Original Article

Cariogram caries risk profiles in adolescent orthodontic patients with and without some salivary variables

Georgia Petsi[a]; Sotiria Gizani[b]; Svante Twetman[c]; Katerina Kavvadia[d]

ABSTRACT

Objective: To compare the Cariogram caries risk profiles with and without salivary buffer capacity and mutans streptococci (MS) counts in adolescents with fixed orthodontic appliances.

Materials and Methods: The sample consisted of 90 healthy Greek adolescents who were undergoing orthodontic treatment. The Cariogram risk model was applied through a questionnaire and clinical and salivary examinations. The actual chance of avoiding new caries was calculated, and participants were categorized into three groups (0–40% = high caries risk, 41–60% = medium caries risk, and 61–100% = low caries risk) using a nine-item Cariogram or by excluding either salivary buffer capacity or MS or both. Cohen's Kappa statistical analysis was used for comparing the Cariogram outcome with and without salivary variables. The distribution of variables was compared by nonparametric marginal homogeneity tests.

Results: Using the Cariogram with nine variables, 62% of the patients were assigned to the high caries risk category, 13% to the medium risk category, and 24% to the low risk category. Omission of salivary buffer capacity did not alter the risk categories significantly, while more subjects were assigned to the medium risk category when MS counts were excluded. The difference between the nine-item Cariogram and the MS-reduced version, however, was not statistically significant ($P = .07$).

Conclusions: The Cariogram model may be used both with and without salivary tests for risk grouping in orthodontic practice. (*Angle Orthod.* 2014;84:891–895.)

KEY WORDS: Caries risk; Orthodontic patients; Cariogram

INTRODUCTION

It is well known that orthodontic patients are more prone to development of white spot lesions (WSL), a finding that is mainly attributed to plaque accumulation and food retention around the brackets. WSL may progress to cavitation or maintain as an eternal ''scar'' on the buccal enamel.[1] Thus, it would be imperative to be able to detect those patients who are at higher risk for caries and WSL formation before the orthodontic treatment in order to implement appropriate and evidence-based preventive strategies. A multifactorial, computer-based caries risk assessment model, Cariogram,[2] has been used and validated in schoolchildren and adult patients.[3–6] Cariogram is an interactive PC program for caries risk evaluation that graphically shows a calculated overall caries risk for future caries after a weighted analysis of different etiologic variables of the patient.[2] The Cariogram program is based on the input of several variables taken from a patient interview or questionnaire and the clinical examination as well as saliva testing.

Cariogram has previously been applied in orthodontic practice for detecting patients at risk for WSL development in order to implement appropriate preventive measures.[7–9] In these previous studies, all 10 variables were employed according to the original manual of the Cariogram. Saliva tests are, however, rarely conducted during routine orthodontic treatment

[a] Clinical Instructor, Department of Pediatric Dentistry, School of Dentistry, University of Athens, Greece.

[b] Lecturer, Department of Pediatric Dentistry, School of Dentistry, University of Athens, Greece.

[c] Professor of Cariology, Department of Odontology, Faculty of Health and Medical Sciences, University of Copenhagen, Denmark.

[d] Associate Professor and Program Director, Department of Pediatric Dentistry, European University College, Dubai; and Assistant Professor, Department of Pediatric Dentistry, School of Dentistry, University of Athens, Greece.

Corresponding author: Dr Sotiria Gizani, Lecturer, Department of Pediatric Dentistry, School of Dentistry, University of Athens, Thivon 2, 11527 Goudi, Greece
(e-mail: stgizani@dent.uoa.gr)

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in Greece as a result of the extra costs, special equipment, and trained personnel required for such testing. In a previous study[10] conducted in schoolchildren it was found that the accuracy of the Cariogram model was impaired when salivary mutans streptococci (MS), secretion rate, and buffer capacity were omitted. The purpose of this clinical study was therefore to compare the caries risk profiles according to Cariogram performed with and without some salivary variables in Greek adolescents undergoing treatment with fixed orthodontic appliances.

MATERIALS AND METHODS

Study Group

The sample consisted of 90 healthy patients of both sexes under treatment with fixed orthodontic appliances at the Postgraduate Orthodontic Dental Clinic at the University of Athens. The mean patient age was 13 years, with patients ranging between 9 and 18 years of age. The patients were consecutively enrolled after informed consent was received, with consent forms signed by the patients as well as their parents. This study protocol was approved by the Ethics Committee of the University of Athens.

Study Design

The study employed a cross-sectional design in which data regarding the Cariogram variables were collected through a questionnaire and clinical and salivary examinations. The outcome measure was the computed ''chance to avoid caries in the near future,'' expressed as a percent.

Procedure

The questionnaires were completed by the patients, and data were retrieved regarding general health, self- and professionally applied fluorides (fluoridated toothpaste, fluoride mouth rinse, fluoride varnish, etc), and dietary habits (frequency of meals, sugar content). The levels of salivary MS and lactobacilli, as well as salivary buffer capacity (SBC), were determined using the commercial chair-side kits (Dentocult® SM Strip mutans, Dentocult® LB, and Dentobuff® Strip; Orion Diagnostica, Espoo, Finland). All tests were performed according to the instructions of the manufacturer. The saliva secretion rate was not determined. The clinical examination was conducted by one single examiner in a dental chair with optimal light using a mouth mirror, an explorer, and a periodontal probe. All teeth were examined while dry and clean.

The following clinical parameters were recorded: dental plaque by the simplified Plaque Index[11]; gingivitis by the Gingival Index[12]; dental caries by DMFT/S Index (D = decayed, M = missing due to caries, F = filled, T = permanent teeth, S = tooth surfaces) according to the World Health Organization (WHO) 1987 caries criteria,[13] and presence of WSL according to the classification system by Gorelick et al.[14] The examiner was calibrated against an experienced pediatric dentist and after examining 15 patients separately, the interexaminer Kappa value was 0.75.

Cariogram Variables

The nine Cariogram variables computed were caries experience, related diseases, diet frequency, diet content, plaque amount, MS, fluoride program, SBC, and clinical judgment. As a reference value for the ''normal DMFT,'' data from a recent epidemiological pathfinder survey in Greek teenagers were used.[15] The scoring of the variables is presented in Table 1. The clinical judgment was upgraded from ''normal'' when a patient exhibited the presence of a WSL adjacent to a bracket base at the examination.

Caries Risk Category

The data were calculated in four ways: (1) Cariogram with nine variables, (2) Cariogram with SBC excluded, (3) Cariogram without salivary MS, and (4) Cariogram with both SBC and MS excluded. The patients were then allocated into three caries risk categories according to their chance of avoiding caries in the near future, as follows: 0–40% chance to avoid caries = high caries risk, 41–60% chance to avoid caries = medium caries risk, and 61–100% chance to avoid caries = low caries risk.

Statistical Analysis

All data were processed with IBM-SPSS (SPSS, Chicago, Ill; version 20.0) and presented in terms of descriptive statistics. The Cohen's Kappa test was used to compare the agreement between the full Cariogram and the reduced versions. Furthermore, the patient distribution into the three risk categories was tested using a nonparametric marginal homogeneity test. The entry of the collected data into the computer was verified in order to optimize the data-entry accuracy. *P*-values of less than .05 were regarded as statistically significant.

RESULTS

The distribution of Cariogram scores in the study group is shown in Table 1, and the mean values of some key variables are presented in Table 2. According to the information collected from the questionnaire, 58% of the patients were brushing their teeth twice

Table 1. Definition of Cariogram Scores and Percentage Distribution of Variables in the Study Group

Cariogram Variables	Sample (n = 90), %
Caries experience	
0: DMFT = 0	37.8
1: DMFT < normal for the age group	21.1
2: DMFT = normal for the age group	14.4
3: DMFT > normal for the age group	26.7
Related diseases	
0: No disease, healthy	100.0
1: General disease, no medication	0.0
2: General disease, medication	0.0
Diet content (Dentocult LB)	
0: Lowest lactobacillus count	7.8
1: Sugar consumption infrequently	30.0
2: Sugar consumption daily	16.7
3: Highest lactobacillus count	45.6
Diet frequency	
0: ≤3 meals	0.0
1: 4–5 meals	84.4
3: >5 meals	15.6
Plaque amount	
0: Plaque index (PI) < 5%	2.2
1: PI 5–20%	1.1
2: PI 20–50%	41.1
3: PI >50%	55.6
Mutans streptococci (Dentocult SM)	
0: $<10^3$ CFU/mL	15.6
1: 10^4 CFU/mL	17.8
2: 10^5 CFU/mL	24.4
3: $>10^6$ CFU/mL	41.1
Fluoride program	
0: Topical F^- twice a year	30.0
1: Topical F^- once a year	13.3
2: Only fluoride toothpaste	56.7
3: No fluoride	0.0
Saliva buffer capacity (Dentobuff)	
0: High	86.6
1: Medium	13.3
2: Low	0.0
Clinical judgment	
1: Normal setting	68.9
2: Presence of white spot lesions, yes	31.1

D = decayed, M = missing due to caries, F = filled, T = permanent teeth, S = tooth surfaces

daily with fluoridated toothpaste but more than half did not benefit from any additional fluoride measures. The SBC was uncompromised in the majority of cases (87%). High levels of salivary lactobacilli and/or MS were found in 40–50% of all patients, although almost 40% were found to be free from obvious decay (DMFT = 0), and the mean DMFT value was 2.3. Furthermore, 28 of the 90 patients (31%) displayed at least one WSL adjacent to a bracket base.

According to the nine-item Cariogram model, 62% displayed high caries risk, 13% displayed medium caries risk, and 24% displayed low caries risk (Table 3). When the SBC was omitted, 96% of the patients remained in the same risk category. Without the salivary MS counts, 23% of the patients changed their risk categories, most of them moving to a lower risk level. The distribution of the risk categories was, however, not significantly altered when compared with the nine-item Cariogram ($P = .07$). When the Cariogram was reduced by both SBC and MS counts, 76% of the patients were unchanged with respect to their risk categories.

Table 2. Age, Clinical Variables (DMFT, Plaque, Gingivitis, Number of white spot lesions [WSL] per Patient), and the 9-Item Cariogram Outcome

	Mean (SD)[a]
Age, y	13.3 (2.3)
DMFT	2.3 (3.1)
Plaque index, %	53.5 (21.3)
Gingival index, %	29.7 (15.6)
WSL, per patient	0.8 (1.5)
Cariogram,[b] %	35.8 (27.5)

[a] Values in table denote mean value and standard deviation (SD).
[b] Calculated chance to avoid new caries.
D = decayed, M = missing due to caries, F = filled, T = permanent teeth, S = tooth surfaces

DISCUSSION

The Cariogram risk assessment model has previously been applied to various age groups as well as to orthodontic patients. In some studies,[16,17] certain age-related adjustments have been suggested, but we followed the "original" manual, with two exceptions. First, the salivary secretion rate was not measured, since the sample consisted of healthy teenagers and none of them displayed any clinical sign of impairment in terms of salivary flow rate. Second, the variable "clinical judgment," which allows the clinician to add a subjective opinion of the patient, was automatically given a higher value when presence of any early sign of WSL was scored. The clinical classification system by Gorelick et al.,[14] rather than the newer ICDAS-II Index,[18] was used for the clinical scoring of WSL because it was more commonly used in the literature and allowed comparisons with previous findings. The chair-side tests were all considered accurate, reliable, and easy to use.[19]

The main finding of this study was that on the group level, no very dramatic differences in the distribution of risk categories appeared when the nine-item Cariogram was reduced. The low risk category remained around 20%, while the high risk category ranged from 54% to 63%. The minute impact of the SBC was expected in light of the high prevalence of noncompromised levels, while the stronger influence of the MS counts was more in line with previous findings.[10] On

Table 3. Comparison of Caries Risk Categories Obtained With the 9-Item Cariogram and Without Salivary Buffer Capacity (SBC) and/or Mutans Streptococci (MS)[a]

	9-item Cariogram			
	High (62%)	Medium (13%)	Low (24%)	
	(n = 56)	(n = 12)	(n = 22)	Total
Cariogram, No SBC[b]				
High (63%)	**56**	1	0	57
Medium (13%)	0	**10**	2	12
Low (23%)	0	1	**20**	21
Cariogram, No MS[c]				
High (54%)	**46**	3	0	49
Medium (26%)	10	**7**	6	23
Low (20%)	0	2	**16**	18
Cariogram, No SBC, no MS[d]				
High (62%)	**49**	6	1	56
Medium (19%)	7	**4**	6	17
Low (19%)	0	2	**15**	17
Total	56	12	**22**	90

[a] Values denote the number of subjects and bold figures indicate risk category agreement.

[b] Ninety-six percent remained in the same risk category (k = 0.916, standard error [SE] = 0.04).

[c] Seventy-seven percent remained in the same risk category (k = 0.596, SE = 0.071).

[d] Seventy-six percent remained in the same risk category (k = 0.549, SE = 0.075).

the individual level, however, the risk category was changed for better or for worse, with the medium category being most volatile. For example, omitting the salivary MS counts, the 12 patients who shifted to a lower risk category were all caries free, had low plaque levels, participated in frequent dental visits, and received frequent fluoride application. On the other hand, the nine patients who shifted to the higher risk category had all caries, high plaque levels, rare dental visits, and infrequent fluoride application. These findings illustrate the value of the Cariogram model as a didactic help for individually targeted motivational interviews and counseling.

The clinical implication of our findings was clear cut: by omitting the salivary MS counts, a higher proportion of ''medium-risk'' patients was obtained, which eventually would not lead to a costly preventive ''overtreatment.'' Nevertheless, when it comes to prevention, overtreatment is definitely to be preferred over undertreatment, at least as long as serious side effects are uncommon and the costs are reasonable. It should also be stressed that WSL development during orthodontic treatment with fixed appliances is an underestimated problem; the incidence is high, and such lesions have very limited ability to improve after appliance removal.[20] Consequently, orthodontists could safely be advocated to adopt the Cariogram model, even without the SBC and MS enumeration. The model is simple to use and easily understood by laypeople.[7] In addition, the use of a formal caries risk assessment model adds structure, consistency, and quality to the risk assessment process and subsequent preventive work and is today regarded as ''best clinical practice.''[21] A more philosophical question would be whether all patients with fixed appliances should be regarded as being at risk as a result of the jeopardized oral cleaning. In this study, depending on the general incidence of WSL in the population, the answer is over 30%. Generally speaking, in populations with a low incidence the need for an individual risk assessment is more urgent than in those with a high incidence; in the latter, a group/community-based preventive approach is preferred.[22]

The mean Cariogram value of ''actual chance of avoiding new cavities'' was 36%. This was within the range of previous studies (28–75%), albeit at the lower end.[8,9] This large variation may likely be due to the different study designs. The caries risk of the orthodontic patients was previously assessed at the end[7] of their orthodontic treatment, while we estimated the risk within 18 months after the application of the appliances. Furthermore, no radiographs were utilized in the present study, in contrast to previous projects.[7–9]

Unfortunately, the present cross-sectional study design did not allow a validation of the risk assessment made against the true incidence of WSL at the time of debonding. Therefore, the accuracy and the predictive values of using the Cariogram in fixed orthodontic patients are still to be established. However, a previous study[10] in schoolchildren showed clearly that the predictive power of the Cariogram was significantly impaired without performing the salivary tests. As concluded by several systematic reviews,[19] the strongest single predictor for more caries is previous caries experience. Transferred to the orthodontic context, a close examination of recent bitewing radiographs before onset of appliances is recommended. A study by Fornell and Twetman[23] strongly associated such findings with WSL development during treatment with fixed appliances.

CONCLUSIONS

- On the group level, the caries risk categories in patients with fixed orthodontic appliances were not significantly altered, when the Cariogram model without MS enumeration was employed, although a higher proportion exhibited a medium caries risk.
- Orthodontists can safely be advocated to adopt the model, even without saliva testing.

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