THE USE OF CARIODGRAM TO EVALUATE CARIES-RISK PROFILES IN ORTHODONTIC PATIENTS

This article describes the usefulness of Cariogram software in three orthodontic patients with high-, medium-, and low-risk caries profiles. Caries-related indicators and information needed for the Cariogram model were registered. The prebonding decayed and filled surfaces (DFS) indices for patient 1 (15-year-old girl) and patient 2 (18-year-old woman) were > 5, while in patient 3 (15-year-old boy), the DFS index was < 2. The data were entered into the interactive Cariogram software, which shows the various caries-related indicators. Patients 1, 2, and 3 had 6%, 58%, and 87%, respectively, actual chance of avoiding new caries. Patient 1 had high lactobacilli and medium mutans streptococci scores and a high caries risk. Patient 2 had a high DFS index and low buffer capacity, resulting in a medium caries risk. Patient 3 had low mutans streptococci and high lactobacilli scores and a low DFS index, resulting in a low caries risk. The Cariogram is available free online and is a useful educational model to illustrate a patient’s caries risk.

Key words: Cariogram, caries risk, DFS, risk indicator, risk model, mutans streptococci

Caries affects individuals differently, which makes it essential to identify high-risk patients so preventive strategies can be undertaken. Krasse introduced the term risk assessment in relation to dental caries more than 20 years ago. Since then, it has been an interesting topic in dentistry.

The concept of caries-risk assessment is simple and straightforward. The idea is to (1) identify patients who are most likely to develop caries and (2) provide these individuals with appropriate preventive measures to stop caries occurrence. Caries-risk assessment and prediction have been focus areas for the past 2 decades. Many studies have been published in this field, centered on various caries indicators, such as saliva, microbiology, diet, oral hygiene, and caries history. Caries experience; decayed, missing, filled surfaces or decayed, missing, filled teeth (DMFS or DMFT); and the amount of mutans streptococci in plaque or saliva are related to caries risk. A free online program, the Cariogram, has been developed to illustrate caries-risk profiles in teenagers and adolescents. It is interactive software that illustrates various caries-related indicators and expresses the actual chance of avoiding new caries.

The purpose of this article is to demonstrate the usefulness of Cariogram in clinical orthodontics by presenting three patients with different caries-risk profiles.

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METHODS AND MATERIALS

From an earlier study\textsuperscript{11} of 100 patients, three subjects were selected for this report. They were chosen to present the three major caries-risk groups: high, medium, and low. The preorthodontic examination charts, panoramic radiographs, and intraoral photos of these patients were carefully examined by the same orthodontist. Prebonding, patient 1 (a 15-year-old girl) and patient 2 (an 18-year-old woman) both had DFS indices $> 5$, while in patient 3 (a 15-year-old boy), it was $< 2$. None underwent any restorative therapy during their orthodontic therapy. They were treated with fixed appliances in both jaws for 1 to 2 years (mean treatment duration 18 months). Synergy brackets were used (Rocky Mountain Orthodontics), bonded with Reliance light bond material (Reliance Orthodontic Products). After bonding, routine instructions were given to all three patients to brush their teeth three times daily with fluoride toothpaste.

After debonding, the patients were examined again in the following order: data collection, plaque score, caries examination, saliva sample, radiographs (bitewing and panoramic), and intraoral digital photographs.

A standardized form was used to collect the data needed for the Cariogram. Each of the 10 parameters was ranked from 0 to 2 or 0 to 3 according to the manual\textsuperscript{10} (Table 1). All data were entered into the software to illustrate the chance of avoiding caries as a percentage (Fig 1). Not to change the built-in evaluation, the tenth factor—clinical judgment—was set to score 1 in all three patients. In accordance with the Cariogram manual,\textsuperscript{10} all three individuals were asked about the presence of general disease, diet frequency, and fluoride. They are described as related diseases, diet frequency, and fluoride program, respectively, in Table 1.

Prophylaxis and flossing were performed before caries registration. Using optimal light, a mirror, and an explorer, all types of caries lesions, in both the enamel and dentin, diagnosed clinically and on the bitewing radiographs, were included in the DFS index. White spot lesions were registered but not included. Thus, only caries was captured in the caries experience, in accordance with the Cariogram.\textsuperscript{10}

For plaque scoring, four scores were used according to Silness and Loe\textsuperscript{12} (Table 1). The amount of plaque in the cervical part of teeth 16, 12, 24, 36, 32, and 44 were registered buccally and lingually and on the proximal surfaces (FDI tooth-numbering system).

Paraffin-stimulated whole saliva was collected for 3 minutes; the secretion rate was expressed in mL/min and transformed to a score (Table 1). The same stimulated saliva was used to evaluate buffer capacity and the number of cariogenic microorganisms. Buffer capacity was checked by giving one drop of saliva on a buffer strip (Dentobuff Strip, Orion Diagnostica). Depending on the color, the saliva was scored (blue = 0, green = 1, yellow = 2). The remaining saliva was poured on the Dentocult LB (Dentocult LB, Orion Diagnostica) agar and incubated at 37$^\circ$ for 4 days to estimate the lactobacillus (LB) count. Subsequently, the colony density on the agar was compared to the respective model chart (Table 1). To determine the count of mutans streptococcus
(MS), a tongue swab of Dentocult SM (Strip Mutans, Orion Diagnostica) was incubated at 37°C for 2 days. Thereafter, the colony density on the test strip was compared with a model chart (Table 1).

Figure 1 shows how the Cariogram appears on-screen. The respective values have to be entered on the right side. The country and group have to be defined to determine whether there is a low, medium, or high risk of caries development. This will dramatically affect the overall Cariogram profile. After entering at least seven (preferably 10) variables/factors, the Cariogram pie chart appears. Based on the formula inserted in the Cariogram, all values interact with each other and illustrate five color-coded sectors with percentage values. The green sector indicates the chance of avoiding caries. The program was developed by Douglas Bratthall more than 10 years ago13 and was recently evaluated by Petersson et al.14–17

**RESULTS**

The Cariogram-related factors and the scores for the three patients of this study are shown in Table 2. All were healthy, considered free from caries-related diseases, ate a maximum of three meals/snacks per day, and used only fluoride toothpaste.
Patient 1

The actual chance of avoiding new caries was 6% in patient 1 (Fig 2), which meant she had a high risk for developing new caries. The dark blue and red sectors (diet and bacteria, respectively) were 8% and partly related to high LB (score 3) and medium MS (score 2), respectively. The susceptibility (light blue sector) was 72% due in part to a low secretion rate (score 3). The absence of caries-related diseases (score 0) and high DFT/DFS (score 3) contributed in part to 5% other circumstances (yellow sector). Her clinical photographs showed multiple composite

Table 2  Debonding caries status and caries-related variables according to Cariogram for patients 1, 2, and 3*

<table>
<thead>
<tr>
<th>Factor</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>DFT/DFS</td>
<td>10/12 (3)</td>
<td>12/17 (3)</td>
<td>1/1 (1)</td>
</tr>
<tr>
<td>Related diseases</td>
<td>No (0)</td>
<td>No (0)</td>
<td>No (0)</td>
</tr>
<tr>
<td>Lactobacilli</td>
<td>High (3)</td>
<td>Low (1)</td>
<td>Very low (0)</td>
</tr>
<tr>
<td>Diet frequency</td>
<td>(0)</td>
<td>(0)</td>
<td>(0)</td>
</tr>
<tr>
<td>Plaque Index</td>
<td>(1)</td>
<td>(3)</td>
<td>(1)</td>
</tr>
<tr>
<td>Mutans streptococci</td>
<td>Medium (2)</td>
<td>Low (1)</td>
<td>Very low (0)</td>
</tr>
<tr>
<td>Fluoride program</td>
<td>(2)</td>
<td>(2)</td>
<td>(2)</td>
</tr>
<tr>
<td>Secretion rate</td>
<td>Very Low (3)</td>
<td>Normal (0)</td>
<td>Normal (0)</td>
</tr>
<tr>
<td>Buffer capacity</td>
<td>Reduced (1)</td>
<td>Reduced (1)</td>
<td>Adequate (0)</td>
</tr>
</tbody>
</table>

*Scores in parentheses.
fillings, sealed fissures, and white spot lesions on the buccal surfaces of her molars, and the bitewing radiographs revealed one proximal caries lesion (distal to tooth 23).

Patient 2

Patient 2’s actual chance of avoiding new caries was 58%, which meant she had a medium risk for developing new caries (Fig 3). Low LB (score 1) and appropriate diet frequency (score 0) contributed to 4% diet (dark blue sector). The Cariogram bacteria (red sector) share was 17%, partially due to a high plaque score (score 3). Her low buffer capacity (score 1), the use of only fluoride toothpaste (score 2), and a normal secretion rate (score 0) resulted in 13% susceptibility (light blue sector). Her other circumstances (yellow sector) were 8%, due in part to high DFT/DFS (score 3). Her clinical photographs showed many amalgam fillings and multiple enamel defects, which made the diagnosis of white spot lesions difficult. On her bitewing radiographs, two proximal caries lesions were obvious (mesial and distal to tooth 35).

Patient 3

Patient 3’s actual chance of avoiding new caries was 87%, which hinted at a low caries risk (Fig 4). A low LB (score 0) and an appropriate diet frequency (score 0) contributed to 1% diet (dark blue sector). Low MS (score 0) and Plaque Index...
(score 1) resulted in 3% bacteria (red sector). His normal buffer capacity (score 0), use of only fluoride toothpaste (score 2), and normal secretion rate (score 0) brought susceptibility (light blue) to 7%. The absence of caries-related diseases and low DFT/DFS (score 1) contributed in part to 2% other circumstances (yellow sector). His photographs showed signs of dental fluorosis and no fillings. On his bitewing radiographs, only one proximal caries lesion was detected (mesial to tooth 46).

**DISCUSSION**

After therapy with fixed orthodontic appliances, enamel demineralization occurs in up to 50% of all patients. A study by Benson et al concluded that orthodontic patients display increased enamel demineralization after wearing fixed appliances. Many studies described how to prevent and reduce caries during orthodontic treatment, but orthodontists are still not always implementing the available action plans to prevent enamel demineralizations. Orthodontic patients are often young and have many newly erupted teeth, which increases the risk of demineralization in those regions adjacent to brackets.

In this report, the caries risk profiles of three patients at debonding based on the Cariogram are demonstrated. This educational model has previously been used in children, adults, and specifically in orthodontic patients. It assesses and predicts the caries risk and can be used...
routinely in the clinic. It illustrates caries-related factors and suggests respective actions. Only seven values are required for its application. The chairside microbiologic tests are easy to perform and can be evaluated by dental assistants. The model is freeware, user-friendly, and easy to understand. It can be used to motivate patients and develop preventive strategies.

The Cariogram varies dramatically if individual values are changed. For example, patient 1 is highly affected by low saliva secretion, so increasing it will also increase her actual chance of avoiding new caries (Fig 5). The reason for this low saliva secretion has to be investigated, especially since she is still young. In any case, she could use sugar-free chewing gum and lozenges to stimulate her saliva secretion.

Many studies have been aimed at the reduction of caries in orthodontic patients. Taking bitewing radiographs in teenagers before orthodontic treatment is important for caries-risk assessment. They allow clinicians to diagnose initial approximal caries lesions, which may not be detected clinically. In this study, white spot lesions were registered but not used as DFT/DFS values in the Cariogram according to the manual. However, with white spot lesions or areas of demineralization are caries lesions of varying depths. Therefore, not to include them and bitewing radiographs seems to be a weakness of the Cariogram. They should be considered if it is changed in the future, especially for teenagers undergoing orthodontic treatment.

Orthodontists should be aware of their patients’ caries-risk profiles, and patients with a high risk should be informed of it. An effective fluoride program can be helpful. At the same time, these patients should be seen more frequently to receive professional prophylaxis including topical fluoride application. Superior oral hygiene and rinsing with fluoride solutions once or twice daily should be advised. There is still not much information available about caries-related preventive measures that orthodontists actually use. Therefore, practice guidelines need to be developed including caries-risk assessment.

CONCLUSION

The Cariogram software is available free online. It could be a useful tool to educate patients about their individual caries-risk profile. If this risk is known, the orthodontist can easily install an adequate customized preventive program.

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