Modified fluoride toothpaste technique reduces caries in orthodontic patients: A longitudinal, randomized clinical trial

Anas H. Al Mulla,a Saad Al Kharsa,b and Dowen Birkhedc
Göteborg, Sweden, and Riyadh, Saudi Arabia

Introduction: The hypothesis of this study was that toothpaste slurry rinsing, combined with other simple postbrushing steps (the modified fluoride toothpaste technique [MFTT]), would reduce the number of decayed and filled tooth surfaces.

Methods: The study population consisted of 100 orthodontic patients randomly divided into 2 groups, 51 in the test group (mean age, 16.2 ± 4 years) and 49 in the control group (mean age, 16.9 ± 4 years). Each patient was examined before starting orthodontic treatment (baseline) and shortly after debonding (follow-up) in a 2-year study period. At each of these 2 visits, the patients were examined in the following order: interviewed by using a standardized questionnaire, plaque index registration, intraoral clinical examination, and radiographic examination (bitewings). The test group patients were instructed to use the MFTT. The control group patients were given the same fluoridated toothpaste as the test group and the routine clinical oral hygiene instructions.

Results: Compared with the control group, the test group had significantly better plaque index scores at the end of the study. At follow-up, the clinical (P < 0.001), radiographic (P < 0.001), and clinical plus radiographic (P < 0.001) incidences of decayed and filled surfaces were significantly reduced: 87%, 78%, and 83%, respectively, in the test group compared with the control group.

Conclusions: Compared with routine oral hygiene instructions with fluoride toothpaste, the use of the MFTT significantly reduced the incidence of new carious lesions in orthodontic patients. We believe that this simple regimen should be considered in orthodontic clinics. (Am J Orthod Dentofacial Orthop 2010;138:285-91)

Fluoride toothpaste has been widely used for more than 4 decades and remains a benchmark for the prevention of dental caries.1,2 It reduces caries in both permanent and deciduous teeth.3 For this reason, fluoride toothpaste is important as an effective caries-prevention measure worldwide.4 Topical fluoride (mouth rinses, gels, or varnishes), used in addition to fluoride toothpaste, achieve a modest reduction in caries compared with toothpaste used alone.5 Several studies have shown that even low levels of fluoride, from the regular use of toothpaste, can have a profound effect on enamel demineralization and remineralization.6,7

Four factors influence the anticaries efficacy of fluoride toothpaste: frequency of brushing, duration of brushing, fluoride concentration, and postbrushing rinsing. Brushing should be done twice daily,8 and patients should be persuaded to brush for a longer time.9 The salivary fluoride concentration measured after dentifrice application decreases significantly as the water rinse volume, rinse duration, and rinse frequency increase.10,11 A toothpaste technique in which a slurry rinse with the toothpaste is used after brushing increases the efficacy of the fluoride toothpaste12; it reduces approximal caries in preschool children by an average of 26%.13 Furthermore, eating immediately after brushing reduces the salivary fluoride level about 12 to 15 times compared with brushing alone.14 Postbrushing rinsing habits might play an important role in the oral retention of fluoride from dentifrices that could, in turn, affect their clinical efficacy.10

Enamel demineralization associated with fixed orthodontic therapy is a rapid process caused by cariogenic microorganisms that develop around brackets and under ill-fitting bands.15-17 Despite improvements in materials and preventive efforts, demineralization can occur around orthodontic appliances after only 1 month.18 There is a higher risk of demineralization adjacent to brackets at earlier ages, because of the lower resistance of enamel and poorer cooperation by younger patients in the orthodontic treatment process.19 Children...
in the Kingdom of Saudi Arabia (KSA) have a high prevalence of dental caries. A recent study by Brown et al. found a mean incidence of decayed, extracted, and filled teeth of 6.3 in healthy 5-year-old children.

Clinical trials are needed to give evidence-based advice on the optimal caries-prevention strategy, with clear practice guidelines. For orthodontic patients, more research is required into the various modes of delivering fluoride. The hypothesis of this study was that toothpaste slurry rinsing would reduce the numbers of decayed and filled tooth surfaces (DFS) in orthodontic patients.

MATERIAL AND METHODS

A power analysis with an assumed significance level of 5%, standard deviations of 3.0 DFS, least detectable difference of 2.0 ΔDFS, and a power for that detection of 90% was performed and produced a minimum sample size of 45 observations per group.

Our subjects consisted of 150 orthodontic patients at baseline, recruited consecutively during 6 months at a private orthodontic clinic in Riyadh, KSA. They were randomly divided into 2 groups (test and control groups) with 75 patients in each. The clinic's receptionist assigned patients with odd birth dates to the test group and patients with even birth dates to the control group. The Saudi Ministry of Health Ethics Committee approved the study. Information leaflets were given to the patients before they consented to participate in the study; written consent was obtained from all subjects before the trial.

Before the start of the treatment or the trial, the following information was obtained for both control and test groups by using a standardized form: frequency of brushing, amount of toothpaste, frequency of fluoride rinses, and the fluoride content of the toothpaste used. The number of meals eaten in a 24-hour period was also recorded. The information was obtained by a dentist (A.M.) who was blinded to the patients’ group.

The examination consisted of recording the plaque index according to Silness and Löe, registration of caries according to the World Health Organization's guidelines, after prophylaxis, flossing, and radiographic examination according to the method of Mejare et al. which consisted of 4 bitewings taken with double film. A total of 24 surfaces were included in the radiographic DFS index, from the distal aspect of the first premolars to the mesial surface of the second molars. Filled surfaces underlined with caries were scored as recurring caries.

After the data collection, the patients in both test and control groups received Colgate Max Cavity toothpaste containing 1450 ppm of fluoride (Colgate, Riyadh, KSA).

The test group received verbal and written instructions about the brushing technique: (1) use 2 cm (1 g) of dentifrice on a wet toothbrush; (2) spread the toothpaste evenly in both arches; (3) brush all surfaces for 2 minutes; (4) use a small amount of water, the equivalent of a handful with the dentifrice remaining in the mouth and filter the dentifrice slurry between the teeth by active cheek movements for 30 seconds before expectorating; (5) avoid further rinsing with water; (6) avoid drinking or eating for 2 hours; (7) brush twice a day, after breakfast and at night before going to bed; and (8) abstain from all other types of dentifrice during treatment and until its completion (Fig 1). To ensure that all patients in both groups had a supply of the study toothpaste, they were given a tube at each visit or on request.

The control group was given the routine clinical oral hygiene instructions: brushing twice a day after breakfast and after dinner before going to bed, and rinsing with a fluoridated mouthwash. At each patient visit to the clinic for the treatment follow-up, the instructions were repeated by the assigned nurse or assistant.

At the end of the trial or treatment, compliance with the use of fluoridated mouthwash and the study toothpaste by the control group and the use of the toothpaste and brushing and rinsing instructions by the test group was assessed. For the test group patients, a standard form was used to rank their compliance with the duration of brushing, the frequency of brushing, the amount of water used, and the method of filtering the dentifrice slurry, and the time between brushing, rinsing, and eating. They were ranked from 1 to 5 according to the number of instructions they had followed. Of the 5 instructions, if patients followed 1 or 2, they were considered “good,” and, if they followed more than 3, they were “very good.”

Statistical analysis

The Statistical Package for Social Sciences (version 18.0, Mac OSX, SPSS, Chicago, Ill) was used for the statistical analysis of the determined measurements. ΔDFS and prevented fractions (PF) were calculated according to these 2 formulas (ΔDFS = follow-up DFS – baseline DFS) and (PF = [control group ΔDFS – test group ΔDFS]/control group ΔDFS × 100).

For the descriptive statistics, the mean values with standard deviations were calculated. To determine statistically significant differences between the groups, the independent sample t test was applied between the groups, control vs test, and good vs very good. The significance level was set at P < 0.05. The paired t test was used to check intraexaminer reliability for the radiographic analysis. The 25 randomly selected radiographs were checked within a 1-week period.
RESULTS

At the end of treatment, 50 patients were lost or excluded, leaving 100 patients. This loss did not affect the power of the study as determined by the power analysis to determine the sample size (Fig 2).

The patients were divided into the test group \((n = 51; 10\) male, 41 female; mean age, 16.2 ± 4 years) and the control group \((n = 49; 17\) male, 32 female; mean age, 16.9 ± 4 years).

Intraexaminer reliability for the radiographic examination showed no significant difference \((P > 0.05)\), indicating good reliability.

The information obtained with the standardized form by the examiner blinded to the patients’ groups showed the following for both groups at the start of the trial: 70% brushed 2 or 3 times daily; about 50% used 1 g of toothpaste, and more than 85% used only fluoride toothpaste with no other fluoride supplements; 90% had 3 to 5 meals (plus snacks) a day; and only 6% had 7 or more meals (plus snacks) a day. At follow-up, 86% of the control patients used fluoride toothpaste only, 8% used fluoride toothpaste with fluoride mouthwash infrequently, and the remaining 6% used no fluoride.

The test and control groups’ baseline and follow-up plaque index, clinical DFS, radiographic DFS, and clinical and radiographic DFS values are shown in Table I. At baseline, there were no significant differences between the groups. At follow-up, the total number of teeth available was almost the same in both groups (test, 26.9 ± 1.7; control, 26.8 ± 1.7). At the end of the study, the test group patients had significantly better plaque index scores compared with the control group \((P < 0.05)\). Both groups had increases in their DFS index, both clinically and radiographically, with a higher increment in the control group.

The clinical, radiographic, and clinical plus radiographic \(\Delta\)DFS (incidences) are shown in Figure 3. Compared with the test group, the control group patients had more than 7 times the clinical DFS \((P < 0.001)\), more than 4 times the radiographic DFS \((P < 0.001)\), and more than 5 times the clinical plus radiographic DFS.

Fig 1. MFTT instructions: A, use 2 cm of dentifrice on a wet toothbrush, spread the toothpaste evenly in both arches, and brush carefully for 2 minutes; B, use a sip of water (1 full hand) with the dentifrice remaining in the mouth and filter the toothpaste slurry between the teeth by active cheek movements for 30 seconds before expectorating; C, avoid further rinsing with water and avoid eating and drinking for 2 hours; D, brush twice a day (after breakfast and immediately before going to bed).
(P <0.001), with PF values of 87%, 78%, and 83%, respectively.

Baseline and follow-up clinical plus radiographic DFS (total) and ΔDFS (incidence) compliance are shown in Table II. The patients with “very good” compliance had lower DFS incidence than those with “good” compliance, but the difference was not statistically significant.

DISCUSSION

The results of this study provide support for the hypothesis that the recommended MFTT was more effective in preventing caries in orthodontic patients than normal oral hygiene instructions. We observed a difference in the mean caries increment between patients who followed the MFTT and those who did not. This technique resulted in 5 times fewer DFS compared with the control group. The focus of the test group was the MFTT. On the other hand, the control group received oral hygiene instructions, but no special instructions on toothpaste technique. Our results therefore indicate that, in this population, the use of fluoride toothpaste combined with the MFTT is an important regimen that should be considered in the orthodontic clinic.

The MFTT aimed to both increase the fluoride concentration and prolong the time that the fluoride level is elevated in the oral cavity. Spreading dentifrice on the teeth before brushing and rinsing with toothpaste slurry.
immediately after brushing can be expected to produce more even distribution of the dentifrice and enhanced fluoride concentration compared with a more conventional technique. Brushing twice daily has been shown to be an important factor for caries prevention, whereas not eating or drinking for 2 hours allows a longer time for the elevated fluoride concentration.\textsuperscript{28} The MFTT contains a package of advice. It is possible to speculate about the factor that is most important, but it is not possible to identify a specific one that made our test patients develop significantly fewer caries. Based on these results, no test group patients scored 0 for compliance, and all 51 patients followed at least 1 of our 8 oral hygiene instructions. Those with “very good” compliance had fewer caries (incidence) compared with those with “good” compliance.

Duckworth et al\textsuperscript{29} found that the fluoride concentration in saliva after brushing vanished rapidly as a result of thorough rinsing. Chesters et al\textsuperscript{30} showed that the water-rinsing pattern of children after brushing

\begin{table}[h]
\centering
\caption{Plaque index, clinical DFS, radiographic DFS, and total DFS of the groups}
\begin{tabular}{|l|c|c|c|c|}
\hline
 & \textbf{Test (n = 51)} & \textbf{Control (n = 49)} & \textbf{Test (n = 51)} & \textbf{Control (n = 49)} \\
\hline
\textbf{Baseline} & \textbf{Follow-up} & \textbf{Baseline} & \textbf{Follow-up} \\
\hline
\textbf{Mean} & \textbf{Mean} & \textbf{Mean} & \textbf{Mean} \\
\textbf{SD} & \textbf{SD} & \textbf{SD} & \textbf{SD} \\
\hline
Plaque index & 1.4 $\pm$ 0.5 & 1.5 $\pm$ 0.6 & 1.1 $\pm$ 0.8 & 1.6 $\pm$ 0.7 \\
Clinical DFS & 5.6 $\pm$ 5.7 & 5.7 $\pm$ 5.4 & 5.8 $\pm$ 6.0 & 7.4 $\pm$ 7.7 \\
Radiographic DFS & 2.7 $\pm$ 3.0 & 2.3 $\pm$ 3.2 & 3.1 $\pm$ 3.0 & 4.1 $\pm$ 4.0 \\
Total DFS & 8.3 $\pm$ 7.5 & 8.1 $\pm$ 8.4 & 9.0 $\pm$ 8.0 & 11.6 $\pm$ 10 \\
\hline
\end{tabular}
\end{table}

There were no statistically significant differences at baseline, and only the plaque index was significant at follow-up.
influences the cariostatic effect of fluoride toothpaste. They concluded that children who did not use water beakers for rinsing had a significantly lower (16%) caries incidence during a 3-year period than those who used water beakers. Sjögren12 and Sjögren et al13 studied different types of postbrushing behavior; they also evaluated the caries-reducing effect of a technique similar to the one used in this study. They concluded that mouth rinsing with the toothpaste foam-water slurry after brushing elevates the concentration of fluoride in saliva for a longer time compared with tooth brushing followed by a single or double water rinse; children who used the MFTT developed fewer DFS. These observations agree with our study results; our test group patients had significantly lower mean caries incidence than did the control group.

The MFTT technique is easy to teach. Patients can be instructed on how to perform it, they can perform it in the orthodontic clinic, and a pamphlet can be handed to them with clear illustrations and instructions. Compared with other dental specialists, orthodontists have a great opportunity to emphasize fluoride toothpaste regimens in their clinics, since patients usually visit the clinic every 8 to 12 weeks, giving the orthodontist an excellent opportunity to stress the importance of using fluoride toothpaste and illustrating the instructions again. Although the MFTT is important, patients must be aware of some side effects. Slurry rinsing with the toothpaste can cause some oral discomfort and irritation of the oral mucosa. In our experience, however, few patients reported any complaints. The MFTT delivers more fluoride to the oral cavity, and it will eventually be ingested. However, only 5% to 10% is swallowed, which is negligible from a toxicologic point of view.31

Orthodontists must be aware that the MFTT used in this study was used for patients with a high risk for caries. The caries prevalence among teenagers and adolescents in KSA is high.20,32 Saudi children have high sugar intake20 and poor knowledge of oral hygiene.33 The large difference found in the ΔDFS between the test and control group patients in KSA would not be expected in other countries with a low DFS prevalence. For example, Sweden has a long tradition of fluoride toothpaste and other fluoride products for orthodontic patients; therefore, the expected caries reduction after using the MFTT is lower.

CONCLUSIONS

The use of the MFTT described in this study significantly reduces the incidence of new caries lesions in orthodontic patients. A regimen of this kind should therefore be considered in the orthodontic clinic, especially for patients with a high risk for caries.

REFERENCES


Table II. Variables for compliance with respect to DFS at baseline, follow-up, and caries incidence (ΔDFS)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Test group (n = 51)</th>
<th>Control group (n = 51)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very good (n = 22)</td>
<td>Good (n = 29)</td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td></td>
</tr>
<tr>
<td>Baseline total DFS</td>
<td>9.3 ± 8.4</td>
<td>7.5 ± 7.0</td>
</tr>
<tr>
<td>Follow-up total DFS</td>
<td>9.7 ± 9.0</td>
<td>8.4 ± 8.0</td>
</tr>
<tr>
<td>ΔDFS (incidence)</td>
<td>0.3 ± 1.5</td>
<td>0.8 ± 2.5</td>
</tr>
</tbody>
</table>

There were no statistically significant differences for any variable.