Original Article

Caries risk profile using the Cariogram in governmental and private orthodontic patients at de-bonding

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ABSTRACT

Objectives: To analyze various caries-related factors in orthodontic patients at de-bonding, and to test the null hypothesis that there is no difference in caries risk between governmental and private orthodontic patients immediately after orthodontic treatment.

Materials and Methods: A cross-sectional examination was carried out on 89 orthodontic patients aged 13–29 years, mean age 21.5 years. They were divided into two groups based on the center of treatment, governmental group (G) ($n = 45$) and private group (P) ($n = 44$). The investigation comprised a questionnaire, plaque scoring, caries examination, bitewing radiographs, salivary secretion rate, buffering capacity, and cariogenic microorganisms. Data were entered into the Cariogram PC program to illustrate caries risk profiles.

Results: Findings revealed that "the chance of avoiding new cavities," according to the Cariogram, was high in the P-group and low in the G-group (61% and 28%, respectively) ($P < .001$). Decayed, missing, and filled surfaces (DMFS), plaque index, mutans streptococcus and lactobacillus counts, and salivary buffer capacity were significantly higher in the G-group compared with the P-group ($P < .05$). The total number of caries lesions at de-bonding in the G-group was more than two times higher than that in the P-group (150 vs 68) ($P < .001$).

Conclusions: The "chance to avoid new cavities" in orthodontic patients at de-bonding was less in the governmental group compared with the private group, as illustrated by the Cariogram. The governmental group also had significantly less favorable values than the private group for most of the caries-related factors. (*Angle Orthod.* 2012;82:267–274.)

KEY WORDS: Cariogram; Orthodontics; Caries lesions

INTRODUCTION

Fixed orthodontic appliances are associated with increased plaque accumulation and high counts of cariogenic microorganisms, and thereby an elevated caries risk.[1,2] The creation of new retentive areas favors the local growth of mutans streptococci, which in turn increases the levels of these organisms in saliva and around orthodontic appliances.[3,4] Despite improvements in materials and preventive methods, orthodontic treatment continues to contribute considerable risk of enamel demineralization.[5,6]

Although caries prevalence has declined among children and adolescents in many countries,[7] caries is still a problem in teenagers and adolescents in many developing countries, such as the Kingdom of Saudi Arabia (KSA).[8,9] In the KSA, governmental clinics offer most dental treatments, including orthodontics, free of charge. On the other hand, patients at private clinics have to pay the full amount for treatment. For this reason, patients have to wait in a long queue to receive orthodontic treatment at governmental clinics. This has caused most patients of high socioeconomic status to seek treatment at private clinics. In the KSA, caries prevalence is higher among children from governmental schools compared with private schools.[9] Recently, a study from Australia showed that patients who visit private dental clinics receive better dental care in comparison with those who attend public clinics.[10]

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Dental caries is a multifactorial disease that is caused by the interaction of several factors. Although various factors have demonstrated strong associations with future caries, no single test is able to predict accurately an individual's susceptibility to caries.[11] However, when various caries-related factors are analyzed with the use of a computer-based program, called the Cariogram,[12] a correlation seems evident between illustrated caries risk and caries increment over time for both children and adults,[13,14] as well as for orthodontic patients.[15]

The aims of the present study were (1) to analyze various caries-related factors in orthodontic patients immediately after orthodontic treatment (ie, at de-bonding), and (2) to compare caries risk profiles obtained by using the Cariogram model between governmental and private orthodontic patients. It was hypothesized that caries risk for patients at governmental clinics is higher than for those at private clinics.

MATERIALS AND METHODS

Study Population and Design

This cross-sectional study was approved by the Ethics Committee at King Saud University, College of Dentistry Research Centre, Riyadh, KSA (Reg. No. NF 2225). It comprised a consecutive sample of 89 patients, who were recruited during a 5-month period from six representative orthodontic clinics in Riyadh, KSA (three governmental and three private). Informed consent was obtained before the start of the examination. Patients were divided into two groups based on the center of treatment: (1) governmental (G) group (n = 45), with a mean age of 22.5 years, and (2) private (P) group (n = 44), with a mean age of 21.2 years. All patients were free of any active caries lesions before receiving orthodontic treatment. They were treated with the same type of fixed orthodontic appliances in both jaws for 1.5–2 years (mean treatment time, 21 months). After bonding, routine instructions were given to all patients in both groups (eg, to brush their teeth with a fluoride toothpaste two times daily).

All patients were interviewed and examined at de-bonding by the first author. Bitewing radiographs, plaque scores, and saliva samples were taken, followed by a clinical caries examination. Intraoral digital photos were taken for illustration purposes.

Questionnaire

Patients were interviewed using a standardized structured questionnaire, as described in the Cariogram manual.[16] Information regarding medical and dental history, dietary habits, and the use of fluoride products was also collected.

Plaque Index

Immediately before de-bonding, Plaque Index (PI) was scored according to Silness and Löe[17] (Table 1). Four sites (buccal, lingual, mesial, and distal surfaces) on six representative teeth (16, 12, 24, 36, 32, and 44) were recorded; if any of these teeth had been extracted for orthodontic purpose, an adjacent tooth was recorded.

Salivary Tests

A whole saliva sample was collected just before de-bonding for measurement of flow rate, buffer capacity, and numbers of mutans streptococci (MS) and lactobacilli (LB). Paraffin-stimulated whole saliva was collected for 5 minutes, and the secretion rate was expressed as mL/min. The saliva was analyzed in terms of buffer capacity and numbers of MS and LB, using chair-side tests (Dentocult SM Strip mutans, Dentocult LB, and Dentobuff Strip, Orion Diagnostica, Espoo, Finland). MS, LB, and buffer capacity were scored in classes (Table 1), according to the manufacturer's model chart. All saliva tests were checked, and the first author and the laboratory technician agreed on the findings.

Clinical Examination of Caries

After plaque scoring, saliva sampling, and de-bonding, the teeth were cleaned with a rubber cup, pumice, and dental floss. They were dried with compressed air and then were examined with the use of a mouth mirror, a standard light, and a dental probe. Caries was scored according to World Health Organization criteria.[18] The number of decayed, missing, and filled tooth surfaces (DMFS) was calculated (ie, missing surfaces due to caries were included). Third molars were not included in this study. Bitewing radiographs were evaluated for the presence of proximal caries. White spot lesions were excluded because only frank lesions are considered in the "caries experience" according to the Cariogram.[16]

Assessment of Caries Risk Profile (Cariogram)

The Cariogram creates an individual caries risk profile.[16] Data on 10 caries-related factors (Table 1) are scored and entered into the program to produce a graphic image that illustrates the "chance of avoiding new cavities" as a percentage value. The factor "Clinical Judgment" was set to 1 for all patients.

The individual caries profile was estimated and presented in a pie chart with five sectors, expressed as percentages: (1) "Diet," based on a combination of sugar intake and the number of lactobacilli (dark blue sector); (2) "Bacteria," which is a combination of the

Table 1. Caries-Related Factors Used for the Cariogram[a,b]

Factor[c]	Information and Data Collected	Cariogram Scores
Caries experience	Past caries experience, including cavities, fillings, and missing surfaces due to caries; data from dental examination and bitewing radiographs.	0: Caries-free and no fillings. 1: Better than normal. 2: Normal for age group. 3: Worse than normal.
Related disease	General diseases or conditions associated with dental caries; medical history, medications; data from interviews and questionnaire results.	0: No disease, healthy. 1: General disease, indirectly influences the caries process to a mild degree. 2: General disease, indirectly influences the caries process to a high degree.
Diet, contents	Lactobacillus counts (Dentocult) used as a measure of cariogenic diet.	0: 0–10^3 CFU. 1: 10^3–10^4 CFU. 2: 10^4–10^5 CFU. 3: $>10^5$ CFU.
Diet, frequency	Estimation of numbers of meals and snacks per day, mean for "normal days"; data from questionnaire results.	0: Maximum 3 meals/d. 1: 4–5 meals/d. 2: 6–7 meals/d. 3: >7 meals/d.
Plaque amount	Estimation of hygiene by scoring Plaque Index according to Silness and Löe.	0: No plaque. 1: Seen by probe or disclosing agent only. 2: Moderate, seen by naked eye on tooth and gingival margin. 3: Severe film around tooth and in gingival pocket.
Mutans streptococci	Estimation of levels of mutans streptococci in saliva, using Strip mutans test; the strip was cultivated for 48 h at 37°C.	0: 0–10^3 CFU. 1: 10^3–10^4 CFU. 2: 10^4–10^5 CFU. 3: $>10^5$ CFU.
Fluoride program	Estimation of the amount of fluoride available in the oral cavity; data from questionnaire results.	0: Maximum fluoride program. 1: Fluoride supplements. 2: Only fluoride toothpaste. 3: Not using fluoride toothpaste.
Saliva secretion	Estimation of flow rate of paraffin-stimulated saliva, as millimeter saliva per minute.	0: Normal, >1.1 mL/min. 1: Low, from 0.9 to <1.1 mL/min. 2: Low, from 0.5 to <0.9 mL/min. 3: Very low, <0.5 mL/min.
Saliva buffering capacity	Estimation of capacity of saliva, using the Dentobuff test.	0: pH ≥6.0, adequate (blue) 1: pH 4.5–5.5, medium (green) 2: pH ≤4.0, low (yellow)

[a] DMFS indicates decayed, missing, filled surfaces; CFU, colony-forming units.

[b] Adapted from Bratthall and Hänsel-Petersson.[13]

[c] For each factor, the examiner has to gather information by interviewing and examining the patient, including performing saliva tests. The result is then given a score on a scale ranging from 0–3 (0–2 for some factors), according to predetermined criteria. A score of 0 is the most favorable value, and a maximum score of 3 (or 2) indicates a high, unfavorable risk value.

Table 2. Mean Values ± SD and Range of Various Caries-Related Factors in the G-Group (n = 45) and the P-Group (n = 44) (Significant Differences Between the Two Groups Are Also Shown)

	Governmental (n = 45)			Private (n = 44)			
Variable	Mean	SD	Range	Mean	SD	Range	Significance
Age	22.5	2.7	18–28	21.2	3.1	13–29	NS[a]
DMFS	13.3	12.1	2–73	8.6	9.5	0–47	$P < .05$
DMFS in anterior teeth	1.6	4.7	0–31	0.9	3.9	0–25	NS[a]
DMFS in posterior teeth	11.7	8.5	2–42	7.7	7.1	0–30	$P < .05$
Saliva secretion rate, mL/min	0.8	0.6	0.2–3.6	1.0	0.5	0.3–2.2	NS[a]
Cariogram[b], %	28	24	1–84	61	28	6–100	$P < .001$

[a] NS indicates not significant.

[b] "Actual chance to avoid new cavities." Median values were 22% and 67%, respectively.

Table 3. Frequency Distribution of Caries-Related Factors According to the Cariogram Score of the Total Number of Individuals in the Governmental Group (G) and the Private Group (P)[a,b]

Factor	Cariogram Score	G-Group (n = 45)	P-Group (n = 44)	Significance
Lactobacillus score, CFU/mL				
0–10^3	0	5	12	
10^3–10^4	1	7	13	$P < .05$
10^4–10^5	2	18	13	
10^5	3	15	6	
Plaque index				
No plaque	0	1	12	
Seen by probe or disclosing agent only	1	16	21	$P < .001$
Moderate	2	18	10	
Severe	3	10	1	
Mutans streptococci, CFU/mL				
0–10^3	0	6	15	
10^3–10^4	1	8	12	$P < .01$
10^4–10^5	2	9	11	
$>10^5$	3	22	6	
Buffer capacity, pH				
≥6.0, adequate	0	11	25	
4.5–5.5, medium	1	17	12	$P < .01$
≤4.0, low	2	17	7	

[a] A chi-square test was used to calculate the difference.
[b] CFU indicates colony-forming units.

plaque score and the number of mutans streptococci (red sector); (3) "Susceptibility," including the fluoride program, the salivary secretion rate, and the buffer capacity (light blue sector); (4) "Circumstances," the past caries experience and general diseases (yellow sector); and (5) "the chance of avoiding caries" (green sector).

Statistical Analysis

To estimate the sample sizes, a power analysis was performed. With a significance level of 5%, standard deviations within groups of 30 units, a least detectable difference of 20 units between groups on the Cariogram, and a power for that detection of 80%, a minimum of 36 patients per group was required.

All data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 18.0 (SPSS Inc, Chicago, Ill). Descriptive statistics, including the mean, standard deviations, and ranges for all factors, were calculated for all individuals in both groups. Moreover, median values for the Cariogram were calculated. To determine statistically significant differences between groups, the independent sample *t*-test was applied to the two main groups; analysis of variance (ANOVA) was used when three or more groups were compared. The chi-square test was used to compare scores. For all tests, the significance level was $P < .05$.

RESULTS

The governmental group included 19 males and 26 females, and the private group comprised 14 males and 30 females. Gender differences were not statistically significant between the two groups ($P > .05$). All

Table 4. Numbers and Locations of Caries Lesions on Groups of Teeth in Governmental and Private Patients at De-bonding

	Occlusal		Approximal		Buccal		Lingual		Total	
Teeth	G	P	G	P	G	P	G	P	G	P
Maxillary teeth										
Incisors and canines	0	0	8	4	1	0	5	0	18	
Premolars	20	11	4	2	2	0	0	0	39	
Molars	36	19	2	0	0	1	5	3	66	
Mandibular teeth										
Incisors and canines	0	0	2	0	0	0	1	0	3	
Premolars	17	6	4	1	0	0	0	0	28	
Molars	39	20	2	0	1	1	1	0	64	
Total G, total P	112	56	22	7	4	2	12	3	150	68
Total G + P	168		29		6		15		218	

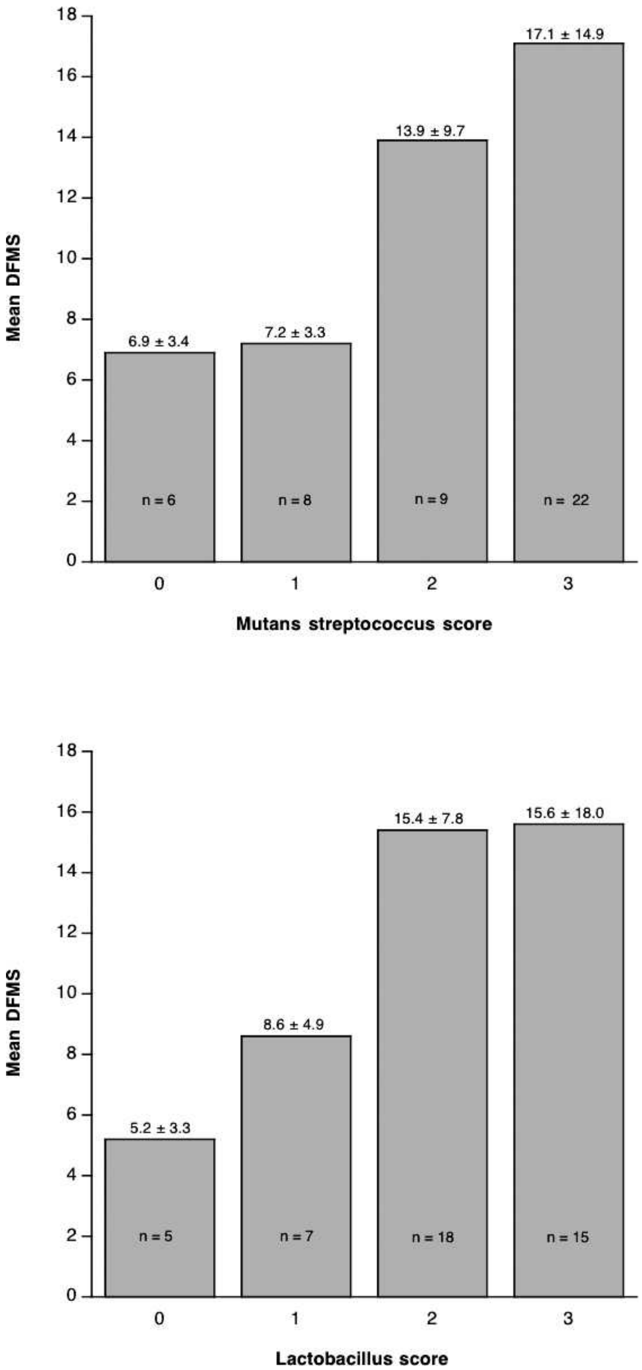

Figure 1. Mean value ± SD of DFMS at de-bonding among G-patients divided into four different MS and LB scores. The number of patients is given in each column.

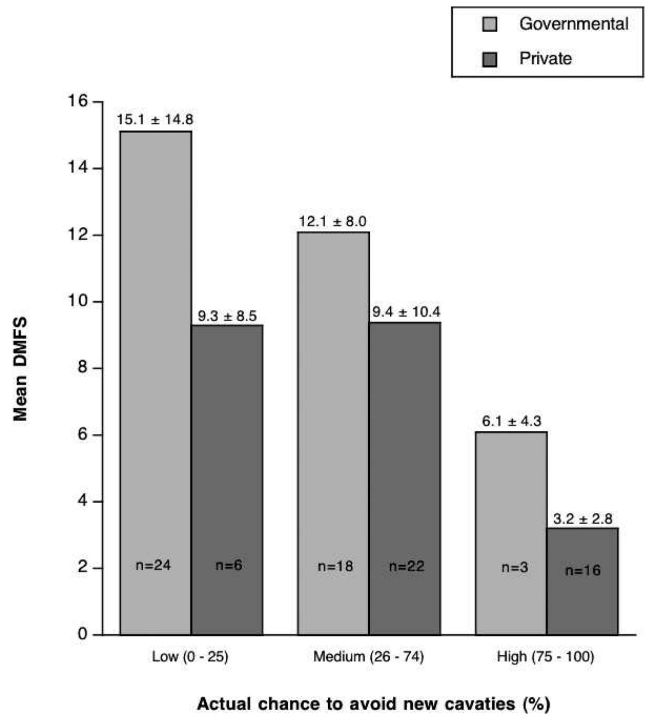

Figure 2. Mean value ± SD of DFMS at de-bonding among G and P patients of "actual chance to avoid new cavities," according to the Cariogram, divided into three different subgroups.

patients in both groups were healthy and free of any diseases or conditions that could be associated with dental caries. Regarding the fluoride program, 18% of the P-group vs 2% of the G-group used extra fluoride products, in addition to toothpaste (ie, tablets or rinsing solutions). In all, 89% of the G-group and 82% of the P-group used only fluoride toothpaste. Moreover, 9% of the G-group used no fluoride products at all. Differences between the two groups with regard to the fluoride program were not statistically significant ($P > .05$).

Statistically significant differences were noted between the two groups in most caries-related factors (Tables 2 and 3). In overall terms, the mean DMFS was higher in the G-group than in the P-group ($P < .05$). The "actual chance to avoid new cavities," according to the Cariogram, was almost three times higher in the P-group compared with the G-group (61% vs 28%) ($P < .001$).

The numbers and the locations of caries lesions at de-bonding are shown in Table 4. The total number of lesions in the G-group was more than two times higher than that in the P-group (150 vs 68) ($P < .001$). The numbers of occlusal, approximal, and lingual caries lesions in the G-group were two, three, and four times higher, respectively, than in the P-group. To check intraexaminer reliability for clinical caries registration, caries examination was done on two different occasions with 2 weeks in between for 20% of patients, and the Kappa value was 0.86.

Figure 1 illustrates the relationship between cariogenic microorganisms and the number of DMFS among G-group patients. No significant difference with regard to DMFS was observed between the different MS and LB classes. Despite this, the trend showed that the more cariogenic microorganisms, the higher was the DMFS.

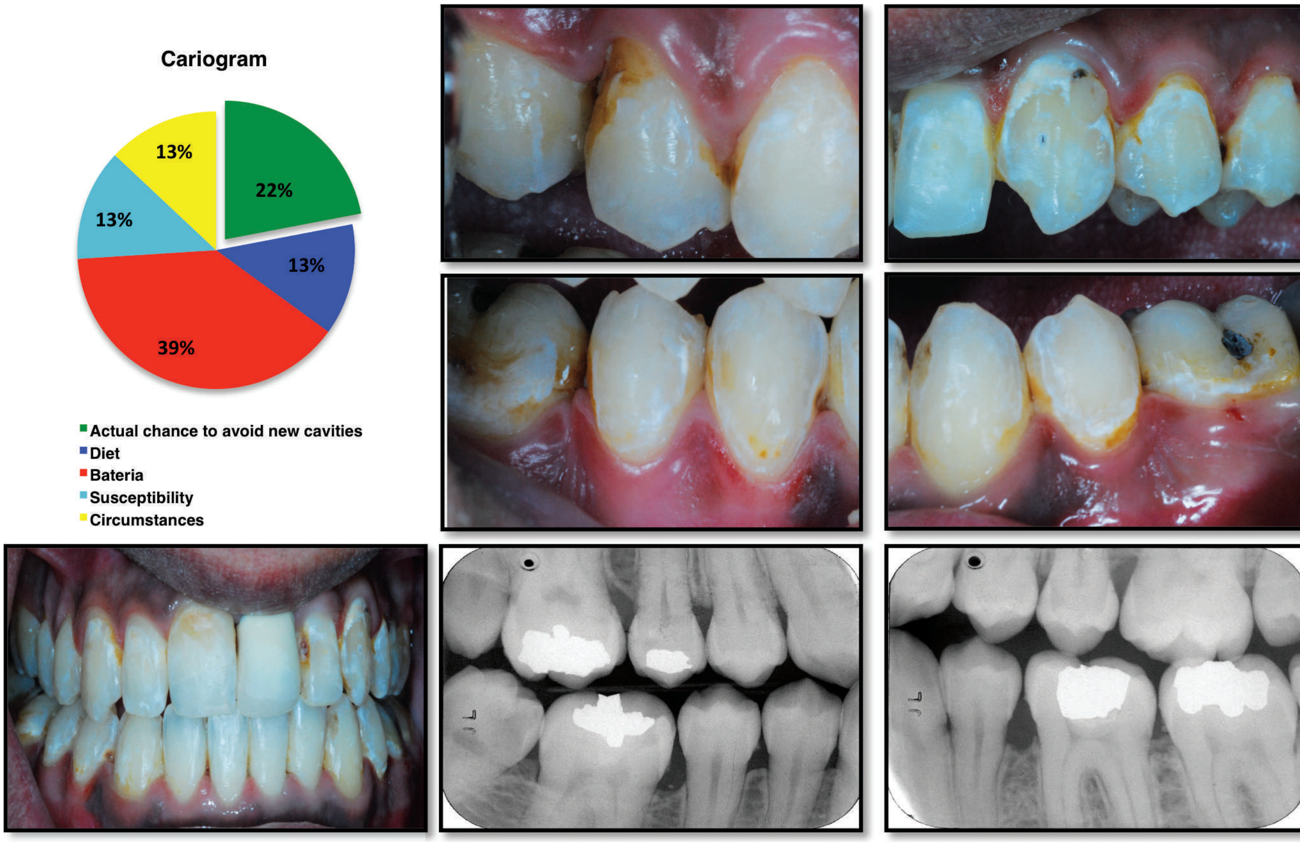

Figure 3. This 23-year-old male patient consumes a maximum of 5 meals/d and uses fluoride toothpaste infrequently (3 times/wk). He has a high number of decayed, filled surfaces and a severe film of plaque around his teeth and gingival margins. Saliva secretion is low (0.6 mL/min), but buffer capacity is good (pH ≥6). High numbers of MS and LB in saliva indicate high intake of fermentable carbohydrates. Cariogram data show a 22% chance of avoiding new cavities (green sector).

Caries risk as illustrated by the Cariogram was divided into two classes, according to the manual[16]: (1) low (≤25%, high caries risk), and (2) high (≥75, low caries risk). A third class was added (ie, 26%–74%, medium caries risk). Figure 2 shows the relationship between Cariogram values and the numbers of DMFS in these three classes. Patients with low "chance to avoid new cavities" (≤25%) had 2.5–3 times more DMFS compared with the group with high values (≥75%) in the G- and P-groups, respectively.

Two cases were selected, one from each group, based on the median value of the green sector of the Cariogram (G = 22%, P = 67%). Digital photos, bitewing radiographs, the Cariogram profile, and related information are presented in Figures 3 and 4.

DISCUSSION

Results of this study reveal that caries risk in the G-group was greater than in the P-group based on the Cariogram; this finding supports the initial hypothesis of this study. The number of DMFS, plaque index, saliva buffer capacity, and counts of LB and MS were the most significant risk indicators for caries risk when the two groups were compared.

The prevalence of caries lesions on different tooth surfaces was higher among G-patients than among P-patients. These findings are in agreement with those of other studies.[9,10] One explanation may be related to differences in fluoride habits, because all patients from the private clinics regularly used fluoride toothpaste on a daily basis, but 9% of patients from the governmental centers did not use fluoride products at all. It can also be speculated that motivation among patients attending private clinics is better, because they pay for the treatment, while those from governmental centers in the KSA receive the treatment free of charge. However, variations in oral health have been largely attributable to socioeconomic factors and to the regularity of dental attendance rather than to the method of payment itself.[19] A third explanation may be related to the preventive measures provided to patients. Orthodontists at the governmental centers may not spend enough time instructing patients about the importance of oral hygiene and the use of fluoride toothpaste during the fixed orthodontic treatment period. This is so mainly because

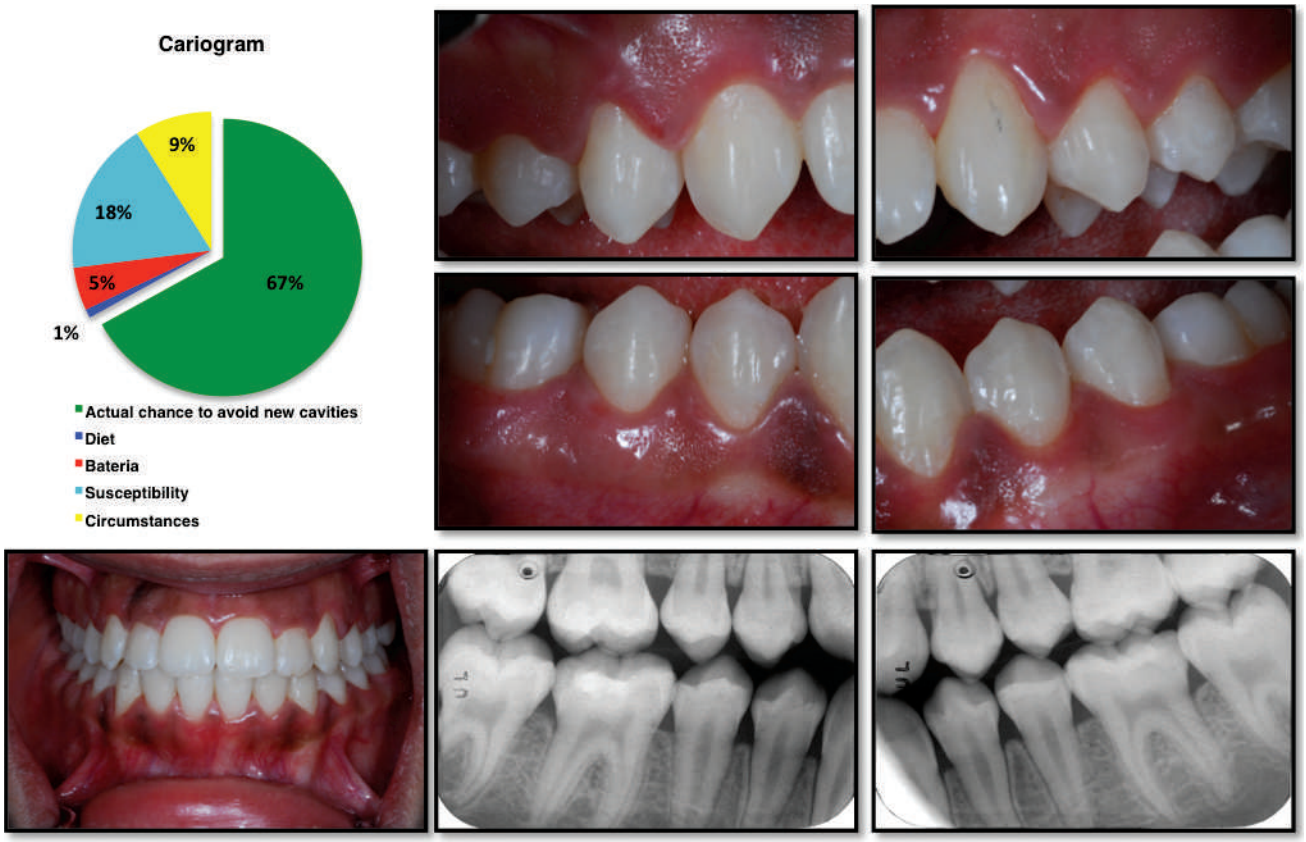

Figure 4. This 22-year-old male patient consumes a maximum of 3 meals/d and uses fluoride toothpaste frequently (2 times/d). He has a low number of filled surfaces and only a slight film of plaque around his teeth upon probing. Saliva secretion is normal (1.1 mL/min), and buffer capacity is medium (pH 4.5–5.5). Low numbers of MS and LB in saliva indicates low intake of fermentable carbohydrates. Cariogram data show a 67% chance of avoiding new cavities (green sector).

of the large numbers of patients seen every day at these centers. On the other hand, orthodontists at private clinics and their assistants may spend more time on instructions and prevention to achieve good results and to promote for their practice. It should be mentioned, however, that these explanations may not be applicable to other countries in which the medical health care system is different.

In the present study, a relationship was noted between the numbers of cariogenic microorganisms and DMFS in both groups (even if it was not statistically significant), but this relationship was most obvious in the G-group. These observations are in the line with results of a previous study by our research group among orthodontic patients.[15] On the basis of these findings, controlling the level of cariogenic microorganisms in orthodontic patients could be recommended.[20] Therefore, early diagnosis and risk assessment, including MS and LB counts in saliva, may help the orthodontist to give the patient customized recommendations to reduce the risk of caries.

The computer-based program, the Cariogram, may be a useful tool for illustrating caries risk profiles in orthodontic patients at de-bonding. It has been used previously in children and adults,[13,14] among endodontic,[21] orthodontic,[15] and periodontal disease patients.[22] The Cariogram is a practical pedagogic tool that can be shown to the patient (as shown in Figures 3 and 4). Caries prevention programs can be formulated on the basis of these profiles during the course of orthodontic treatment. However, further longitudinal validation of the Cariogram in orthodontic patients is required.

CONCLUSIONS

- The null hypothesis was rejected. In KSA, the chance to avoid new cavities in orthodontic patients at de-bonding appears to be more negative at governmental clinics than at private clinics.
- This study shows the importance of improving preventive measures used during orthodontic treatment, especially at governmental clinics.
- The Cariogram may be a useful tool for illustrating caries risk profiles for orthodontic patients.

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REFERENCES

1. Chatterjee R, Kleinberg I. Effect of orthodontic band placement on the chemical composition of human incisor tooth plaque. *Arch Oral Biol*. 1979;24:97–100.
2. Gwinnett AJ, Ceen RF. Plaque distribution on bonded brackets: a scanning microscope study. *Am J Orthod*. 1979; 75:667–677.
3. Scheie AA, Arneberg P, Krogstad O. Effect of orthodontic treatment on prevalence of Streptococcus mutans in plaque and saliva. *Scand J Dent Res*. 1984;92:211–217.
4. Øgaard B, Rølla G, Arends J. Orthodontic appliances and enamel demineralization. Part 1. Lesion development. *Am J Orthod Dentofacial Orthop*. 1988;94:68–73.
5. Lovrov S, Hertrich K, Hirschfelder U. Enamel demineralization during fixed orthodontic treatment—incidence and correlation to various oral-hygiene parameters. *J Orofac Orthop*. 2007;68:353–363.
6. Borzabadi-Farahani A, Eslamipour F, Asgari I. Association between orthodontic treatment need and caries experience. *Acta Odontol Scand*. 2011;69:2–11.
7. World Health Organization. *Continuous Improvement of Oral Health in the 21st Century: The Approach of the WHO Global Oral Health Programme*. Geneva: WHO; 2003.
8. Al Dosari AM, Wyne AH, Akpata ES, Khan NB. Caries prevalence and its relation to water fluoride levels among schoolchildren in central province of Saudi Arabia. *Int Dent J*. 2004;54:424–428.
9. Wyne AH. Caries prevalence, severity, and pattern in preschool children. *J Contemp Dent Pract*. 2008;9:24–31.
10. Brennan DS, Do LG, Slade GD. Caries experience of adults attending private and public dental clinics in Australia. *J Public Health Dent*. 2011;71:32–37.
11. Reich E, Lussi A, Newbrun E. Caries-risk assessment. *Int Dent J*. 1999;49:15–26.
12. Bratthall D. Dental caries: intervened–interrupted–interpreted. Concluding remarks and cariography. *Eur J Oral Sci*. 1996; 104:486–491.
13. Hänsel Petersson G, Twetman S, Bratthall D. Evaluation of a computer program for caries risk assessment in schoolchildren. *Caries Res*. 2002;36:327–340.
14. Hänsel Petersson G, Fure S, Bratthall D. Evaluation of a computer-based caries risk assessment program in an elderly group of individuals. *Acta Odontol Scand*. 2003;61: 164–171.
15. Al Mulla AH, Kharsa SA, Kjellberg H, Birkhed D. Caries risk profiles in orthodontic patients at follow-up using Cariogram. *Angle Orthod*. 2009;79:323–330.
16. Cariogram computer program manual, Available at: http://www.mah.se/fakulteter-och-omraden/Odontologiska-fakulteten/Avdelning-och-kansli/Cariologi/Cariogram/. Accessed February 17, 2008.
17. Silness J, Löe H. Periodontal disease in pregnancy: correlation between oral hygiene and periodontal condtion. *Acta Odontol Scand*. 1964;22:121–135.
18. World Health Organization. Oral Health Surveys: Basic Methods. 4th ed. Geneva: World Health Organization; 1997.
19. McGrath C, Bedi R. Dental services and perceived oral health: are patients better off going private? *J Dent*. 2003; 31:217–221.
20. Alves PV, Alviano WS, Bolognese AM, Nojima LI. Treatment protocol to control Streptococcus mutans level in an orthodontic patient with high caries risk. *Am J Orthod Dentofacial Orthop*. 2008;133:91–94.
21. Merdad K, Sonbul H, Gholman M, Reit C, Birkhed D. Evaluation of the caries profile and caries risk in adults with endodontically treated teeth. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2010;110:264–269.
22. Fadel H, Al Hamdan K, Rhbeini Y, Heijl L, Birkhed D. Root caries and risk profiles using the Cariogram in different periodontal disease severity groups. *Acta Odontol Scand*. 2011;69:118–124.