Effect of Follow-Up Intervention of Toothbrushing on Periodontal Health in Workplace Dental Examination

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Abstract: Effect of Follow-Up Intervention of Toothbrushing on Periodontal Health in Workplace Dental Examination: Takashi Hanioka, et al.

Department of Preventive and Public Health Dentistry, Fukuoka Dental College—This study examined the effect of follow-up intervention on periodontal health of workers on the basis of clinical assessment and a laboratory test. Toothbrushing instruction was given to 26 workers (41.4 ± 7.8 yr of age). In the experimental group (EG), 13 workers received re-instruction and reminder messages after the initial intervention. The remaining 13 workers, who served as a control group (CG), underwent no follow-up. Brushing skill was assessed on the basis of plaque scores for the whole mouth (Plaque Control Record, PCR) and for eight representative teeth (Plaque Index, PLI). Periodontal health was evaluated with the Community Periodontal Index (CPI). Assessment of gingival inflammation (Modified Gingival Index, MGI), measurements of pocket depth (PD) and attachment level (AL), and collection of gingival crevicular fluid (GCF) were performed at the representative sites. Aspartate aminotransferase (AST) in GCF was determined. Periodontal assessments were conducted prior to and three months after the first examination. Data were analyzed on site- and subject-bases. Both groups exhibited a significant reduction in PLI and MGI. PCR and PD significantly decreased exclusively in the EG. No significant change was observed in the CPI or AL. A significant reduction in PD in shallow pockets (PD<3 mm) and declines in AL and AST in deeper pockets (PD>4 mm) were detected in EG. A reduction in PD in deeper pockets was significant in the CG.

These results indicate that intervention with follow-up is more effective with respect to periodontal health of workers than is a single intervention; moreover, the laboratory GCF test could be employed to ascertain the outcome of behavioral change.

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Key words: Periodontal disease, Workplace, Toothbrushing, Intervention, Behavioral change, Gingival crevicular fluid, Laboratory test, Aspartate aminotransferase

Workplace health promotion is an important component of public health in terms of community intervention¹, ²). The Ministry of Health, Labor and Welfare of Japan adopted the National Health Promotion Movement in the 21st Century (Healthy Japan 21), which includes oral health as one of nine major subjects³). Promotion of periodontal health in the workplace is recommended for prevention of periodontal disease. Progression of periodontal disease, which is characterized by destruction of supportive periodontal tissues, loss of periodontal attachment and alveolar bone, leads to tooth loss. Thus, loss of teeth may diminish the quality of later life of workers.

Recent epidemiologic studies and investigations involving bio-medical methods indicated a significant correlation of periodontal disease with several general conditions: osteoporosis, cardiovascular and respiratory diseases, pregnancy disorders and diabetes mellitus⁴). The periodontal-body connections operate under a variety of possible mechanisms, including delivery of periodontal pathogens and inflammatory cytokines from periodontal lesions to the body via the blood stream⁵). In periodontal lesions, areas of connection between host tissue surface and the bio-film, i.e., dentogingival surface area, where periodontal pathogens could interact with tissue ranges from 8 cm² to 200 cm² ⁶). The dentogingival surface area

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may vary according to pocket depth; consequently, reduction of periodontal pocket size could the decrease risk of bio-film-related general diseases.

Laboratory tests for periodontal deterioration employing gingival crevicular fluid (GCF) were developed for application in clinical settings. Aspartate aminotransferase (AST) is a cytoplasmic enzyme, release of which is associated with cell damage and cell death. AST has been implicated as a predictor of periodontal disease progression\textsuperscript{7,8}. Laboratory testing of urine and peripheral blood is utilized in the workplace for early detection of general diseases and to motivate workers with respect to modification of unfavorable health behavior. The GCF laboratory test might be suitable for use in the workplace in terms of promotion of periodontal health.

Workplace dental examinations and subsequent treatment recommendations were performed annually. The program often includes intervention for toothbrushing. In clinical settings, patients receive toothbrushing instruction, which accompanies follow-up intervention during dental treatment. Literature addressing follow-up intervention for toothbrushing in the workplace is scarce. The objective of the present study was to examine the effects of intervention with follow-up on periodontal health of workers via clinical assessment and laboratory testing.

**Materials and Methods**

This investigation was conducted between April and July 2000 at a business in Kyoto prefecture, Japan. The protocol, which was designed after careful consideration of the Declaration of Helsinki of the World Medical Association, was approved by the company’s committee of occupational safety and health prior to the study. Twenty-six office personnel (18 males and 8 females, 41.4 yr of age on average, ranging from 27–54) volunteered for this investigation. Informed consent was obtained. On the first day of the study, all subjects underwent dental examination and toothbrushing instruction in the workplace.

In order to assess the effect of intervention, periodontal health was examined prior to intervention: Community Periodontal Index (CPI) functioned as the comprehensive indicator of periodontal health\textsuperscript{9}. Toothbrushing skill was assessed on the basis of the whole-mouth plaque score (Plaque control record, PCR\textsuperscript{10}) as well as in a site-specific manner (Plaque Index\textsuperscript{11}, PLI) involving eight representative teeth, namely, 12, 16, 24, 26, 36, 32, 44 and 46. Examination of gingival inflammation (Modified Gingival Index\textsuperscript{12}, MGI) and measurement of pocket depth (PD) and attachment level (AL) with a pressure-sensitive probe (Vivacare TPS Probe, Vivadent, Schaan, Lichtenstein) were also conducted in order to evaluate the periodontal health status of the representative teeth.

GCF samples were collected from the first molars, 16, 26, 36 and 46, prior to periodontal probing. The collection was performed at the mesial line angles of the palatal aspect of the upper teeth and the buccal aspect of the lower teeth. A paper strip (Periopaper, ProFlow Inc., Amityville, NY, USA) was inserted into the gingival crevice until resistance was encountered; subsequently, it remained in place for 30 s. After removal, the paper strip was stored in a sampling tube until the assay. Periodontal assessment and collection of GCF were performed three months after the initial examination.

Toothbrushing instruction by a dental hygienist included disclosure of dental plaque followed by recommendations regarding favorable skills and behavior related to toothbrushing. Participants were divided into two groups on the basis of pocket depth. In the experimental group, 13 workers received follow-up intervention based on the instruction records of the first day; follow-up intervention consisted of brief instruction 2–3 wk after the initial intervention in the workplace and delivery of reminder messages via telephone, fax or the internet two months after the initial intervention. The remaining 13 workers, so as to serve as controls, underwent no follow-up intervention. Participants were assigned to each group according to the average PD value of both sexes.

GCF samples were analyzed in a laboratory. Elution of components from paper strips was effected via gentle agitation of the samples in 400 \mu{l} of 0.02 M Tris-HCl buffer (pH 7.5) for 30 min. AST was determined by enzymatic methods with an automatic analyzer (Auto analyzer AU-5242, Olympus, Tokyo, Japan). The analysis, which involved a colorimetric test, was conducted according to the manufacturer’s recommended protocol. The AST measurements were based on the absorbance coefficient of NADH with L-aspartate as a substrate. The rate of decrease in the concentration of NADH is proportional to the AST activity in the sample. All samples were assayed in duplicate. This elution technique afforded approximately 90% recovery from the paper strips (unpublished data, this laboratory). The AST level standardized to a 30-second collection interval was expressed in international units (IU) per sample.

PLI, MGI, PD and AL of each tooth were summarized in the form of a subject mean; furthermore, data were analyzed on both site and subject-bases. The periodontal sites were classified further as shallow (PD<3 mm) and deeper pockets (PD>3 mm). Differences in PCR, PPD and CAL prior to and after intervention were evaluated with the paired \( t \)-test. Differences in CPI, MGI and PLI and AST in GCF were assessed with the Mann-Whitney test. AST in GCF was analyzed on a site-specific basis due to the existence of great variations in the amount of the substance in GCF between sites\textsuperscript{13}. These analyses were performed with statistical software (SPSS 11.0J,
The level of significance was set at 5%.

Results

The CPI score exceeded 1, which is indicative of the presence of gingival bleeding on periodontal probing; consequently, all participants were affected periodontally (Table 1). The whole-mouth plaque score (PCR) was distributed over a wide range (11.6%–81.3%). In the eight representative teeth, average scores of MGI and PLI scores were 1.5 and 1.2, respectively, indicating slight to mild gingival inflammation with slight plaque accumulation. Wide distribution ranges for the representative teeth were also observed in PD and AL.

Changes in clinical indices are shown in Table 2. Prior to intervention, each index was similar in both groups. No significant change was evident in CPI scores of both groups. Decreases in the PCR score were observed in both groups, but the decrease was significant only in the experimental group ($p=0.001$). PLI of representative teeth showed a significant reduction in both control ($p=0.003$) and experimental ($p=0.002$) groups. MGI also decreased significantly in both control ($p=0.003$) and experimental ($p=0.013$) groups. Periodontal deterioration indices (PD and AL) revealed significant improvement in PD exclusively in the experimental group ($p=0.015$).

Site-basis analyses were conducted separately in shallow (PD<3 mm, Table 3) and deeper pockets (PD>4 mm, Table 4) in both groups. Depth of shallow pockets (N=74) significantly decreased in the experimental group ($p<0.001$). No significant change in PD was observed in shallow pockets (N=70) in the control group. AL and AST in GCF demonstrated no significant change in either group. In terms of deeper pockets (Table 4), PD decreased significantly in both control (N=34, $p<0.001$) and experimental (N=30, $p<0.001$) groups. AL and AST in GCF declined significantly in the experimental group ($p=0.003$); in contrast, AL and AST in GCF displayed no significant change in the control group.

Table 1. Descriptive statistics of clinical variables for all participants

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPI</td>
<td>2.4</td>
<td>0.9</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>PCR (%)</td>
<td>43</td>
<td>18.9</td>
<td>11.6</td>
<td>81.3</td>
</tr>
<tr>
<td>PLI</td>
<td>1.2</td>
<td>0.5</td>
<td>0.5</td>
<td>2.3</td>
</tr>
<tr>
<td>MGI</td>
<td>1.5</td>
<td>0.6</td>
<td>0.4</td>
<td>2.4</td>
</tr>
<tr>
<td>PD (mm)</td>
<td>2.9</td>
<td>0.7</td>
<td>1.9</td>
<td>5.1</td>
</tr>
<tr>
<td>AL (mm)</td>
<td>1.9</td>
<td>1.3</td>
<td>0</td>
<td>6.2</td>
</tr>
</tbody>
</table>

Table 2. Changes in clinical indices of workers in control and experimental groups

<table>
<thead>
<tr>
<th>Variables</th>
<th>Baseline</th>
<th>3 months</th>
<th>$p$</th>
<th>Baseline</th>
<th>3 months</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPI</td>
<td>2.2 ± 0.8</td>
<td>2.5 ± 0.9</td>
<td>0.083</td>
<td>2.5 ± 1.0</td>
<td>2.2 ± 0.8</td>
<td>0.157</td>
</tr>
<tr>
<td>PCR (%)</td>
<td>42.0 ± 18.5</td>
<td>35.4 ± 20.2</td>
<td>0.310</td>
<td>43.9 ± 19.9</td>
<td>25.1 ± 11.9</td>
<td>0.001</td>
</tr>
<tr>
<td>PLI</td>
<td>1.2 ± 0.4</td>
<td>0.6 ± 0.5</td>
<td>0.003</td>
<td>1.3 ± 0.6</td>
<td>0.5 ± 0.4</td>
<td>0.002</td>
</tr>
<tr>
<td>MGI</td>
<td>1.5 ± 0.6</td>
<td>0.9 ± 0.6</td>
<td>0.003</td>
<td>1.4 ± 0.6</td>
<td>0.9 ± 0.7</td>
<td>0.011</td>
</tr>
<tr>
<td>PD (mm)</td>
<td>2.9 ± 0.7</td>
<td>2.6 ± 0.8</td>
<td>0.172</td>
<td>2.9 ± 0.8</td>
<td>2.3 ± 0.7</td>
<td>0.015</td>
</tr>
<tr>
<td>AL (mm)</td>
<td>1.9 ± 1.2</td>
<td>2.0 ± 1.1</td>
<td>0.756</td>
<td>1.9 ± 1.5</td>
<td>1.7 ± 1.0</td>
<td>0.261</td>
</tr>
</tbody>
</table>

Groups: Experimental group; instruction in toothbrushing at baseline with follow-up intervention for re-instruction in 2–3 wk and delivery of reminder messages via telephone, fax or internet two months after initial intervention, and Control group; single intervention for toothbrushing.
Workplace promotion of periodontal health has been reported globally, e.g., Hong Kong\textsuperscript{14}, Great Britain\textsuperscript{15}, Australia\textsuperscript{16} and Germany\textsuperscript{17}, but the effect of follow-up for toothbrushing on periodontal health of workers has not been described. In the present study, PLI improved and MGI decreased possibly as a result of plaque reduction after intervention for toothbrushing. In the experimental group, additional improvement was observed in PCR (as an indicator of toothbrushing skill) and PD, which may be attributable to improvements associated with brushing skill in the experimental group with follow-up. These results indicate that workplace intervention for toothbrushing is effective with respect to plaque reduction and periodontal health; moreover, the effect of intervention with follow-up is more apparent than that of single intervention.

Detection of the effects of intervention may be facilitated in site-basis analysis in comparison to subject-basis analysis as changes in individual sites could be diluted in subject-basis analysis. Improvement of PD was detected even in sites exhibiting shallow pockets in the group characterized by follow-up after intervention. This finding supports the aforementioned conclusion; that is, intervention with follow-up could be more effective than single intervention. Furthermore, the reductions of PD detected in both deeper and shallow sites indicate bifunctional effects of intervention of toothbrushing with follow-up; recover and promotion of periodontal health, respectively. The decrease in PD may contribute to a reduction in the dentogingival surface area and connection area of bio-film to tissue, which may reduce the possibility of general periodontal-related diseases. Site-base analyses of deeper pockets in the control group detected a further decrease in PD. Single intervention for toothbrushing may be effective with respect to a reduction in periodontal pockets. Since reductions in periodontal pockets and gingival inflammation could diminish the risk of bad breath\textsuperscript{18}, toothbrushing instruction may be an important intervention for worker engaging services.

Site-base analyses of the experimental group revealed improvement in AL and AST in GCF. AL is an important measure of periodontal destruction as the attachment is located at the bottom of the periodontal pocket, which directly indicates the loss of supportive tissue directly. Improvement in AL evident in the experimental group suggests a more apparent health outcome of follow-up intervention in comparison with single intervention. Similarly, improvement of AST in GCF was observed in laboratory tests. Biological markers in the GCF test are employed as indicators of periodontal treatment intervention\textsuperscript{19}. AL is a definitive indicator of the health of supportive periodontal tissue; nevertheless, measurement of AL is extremely difficult in the workplace as the measurement requires identification of the pocket bottom and the cement-enamel junction for each procedure. Substantial opportunity exists in terms of further improvement regarding collection of GCF in the workplace. For example, workers could collect GCF

### Table 3. Changes in clinical and biochemical variables in GCF at sites exhibiting probing depth <= 3 mm in control and experimental groups

<table>
<thead>
<tr>
<th>Variables</th>
<th>Control group (N=70)</th>
<th>Experimental group (N=74)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>3 months</td>
</tr>
<tr>
<td>PD (mm)</td>
<td>2.3 ± 0.5</td>
<td>2.3 ± 0.8</td>
</tr>
<tr>
<td>AL (mm)</td>
<td>1.3 ± 0.9</td>
<td>1.5 ± 1.0</td>
</tr>
<tr>
<td>AST (mIU)</td>
<td>0.9 ± 1.1</td>
<td>1.0 ± 1.7</td>
</tr>
</tbody>
</table>

Description of the control and experimental groups is shown in Table 2.

### Table 4. Changes in clinical and biochemical variables in GCF at sites exhibiting probing depth >= 4 mm in control and experimental groups

<table>
<thead>
<tr>
<th>Variables</th>
<th>Control group (N=34)</th>
<th>Experimental group (N=30)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>3 months</td>
</tr>
<tr>
<td>PD (mm)</td>
<td>4.0 ± 0.6</td>
<td>3.1 ± 1.3</td>
</tr>
<tr>
<td>AL (mm)</td>
<td>3.1 ± 1.3</td>
<td>3.0 ± 1.4</td>
</tr>
<tr>
<td>AST (mIU)</td>
<td>3.6 ± 6.0</td>
<td>2.5 ± 3.3</td>
</tr>
</tbody>
</table>

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**Discussion**

Workplace promotion of periodontal health has been reported globally, e.g., Hong Kong\textsuperscript{14}, Great Britain\textsuperscript{15}, Australia\textsuperscript{16} and Germany\textsuperscript{17}, but the effect of follow-up for toothbrushing on periodontal health of workers has not been described. In the present study, PLI improved and MGI decreased possibly as a result of plaque reduction after intervention for toothbrushing. In the experimental group, additional improvement was observed in PCR (as an indicator of toothbrushing skill) and PD, which may be attributable to improvements associated with brushing skill in the experimental group with follow-up. These results indicate that workplace intervention for toothbrushing is effective with respect to plaque reduction and periodontal health; moreover, the effect of intervention with follow-up is more apparent than that of single intervention.

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themselves. The use of a paper strip may be more convenient than a probing examination; as a result, the GCF test could encourage workers to establish and to continue appropriate behavior with respect to toothbrushing.

Changes in several behaviors, which are risk factors for chronic disease in later life, were recommended in workplace health promotion. Toothbrushing may be important with respect to behavioral change in the workplace for several reasons: Behavioral change related to toothbrushing could be achieved more readily than changing of other health behaviors such as smoking and exercise for prevention of obesity as toothbrushing is an existing behavior, which requires modification only. Health outcome following behavioral change in this case could become apparent quickly, within three months in the present study, compared with chronic general diseases. Thus, the individual worker could recognize the importance of behavioral change, i.e., intervention for toothbrushing might serve as a gateway for health awareness in the workplace. Periodontal disease leads to tooth loss, which may diminish the QOL in later life of workers. Periodontal pathogens and inflammatory cytokines from periodontal lesions possess the potential for periodontal-body connections. Thus, two favorable health outcomes in later life are possible if appropriate toothbrushing is established: QOL with excellent oral function and diminished risk of life-threatening chronic disease through reduction of exposure of oral bio-film.

In the experimental group, several modes of communication were employed for follow-up intervention, namely, fax, telephone and the internet. Follow-up intervention assumed the form of re-instruction in the workplace in order to confirm behavioral change. Dental hygienist visits to the workplace for follow-up may be expensive, but the cost could be reduced by using interactive internet telecommunication devices involving television.

Despite the limited number of participants in the present investigation, differences in the outcome of intervention for toothbrushing were apparent consequent to the application of a variety of indices of periodontal health. The results indicated that intervention with respect to toothbrushing in the workplace is effective in terms of improvement in periodontal health and that intervention with follow-up is more effective than single intervention. Convenient laboratory testing could be employed to determine the outcome of behavioral change associated with toothbrushing among workers.

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