Root Caries Risk Assessment among Subjects with Periodontal Disease Using Cariogram Study Model- A Cross Sectional Study

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Abstract

Background: Root caries is considered a serious problem affecting the long term prognosis of both treated and untreated periodontally involved teeth and have become a major public health problem among adults.

Aim: To assess root caries risk among subjects with periodontal disease using the Cariogram study model.

Methodology: A descriptive cross-sectional study was conducted among 220 participants aged ≥ 35years who were categorized as cases and controls based on inclusion criteria. Data was collected using the specially designed proforma. Clinical oral examination was done for recording plaque scores (Silness and Loe), periodontal status and dental caries experience (WHO 1997). Salivary profile was generated by recording stimulated salivary flow rate, buffering capacity and microbiological status.

Results: Cariogram model revealed 39% and 51 % chance of avoiding caries for cases and controls respectively. Higher coronal and root caries experience was observed among cases than controls. Subjects categorized into high risk, according to cardiogram had higher mean DMFT (16.79 ± 4.58) and RDFT (1.47 ± 1.27) than other risk groups. Active periodontal disease and past caries experience were significantly associated with root caries through logistic regression analysis.

Conclusion: Cariogram can be a useful tool to illustrate caries risk profiles among periodontal disease patients. Along with baseline root caries experience, active periodontal disease, plaque, lactobacilli and mutans streptococci were identified as a major risk factors associated with root caries.

Key Words: Risk assessment, Periodontal disease, Root caries, Cariogram

Introduction

Oral health is a critical but overlooked component of overall health and well-being among adults [1]. Longer life expectancy and decreased edentulism has resulted in an ever-increasing number of adult patients retaining their natural dentition in advanced age and being in need of special dental service [2]. The worldwide rising burden of oral diseases among older people currently is becoming a public health problem for health authorities. Studies relating causal factors of tooth extraction have shown that caries is an important reason for the loss of tooth even in older age group. Because of increased life expectancy and greater retention of natural teeth compared with previous generations, root caries is becoming an important health problem among the dentate elderly [3].

Root caries is now being considered as a major public health problem for middle aged and elderly. The increased prevalence is associated with people keeping their teeth longer, and with root surfaces becoming physiologically (aging) or pathologically (periodontal disease) exposed in to oral cavity and therefore encountering risk. The prevalence of dental caries, the severity of periodontal disease, and the rate of edentulousness have all come down to an extent that early identification of at risk subpopulation could become an important facet of dental practice in both the private and public health context. A systematic review of the available literature reported root caries prevalence at baseline, i.e. the past root caries experience, the number of teeth and dental plaque as risk indicators for root caries [4]. The relationship between periodontal disease and root caries in particular has been the focus of many research groups. Furthermore, gingival recession changes the oral conditions, which may cause ecological changes, resulting in microbiological changes and attachment of cariogenic bacteria to supra gingival plaque [5,6].

During the past decade, risk assessment and its application to oral diseases have marched to the forepart of the dental health care policy arena. Much of the recent oral-health-oriented risk assessment research has focused on dental caries. The skewed distribution of caries within the population today calls for risk assessment and the challenge is to identify and estimate the probability of a patient of developing new caries lesions or progression of existing lesions during a specified period of time [7]. Many different risk models for caries prediction are available, using different methods for measuring the signs of disease. The risk for a future caries development has been examined using a number of pedagogic models, one of which was a caries risk assessment computer program Cariogram Malmo university, Sweden [8].

A variety of risk indicators have been associated with root caries in cross-sectional and longitudinal studies [9-12] but the heterogeneous results of these many studies are difficult to interpret and apply concisely in clinical situations. Research

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in the field of root caries prediction among subjects with periodontal disease by risk modeling is inconclusive and inconsistent. Considering the magnitude of the problem and the paucity of human research regarding root caries among periodontal disease subjects, the present study was undertaken to assess root caries risk among subjects with periodontal disease.

Methodology

A risk assessment was conducted to assess root caries risk among subjects with periodontal disease using Cariogram model. The ethical clearance was obtained from the Institutional Review Board. Data collection was carried out at the department of Periodontology in Narayana dental college & hospital. A pilot study was conducted prior to the main study to standardize the proforma and methodology planned. Data from the pilot study was used to determine the sample size.

Sample size estimation

The sample size was estimated based on the findings of a pilot study which revealed the mean difference between the cases (active periodontal disease) and controls (inactive periodontal disease) as 8.32% (Effect size=0.619) based on chance to avoid caries (Cariogram in %). The estimated sample size was 110 in each group at an accepted minimum possible error of 0.05% with 90% power of two sided tests. The pilot study subjects were not included in the main study.

Sampling procedure

A total of 480 patients were approached for the study, 300 patients gave informed consent to participate in the study. Among them, 110 subjects who were able to procure their biologically related individuals as controls, thus fulfilling inclusion criteria, were involved in the study.

Inclusion criteria

Cases: Subjects aged ≥ 35 years with active periodontal disease and who were able to procure their biological related individual as a control.

Controls: Subjects of similar age who were biological relative of cases with no active periodontal disease.

Exclusion criteria for both cases and controls

Patients who have undergone any therapy for the periodontal disease in the past 18 months. Subjects under medications that effect salivary parameters. Subjects with a history suggestive of systemic diseases and smoking and subjects with lack of functional dentition.

Training and calibration

The investigator was trained and calibrated for data recording in the department of Public health dentistry, Narayana dental college and hospital before conducting the study. Training was carried on till the examiner produced consistent observations. Intra examiner kappa statistic scores were calculated pertaining to plaque index, CPI-LOA and DMFT index and were 0.87, 0.85 and 0.84 respectively.

Study procedure

Data was collected using a specially designed proforma consisting of three parts. First part recorded socio demographic details, past medical history, diet history and propensity of usage of fluoridated toothpaste and mouth rinses. Second part, clinical oral examination was done for recording plaque scores [13] periodontal status and dental caries experience [14]. Finally the salivary profile was created by recording stimulated salivary flow rate, buffering capacity and microbiological status.

The participants were individually interviewed to record the proforma followed by a Type III clinical examination according to the ADA and stimulated saliva was collected from each participants' to create their salivary profile.

Assessment of salivary parameters

Stimulated whole saliva was collected under resting conditions and at the same time to minimize the effects of the diurnal variation in salivary composition. The saliva samples were obtained two hours after breakfast between 9-12 a.m. Two hours prior to the evaluation of stimulated whole saliva production, subjects were instructed not to eat, drink, or rinse their mouths until the test was completed. Thereafter, whole stimulated saliva was collected for about five minutes into a dry, milli metric and sterilized plastic tube. The flow rate of saliva was estimated by asking participants to spit into the preweighed plastic cylinders for 5 minutes. These plastic cylinders (containing saliva) were then weighed and the flow rate was calculated in g/ml which is almost equivalent to ml/min [15]. The saliva collected was divided into two separate milli metric tubes to calculate the buffer capacity of the saliva by Ericsson method (1959) [16] and to determine mutans streptococci and lactobacilli levels. The sample was taken immediately to central laboratory of Narayana medical college& hospital for microbiological analysis.

Microbiological culture

The samples were processed on the same day by trained personnel in the central laboratory. Mitis salivarius agar (MSA) supplemented with potassium tellurite and Rogosa SL was used as culture media for isolation of total salivary streptococci and lactobacilli respectively, and incubated anaerobically using anaerobic gas pack system (Hi-media) at 37^{o}C for 48 and 72 hours respectively. Colony counting was done manually and represented as the number of the colonies which were multiplied by the number of times the original ml of the sample was diluted (the dilution factor of the plate counted) and expressed as the number of colony forming units per milliliter (CFU/ml) of saliva [17].

Creation of Cariogram model

Relevant information regarding the subjects was collected, scored according to a standardized protocol mentioned in the manual and then entered into the computerized software program, Cariogram 3.0 version (Malmo University Sweden) to calculate the caries risk and conversely chance of avoidance of caries in future for each individual [8]. A aseptic protocol was developed and strict procedures were followed for infection control. The required instruments were autoclaved daily during the study period.

Data analysis

Data was computerized into SPSS version 20. Chi square test was used to compare study parameters, the periodontal status and caries related factors between two groups. Logistic regression analysis was performed to identify the impact of various independent Cariogram related risk factors on root caries. Statistical significance was set at $p< 0.05$.

Results

A total of 480 participants were examined, 220 out of participants were included as cases and their biological relatives as controls. Data was collected from the 220 participants representing 110 each in case and control group. There was no statistically significant difference in gender distribution and sociodemographic characteristics among cases and controls. *Table 1* shows the distribution of subjects in relation to their periodontal condition, 32.73% of subjects from cases had a loss of attachment of 6-8mm followed by 49.09% with loss of attachment of 4-5mm. In contrast, only 5.45% of subjects from controls had a loss of attachment of 6-8 mm and majority of them, 54.55% were in the range of 0-3 mm.

Further analysis was performed to compare various Cariogram related parameters among cases and controls. The past caries experience was 32.73% of cases and 18.18% in the control group. The majority of subjects in cases and controls had a diet frequency of 4-5meals per day. Assessment of amount of plaque revealed 56.36% of subjects in cases had a plaque score of ≥ 0.4 compared to 34.55% among controls. The majority of subjects among cases and controls used fluoridated toothpaste once daily. Subjects with low Saliva flow rate were higher in cases than controls, around 40% of subjects in the cases had salivary flow rate (<1.1ml/ minute) compared to 20% among controls. There was not much difference in the buffering capacity of saliva among cases and controls, 40% subjects in cases and 32.73% in the control group had a salivary pH of ≤ 4.0. Microbiological analysis revealed that the majority of subjects 49.09% of cases had more than one million colony forming units of mutans streptococci compared to 34.55% subjects in controls. 52.73% of cases had more than one million lactobacilli colony forming units (CFU/ml) compared to controls (23.64%). A statistical significant difference was observed between cases and controls in terms of quantity of plaque, salivary flow rate and lactobacillus colony forming unit (*Table 2*).

Table 3 showed the distribution of cases and controls into different Cariogram risk groups, expressed as a percentage chance of avoiding caries according to Cariogram. Majority of the subjects in cases (36.36%) were categorized as high risk followed by 30.91% subjects at high medium risk for developing future caries. In contrast, only 12.73% of subjects in the control group were categorized as high risk followed by 27.27% in high medium for developing future caries. The difference between the two groups was found to be statistically significant. When the caries risk profile was plotted among cases with and controls without root caries. Subjects with root caries showed a 17% compared to 48% chance of avoiding caries among subjects without root caries.

Analysis of coronal and root caries experience among cases and controls, indicating a higher coronal and root caries experience among cases than controls, which was statistically significant. The prevalence of root caries among cases and controls was 50.9% and 21.8% respectively. Among cases 58 out of 110 subjects had root caries and 24 out of 110 in controls had root caries. Subjects categorized into high risk, according to Cariogram had higher mean DMFT and RDFT than other risk groups among cases (DMFT 16.79 ± 4.58, RDFT 1.47 ± 1.27) and controls (DMFT 12.34 ± 5.45, RDFT 1.64 ± 0.89) (*Table 4*).

Logistic regression analysis was performed to identify the impact of various independent Cariogram related variables and periodontal status on root caries prevalence. Subjects with past caries experience (DMFT) had highest odds 2.94 times chance of developing root caries followed by a high lactobacillus count (1.65), the amount of plaque (1.43), streptococcus mutans count (1.39) and low buffering capacity (1.25). Subjects with active periodontal disease and loss of attachment had 1.28 and 1.02 times odds of developing root caries. Active periodontal disease and past caries experience were significantly associated with root caries (*Table 5*).

Discussion

Despite the evidence linking periodontal disease to root caries (RC) development is well established, it seems that the implications of the interrelationship between these two clinical entities have not been routinely seen in the course of root caries investigations. It is considered a serious problem affecting the long term prognosis of both treated and untreated periodontally involved teeth by Krasse B [18]. So this study was planned to assess root caries and its risk factors among subjects with periodontal disease using a cariogram study model.

The cariogram is regarded as a useful tool for assessing and predicting caries risk and has been validated for predicting future coronal and root caries among elderly individuals [19]. In the present study cariogram - multifactorial caries risk assessment model has been used to predict root caries risk among individuals with and without active periodontal disease in an attempt to identify the risk factors associated with root caries. Remarkably, we used both coronal and root caries experience as one of the predictor for future root caries. Since both coronal and root caries have common risk factors with root exposure being the only additional requirement for the development of root caries [20].

Comparison of various caries related parameters between two groups showed a significant difference between cases and controls in terms of quantity of plaque, salivary flow rate and lactobacillus colony forming unit indicating a poor oral hygiene among cases with active periodontal disease compared to controls. The present study findings were in accordance to study conducted by Ravald et al. [21] in which Poor oral hygiene was a significant predictor for root caries. The findings were also similar to the findings of Reiker et al. [6] in

Table 1: *Distribution of study subjects in relation to their periodontal condition Chi square test, *p<0.05.*

Community Periodontal Index (CPI)	Cases % n=110	Controls % n=110	p-value
Bleeding on probing	0	28(25.45)	0.00001*
calculus	0	82(74.55)	
Shallow pockets	46(83.64)	0	
Deep pockets	9(16.36)	0	
Loss of Attachment (LOA)			
0-3 mm	16(14.54)	60(54.55)	0.00001*
4-5 mm	54(49.09)	44(40.00)	
6-8 mm	38(32.73)	6(5.45)	
9-11 mm	4(3.64)	0	
>12 mm	0	0	

Table 2: *Comparison of Cariogram related parameters between cases and controls.*

S.no	Characteristics	Category	Cases n=110(%)	Controls n=110(%)	p-value
1	Past caries experience	Caries free/ no fillings	0	0	0.12
		Better than normal	52(47.27)	72(65.46)	
		Normal	22(20.00)	18(16.36)	
		Worse than normal	36(32.73)	20(18.18)	
2	Diet frequency	Max 3 meals/day	16(14.54)	22(20.0)	0.46
		4-5 meals	92(83.64)	88(80.0)	
		6-7 meals/day	2(1.82)	0	
		>7 meals/day	0	0	
3	Plaque amount	PI < 0.4	48(43.64)	72(65.45)	0.05*
		PI = 0.4-1.0	60(54.54)	38(34.55)	
		PI = 1.1- 2.0	2(1.82)	0	
		PI > 2.0	0	0	
4	Fluoride program	Max fluoride program	0	0	0.1
		Fluoride supplements	0	0	
		Only fluoride toothpaste	88(80.00)	100(90.91)	
		No fluoride	22(20.00)	10(9.09)	
5	Salivary flow rate	>1.1ml/min	66(60.00)	88(80.00)	0.02*
		>0.9-1.1ml/min	44(40.00)	22(20.00)	
		0.5-0.9ml/min	0	0	
		<0.5ml/min	0	0	
6	Buffer capacity	pH>=6.0	20(18.18)	24(21.82)	0.71
		pH 4.5-5.5	46(41.82)	50(45.45)	
		pH<=4.0	44(40.00)	36(32.73)	
7	Mutans streptococci	<20000	0	0	0.13
		20000-100000	8(7.27)	40(18.18)	
		>100000-1million	48(43.64)	52(47.27)	
		>1million	54(49.09)	38(34.55)	
8	Lactobacilli (CFU/ml)	<20000	0	0	0.00*
		20000-100000	16(14.54)	24(21.82)	
		>100000-1million	36(32.73)	60(54.54)	
		>1million	58(52.73)	26(23.64)	

Chi square test, *p<0.05

Table 3: *Distribution of cases and controls into Cariogram risk groups expressed as percent chance of avoiding caries according to Cariogram model.*

Cariogram	Cases n=110(%)	Controls n=110 (%)	p-value
High risk (0-20%)	40(36.36)	14(12.73)	0.00*
High medium (20-40%)	34(30.91)	30(27.27)	
Moderate (40-60%)	32(29.09)	50(45.45)	
Low medium (60-80%)	4(3.64)	16(14.55)	
Low risk (80-100%)	0	0	

Chi squaretest *p<0.05

which patients with root caries showed a higher bacteria count for mutans streptococci and lactobacilli. It is well established that mutans streptococci and lactobacilli species constitute as one of the major risk factors for the development of coronal caries Ruitz et al. [22], Peterson [10] and also these cariogenic species have been recovered from the root surface Ravald and Hamp [23] Ellen et al. [24] Fure et al. [3].

Subjects who were categorized as a high risk group according to Cariogram had higher mean DMFT and RDFT compared to other groups in subjects with active periodontal disease. The high caries experience, DMFT and RDFT can be considered as a risk factor for development of future caries in the present study, which was found similar to studies reported by Zero et al. [25]; Fontana and Zero [26], where DMFT was considered as a strong predictor for future caries. The present study findings were also similar to studies conducted by Powell et al. [27] Vehkalahti [20] Fure and Zickert [3], establishing baseline coronal caries as a best predictor for root caries incidence.

The prevalence of root caries among cases and controls was 50.9% with a mean of 0.87 ± 1.04 and 21.8% with a mean of 0.38 ± 0.85 respectively. The prevalence was higher than the findings of study conducted by Fadel. H et al. [28] in Saudi Arabia and lower than reports of studies conducted by Ravald et al. [23,29] which ranged from 58% to 87%. This low prevalence in the present study may be due to the

Table 4: *Prevalence of coronal and root caries among studied population in different Cariogram groups.*

Cariogram	Cases n=110(%)	Controls n=110 (%)	p-value
High risk (0-20%)	40(36.36)	14(12.73)	0.00*
High medium (20-40%)	34(30.91)	30(27.27)	
Moderate (40-60%)	32(29.09)	50(45.45)	
Low medium (60-80%)	4(3.64)	16(14.55)	
Low risk (80-100%)	0	0	

Table 5: *Logistic regression analysis of impact different Cariogram related variables and periodontal statuson root caries prevalence.*

Cariogram related variables	Std. Error	Z-value	Odds Ratio (95%CI)
Diet frequency	0.6836	-0.22	0.42 (0.08-2.09)
Fluoride program	0.8226	-1.07	0.71 (0.23-2.16)
Amount of Plaque	0.5669	-0.6	1.43 (0.67-3.81)
Salivary flow rate	0.5358	0.54	0.92 (0.42-1.99)
Buffer capacity	0.3952	-0.22	1.25(0.64- 4.23)
Mutans streptococci	0.4816	1.03	1.39(0.66-2.92)
Lactobacilli	0.3796	0.87	1.65(0.91-2.16)
DMFT	0.0517	0.03	2.94*(1.34-6.48)
Periodontal status			
CPI–LOA	0.4022	2.69	1.21*(0.45-2.23)
LOA	0.4071	0.02	1.02 (0.48-2.10)

p<0.05*

initial exclusions of patients with fewer than 20 teeth from the current investigation who may also have exhibited root lesions in their remaining teeth.

The caries risk profile was plotted among cases with and without root caries. Subjects with root caries showed a 17% compared to 48% chance of avoiding caries among subjects without root caries. Subjects with root caries were at higher risk of developing future caries compared to subjects without root caries among cases and controls. Red (plaque and mutans streptococci) followed by dark blue (diet) sectors occupied larger area difference under Cariogram with and without root caries indicating the amount of Plaque, mutans streptococci and lactobacillus counts as the major risk factors for root caries. The present study findings were in accordance to studies reported by Saotome [30].

Logistic regression analysis to assess the impact different cariogram related variables and periodontal status on root caries prevalence, revealed subjects with past caries experience had highest odds 2.94 followed by a high lactobacillus count (1.65), plaque amount (1.43) and active periodontal disease (1.21). The odds of past caries experience in the present study was significantly associated with root caries prevalence and was in accordance to the study conducted by Joshi et al. [31] and Scheinin et al. [32] and contrast to the studies conducted at Greece and Mexico [33,34].

Conclusion

Cariogram can be a useful tool to illustrate caries risk profiles among periodontal disease patients. Along with baseline root caries experience, active periodontal disease, plaque, lactobacilli and mutans streptococci were identified as a major risk factors associated with root caries.

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