of recommendations for preventive action according to the caries risk. Cariogram® has been investigated and validated for use in both children and elderly individuals and has been used in various cross-sectional studies.[15,16]In this study, the Cariogram® risk assessment tool was also used to educate and motivate the patients or caregivers about the caries risk status in both the case and control groups. They were made aware of the preventive

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strategies to be adopted according to their caries risk status and dental referral was done wherever required.A limitation of this study is that only age and gender were used to match the children in this study although socioeconomic level may also influence dental health. In the present study most of the children with CHD selected as study subjects were part of a rural health treatment camp conducted in collaboration with M.S.Ramaiah Medical Hospital. Though Cariogram® does not address social factorsdirectly, it includesfactors such as oral hygiene and sucrose consumption, which are directly related to socioeconomic background. Another limitation of the present study is that, the amount of precision associated with salivary sampling, microbial culture and colony counting may have influenced the scoring and predictive value of Cariogram®. Furthermore, extensive research on a larger study population is required for establishing the association and extent of contribution of all these caries related factors in children with CHD.

Conclusion

Various research and studies have shown that children with CHD constitute a high caries risk group and a similar finding was obtained with the Cariogram® caries risk assessment model too.In this study it was observed that children with CHD are more prone to risk from diet and bacteria because diet frequency and plaque amount were found to be the significant caries risk factors associated. This warrants the dentist to perform aggressive individualized preventive programs especially dietary counselling, oral hygiene maintenance and if necessary, fluoride supplementation. Children with CHD should be referred to a paediatric dentist at a younger age itself so that an individual treatment plan to maintain oral health, based on risk assessment could be established.

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Legends Tables and Figure

Table-1: Caries related factors according to Cariogram®

Factor	Comment	Data Needed	Score
Caries experience	Past caries experience -cavities, fillings & missing teeth due to caries	dmft/DMFT	0= completely caries free, no previous fillings, no cavities or no missing teeth due to caries. 1= better than normal for that age group 2= normal for that age group 3= worse status than normal for that age group, or several new caries-lesions in the last year.
Related general diseases	General disease or conditions associated with dental caries	Medical history, medications	0=No disease 1=Physically and mentally retarded 2=Severe degree, long- lasting (patient could be bed ridden or may need continuous medication, for example affecting the saliva)
Diet, contents	Estimation of the cariogenicity of the food, in particular fermentable carbohydrate content	Lactobacillus test count	0=Very low fermentable carbohydrate (Lactobacillus count<10^2 CFU/ ml) 1=Low fermentable carbohydrate ($10^2 \leq LB < 10^3$ CFU/ml) 2=Moderate fermentable carbohydrate ($10^3 \leq LB < 10^4$ CFU/mL) 3=High fermentable carbohydrate ($LB \geq 10^4$ CFU/mL)

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Diet, frequency	Estimation of number of meals and snacks per day, mean for a normal day	Questionnaire results (24 hour recall or 3 days dietary recall)	0 = maximum 3 meals per day[including snacks] 1 = maximum 5 meals per day 2 = maximum 7 meals per day 3 = more than 7 meals per day
Plaque amount	Estimation of hygiene, for example according to Silness-Löe Plaque Index (PI)	Plaque index	0= No plaque 1=A film of plaque adhering to the free gingival margin and adjacent area of the tooth 2=Moderate accumulation of soft deposits within the gingival pocket or on the tooth and gingival margin which can be seen with the naked eye. 3=Abundance of soft matter within the gingival pocket and/or on the tooth and gingival margin
Mutans streptococci	Estimation of levels of Streptococcus mutans in saliva	Streptococcus mutans count test	0= Very low, $< 10^4$ CFU/ml 1=Low, $> 10^4$-10^5 CFU/ml 2=Moderate, $>10^5$ to 5 x 10^5 CFU/ml 3=High, $>5x10^5$ to 10^6 CFU/ml
Fluoride programme	Estimation of as to what extent fluoride is available in the oral cavity over the coming period of time	Fluoride exposure-interview the patient	0=Receives “maximum” fluoride program 1= Additional fluoride measures (other than tooth paste) but infrequent application 2= Fluoride tooth paste only 3= Avoiding fluorides, no fluoride
Saliva secretion	Estimation of amount of saliva	Unstimulated /Stimulated saliva test - secretion rate	0= More than 0.7 ml/min 1= Low 0.3 to 0.7 ml/min 2=Very Low < 0.3 ml/min
Saliva buffer capacity	Estimation of capacity of saliva to buffer acids	pH determination	0= Adequate [pH >=6] 1= Reduced [pH= 4.5 to 5.5] 2= Low [pH<= 4]
Clinical judgment	Examiners clinical and personal score for the individual patient	A pre-set score of 1 comes automatically	

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Table 2: Mean dmft& DMFT scores

Variable	CHD children	Controls	p value
Mean dmft	5.4	2.8*	0.002
Mean DMFT	1.1	0.9*	0.16

(*p<0.05 significant compared CHD children with controls)

Table 3: Mean overall caries risk percentage (calculated from Cariogram® pie profile)

Variable	CHD children	Controls
Mean Actual chance to avoid new cavities (in percentage)	32	74
Mean Overall caries risk (in percentage)	68	26

Table 4: Correlation between variables in Cariogram® and overall caries risk for cases

Comparison		dmft/DMFT		Plaque amount	
		Primary dentition (n=12)	Mixed dentition (n=18)	Primary dentition (n=12)	Mixed dentition (n=18)
Overall caries risk	Correlation Coefficient	0.937	0.644	0.426	0.728
	Sig. (2 tailed) (p value)	0.001	0.000	0.004	0.001

Table-5: Comparison of caries risk factors between cases and controls (Multiple logistic regression analysis)

Variables	Model log likelihood	Degree of freedom	Odds ratio	p value
Plaque amount	-11.44	1	4.06	0.000
Diet frequency	-4.88	1	3.72	0.002

Figure 1: Collection of saliva

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Figure 2: Sample analysis

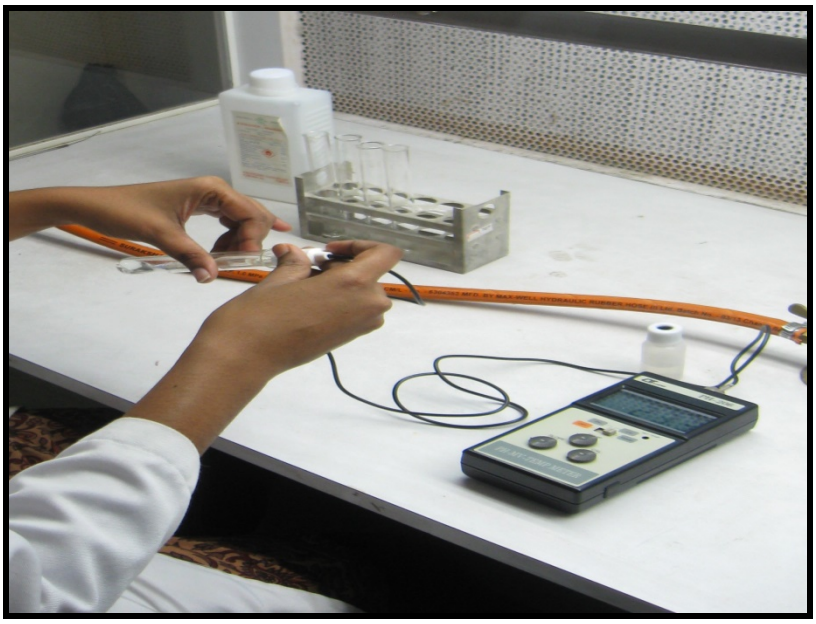

Figure 3: Growing micro organism

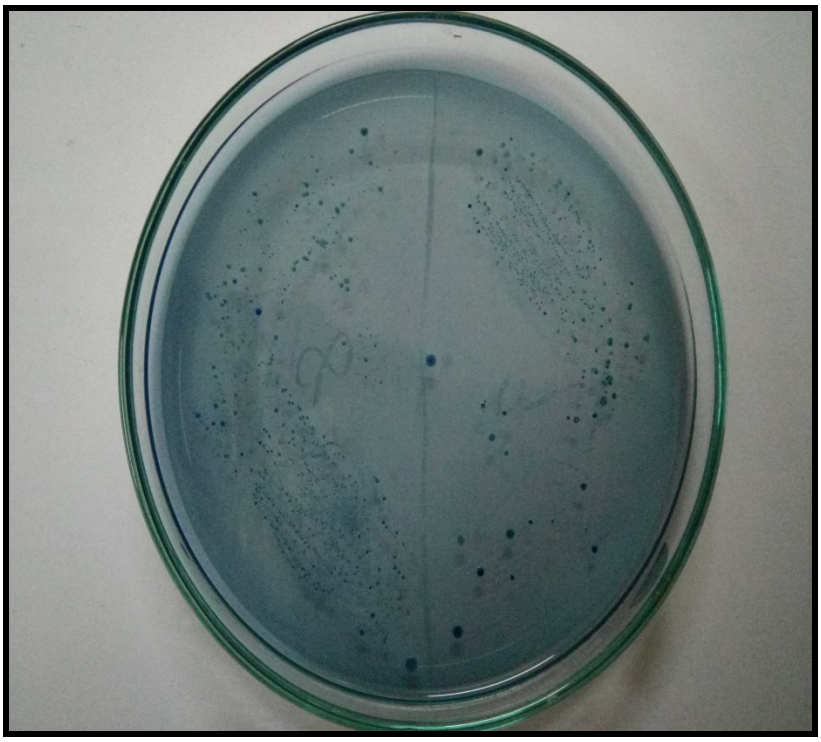

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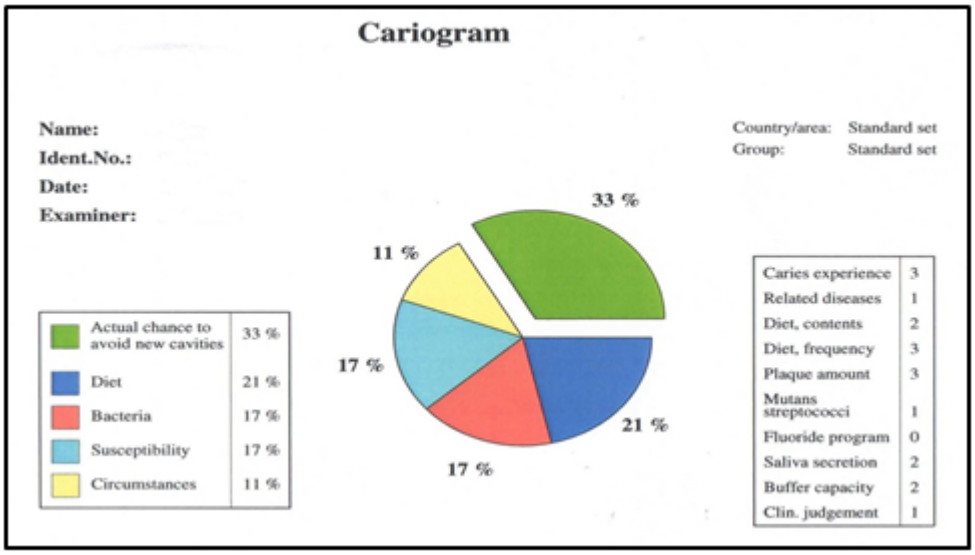
Figure 4: Cariogram



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