Effect of gingival displacement cord and cordless systems on the closure, displacement, and inflammation of the gingival crevice

Sumi Chandra, MDS,a Ajay Singh, MDS,b K. K. Gupta, MDS,c Chetan Chandra, MDS,d and Varun Arora, MBA, MEARMAe

Gingival displacement allows a gingival or subgingival finishing line and the unprepared part of the tooth adjacent to it to be recorded in the impression. This provides sufficient space for an adequate bulk of material between the tooth and the sulcal wall. The impression material entering the gingival crevice must have sufficient bulk and rigidity to withstand distortion and tearing when the impression is removed from the undercut areas and poured.1

The critical sulcal width has been reported to be approximately 0.2 to 0.4 mm at the level of the finishing line.2 Impressions with less sulcal width have a higher incidence of voids, tearing of impression materials, or reduction in marginal accuracy.2 The quality of the impression, however, is directly influenced by clinical parameters such as the location of the finish line, periodontal health, and sulcal bleeding during impression making.3

ABSTRACT

Statement of problem. The gingival sulcus should remain open long enough for the impression material to flow into it and completely fill the space provided by the gingival displacement. Impressions with less sulcal width have a higher incidence of voids, tearing of impression materials, and reduction in marginal accuracy.

Purpose. The purpose of this clinical study was to investigate the closure, gingival displacement, and gingival inflammation of the gingival crevice after the use of medicated gingival displacement cord and cordless systems.

Material and methods. Gingival sulcus closure was studied in 40 participants. They were divided into 4 groups: 2 cord (Ultrapack, SilTrax AS) and 2 cordless (Expasyl, Traxodent Hemodent paste) methods. The labial surfaces of the maxillary right and left central incisors were evaluated. Gingival sulcus was photographed every 20 seconds from 0 to 180 seconds after the removal of the cord or cordless system. The bleeding index (BI) and gingival index (GI) were measured at day 0, day 1, and day 7. The width of the sulcal orifice was measured at the mid-buccal (MB) and transitional line angle (TLA) on a digital image, using computer software (Photoshop version 7.0; Adobe). Data were analyzed with ANOVA, Tukey honest significant difference (HSD), Kruskal-Wallis, and Mann-Whitney U tests (α=.05).

Results. All groups showed a sulcal width greater than 0.22 mm up to 60 seconds after the removal of the displacement materials at the MB and up to 40 seconds at the TLA. Among all groups, Expasyl showed the fastest closure. Gingival displacement in the MB area for the cord group was greater than for the cordless groups. GI and BI indices were larger for the cord group than for the cordless group at days 0 and 1.

Conclusions. At up to 60 seconds, the cord and cordless techniques were equally effective. The cord group showed a greater amount of displacement than the cordless group. However, the cordless materials showed reduced frequency of changes to the gingival index. (J Prosthet Dent 2016;115:177-182)

The use of displacement cords as a mechanical or chemomechanical technique is well established because of its relative predictability, effectiveness, and safety.
compared with that of rotary gingival curettage or electrosurgery.\textsuperscript{3-5} However, the use of gingival displacement cord can be laborious and time consuming and can cause gingival bleeding and lead to direct injury and gingival recession.\textsuperscript{6-9} Recently, cordless techniques have been introduced with several claimed advantages, such as time savings, enhanced patient comfort, and minimal invasiveness.\textsuperscript{10,11}

The only reported criteria for clinical assessment of displacement cords are the ability to inhibit hemorrhage and indirect assessments of the crevice dilation with impression materials. However data for the precision and accuracy of these measurements have not been reported. Kazemi et al\textsuperscript{12} compared the effectiveness of 2 gingival displacement procedures on the cast obtained from the impressions made after gingival displacement. In another study, Raja et al\textsuperscript{13} used a flexible scale for the measurements.

Until now, no study has demonstrated the closure of the gingival crevice after the removal of the displacement cord and cordless materials. The present study was undertaken to study the closure and inflammation of the gingival crevice after removal of the medicated displacement cord and cordless systems. The study was also conducted to investigate the gingival displacement of cordless materials in comparison with conventional displacement cords.

**MATERIAL AND METHODS**

The study was performed in 40 study participants who volunteered for the study. Prior to the study, the protocol was explained to the participants, and informed consent was obtained. The study protocol was approved by the institutional ethical committee. Participants included in the study were between 20 and 40 years of age, were of both sexes and of varying socioeconomic status, and were clinically free of gingival inflammation or systemic disease. Individuals with relevant medical history, signs of periodontal disease and attachment loss, history of systemic disease, and smokers were excluded from the study.

The 40 participants were randomly divided by drawing lots among 4 experimental groups: group U (Ultra-pack), group S (SilTrax AS), group E (Expasyl), and group T (Traxodent Hemodent paste) (Table 1). The study was conducted on the labial surface of the maxillary right and left central incisors. Sulcal depth was measured by inserting a periodontal probe (UNC-15; Hu-Friedy Mfg Co, LLC) into the gingival sulcus opposite the transitional line angles (TLA) and mid-buccal areas of the tooth until slight resistance was felt. Measurements were made at the TLA and mid-buccal areas to rule out the presence of periodontal pockets. On a diagnostic cast, an acrylic resin jig was fabricated to fit over the mandibular teeth to prop the mouth open and to stabilize the mandible during assessment (Fig. 2).

Gutta percha points (no. 40) were attached to the labial surface of the tooth in the mid-buccal area, and at the distal transitional line angle with a light-polymerized flowable composite resin material (Image Flowable light-cured low-viscosity composite; Septodont). Gingival displacement was done using a double cord displacement technique\textsuperscript{14} with black braided silk, size 3-0 (Ethicon; Johnson & Johnson Ltd), which remained in the sulcus during the entire investigation of closure of the sulcus, regardless of the displacement material.\textsuperscript{15} The black braided silk remaining in the sulcus facilitated identification of the inner wall of the sulcus (Fig. 3). Although the black cord might have affected the behavior of the closing sulcus, its use in both the TLA and mid-buccal sulci was assumed not to invalidate the comparison of their closure rates.

Both displacement cords (Fig. 4A, B) were placed in the sulcus with a cord packer (Dispodent) and remained in the sulcus for 5 minutes. After cords were removed, the sulcus was photographed at an interval of 20 seconds from 0 to 180 seconds. Both of the cordless materials

---

**Clinical Implications**

At up to 60 seconds, cord and cordless materials are equally effective. The cordless technique is not recommended for multiple abutment impressions because of inadequate sulcal width.

---

**Table 1. Distribution of different experimental groups**

<table>
<thead>
<tr>
<th>Experiment Group A (Cord)</th>
<th>Experiment Group B (Cordless)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group U = Ultrapak no. 1 knitted cord impregnated with epinephrine, 1:1000 dilution (Ultradent Products Inc)</td>
<td>Group T = Traxodent hemodent paste displacement system, 15% aluminum chloride (Premier Dental Products)</td>
</tr>
<tr>
<td>Group S = SilTrax AS no. 1, braided gingival displacement cord impregnated with aluminum sulfate (Pascal Company, Inc)</td>
<td></td>
</tr>
<tr>
<td>Group E = Expasyl (Kerr Corp) kaolin, 15% aluminum chloride (Pierre Rolland Acteon Labs)</td>
<td></td>
</tr>
</tbody>
</table>

*See Figure 1.*

---

**Figure 1. Cord and cordless gingival displacement material.**
were injected into the sulcus without exerting pressure on the gingiva (Fig. 4C, D). The material remained in the sulcus for 2 minutes, after which it was removed with a 3-way syringe and photographs were made. A camera (model D-300S with 60-mm lens and ring flash; Nikon Corp) was positioned on a heavy-duty tripod stand at an appropriate angle and distance from the participant’s mouth, and was kept constant throughout the assessment of each participant (Fig. 2).

The BI and GI were measured at day 0, day 1, and day 7. The width of the sulcal orifice was measured at the mid-buccal point and the TLA on the digital photograph. Closure of the sulcus was assessed with computer software (Photoshop v7.0; Adobe). Measurements were made in picas (1 picas=4.23 mm) for convenience and accuracy (Fig. 5). Measurements were made from the inner gingival wall across to the tooth surface at a 90-degree angle. The sulcus was photographed with markers of known width (gutta percha no. 40) placed across the mid-buccal and TLA sulci to calculate magnification (Fig. 5).

The following clinical parameters were measured at each of the following selected sites: gingival sulcus closure, gingival displacement, BI, and GI. ANOVA, the Tukey HSD test, the Kruskal-Wallis test, and Mann-Whitney U tests (α=.05) were used.

RESULTS

The mean closure at different time intervals was highest for group U (Ultrapack) and lowest for group T (Traxodent). At 20, 60, and 80 seconds, none of the differences between the 2 groups were statistically significant (P>.05). At all other time intervals, group S (SilTrax) had a significantly higher mean value than group E (Expasyl) (P<.05). At 140-, 160-, and 180-second intervals, the mean value of group U was significantly higher than that of group E (P<.05). With the exception of group E, all 3 groups were found to be comparable at all time intervals (Table 2). At TLA and at all time intervals, group U had a significantly higher mean value than that of group E (Table 3).

With time, the closure rate decreased. Between 0 and 20 seconds, it was maximum in group U for TLA and in group S for MB. For MB, on most occasions, it was maximum for group S up to 80 seconds. Subsequently, group U showed the maximum rate on most occasions. In general, at both locations, the closure rates slowed down with the passage of time.

The GI was maximum for group U and minimum for group E at day 0 and day 1. At day 7, all the participants had a GI score of 0. At day 0, a statistically significant intergroup difference was observed (F=12.169; P<.001). However, from day 1 onward, no significant differences were observed among the groups. At day 7, all participants had a GI score of 0 (Fig. 6).

No bleeding was noticed in group E at any time interval. On day 1, only group E (SilTrax braided cord) showed bleeding. At day 0, group U (Ultrapack knitted cord) had the maximum score, whereas group T had the minimum. At day 0, cord groups (U and S) had significantly higher values than the cordless groups (E and T) (Fig. 7). None of the other comparisons were found to be statistically significant.

DISCUSSION

The accurate transfer from the patient to the definitive cast with an impression is crucial to obtain restorations with precise marginal fit.1 Gingival displacement is necessary to allow a gingival or subgingival finishing...
line and to allow the unprepared part of the tooth adjacent to it to be recorded in the impression. This study was performed using unprepared teeth, which avoided the adverse effects of preparation and interim restoration fabrication steps on the gingival tissue. This provided the study with a homogenous group, as shown by the periodontal baseline measurement. However, because the displacement materials were applied to structurally healthy teeth, in which no crown preparation was performed, the results should be extrapolated to the clinical situation with caution. Nevertheless, the technique and time of application followed the manufacturer’s instructions. This is in accordance with Al Hamad et al.11


Figure 5. Measurements of closure of gingival crevice from mid-buccal gutta percha to inner wall of gingival sulcus with photoimaging software. A, At 0 seconds. B, At 180 seconds.
The recovery of an impression without marginal tears depends on the thickness of the impression margin, the tear strength of the impression material, and its ability to undergo elastic deformation when being removed from undercut areas. In the present study, all groups showed a sulcal width greater than 0.22 mm up to 60 seconds after removing the gingival displacement materials at the mid-buccal area and up to 40 seconds at the transitional line angle. (Figs. 6, 7) This indicated that up to 60 seconds, all materials were equally effective. The cordless groups showed inadequate sulcal width after 60 seconds at the mid-buccal and after 40 seconds at the TLA area, which may result in defects in the impression. For a single abutment, 40 seconds is sufficient time to insert the impression. However, when an impression is made of multiple abutments, the crevice of the last abutment may close considerably before the wash impression material has been injected. Among all groups at all time intervals, Expasyl showed the minimum sulcal width. This agrees with the study by Kazemi et al.\textsuperscript{12} which found that the mean width of the displaced sulcus in the presaturated cord group (0.46 ±0.34 mm) was greater than that of the Expasyl paste group.

The widening of the sulcus at the mid-buccal area for the cord groups (U and S) was 1.08 mm and 1.05 mm, respectively, and 0.44 mm and 0.71 mm for the cordless groups (E and T), respectively, 3 minutes after the removal of the gingival displacement material. The cord group showed a greater amount of displacement than the cordless group. This result is similar to that in the study by Kazemi et al.\textsuperscript{12} In the present study, no statistically significant differences were found between the closure of the sulcus with the knitted (group U) and that of the braided (group S) cords. However, this finding is contrary to the results reported by Jokstad\textsuperscript{9} and Raja et al\textsuperscript{13} who found that knitted cords were better than braided cords, with greater gingival displacement.

Laufer et al.\textsuperscript{15} found that the mid-buccal sulcus remained open longer than the transitional line angle. In the present study, all groups showed a faster closure rate at the transitional line angle than at the mid-buccal area. Although the sulcal widths at the mid-buccal and TLA points were similar immediately after the cords were removed, the mid-buccal sulcus remained open longer. The study showed that with the passage of time, the closure rate decreased.

In this study, the GI was maximum for Ultrapack knitted cord (group U) and minimum for the cordless group (group E/T) at days 0 and 1. Results for the knitted cord (group U) in this study were similar to those reported by Feng et al.\textsuperscript{6} who reported that GI was the highest on the first and second day after placement of the

---

**Table 2.** Mean ±SD picas of closure of gingival sulcus in different groups at different time intervals (mid-buccal GP)

<table>
<thead>
<tr>
<th>Time Interval</th>
<th>Group U</th>
<th>Group S</th>
<th>Group E</th>
<th>Group T</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>0.064 ±0.039</td>
<td>0.043 ±0.026</td>
<td>0.015 ±0.007</td>
<td>0.036 ±0.022</td>
<td>2.414</td>
<td>0.083</td>
</tr>
<tr>
<td>40</td>
<td>0.094 ±0.053</td>
<td>0.091 ±0.044</td>
<td>0.032 ±0.017</td>
<td>0.075 ±0.062</td>
<td>3.054</td>
<td>0.041</td>
</tr>
<tr>
<td>60</td>
<td>0.110 ±0.065</td>
<td>0.117 ±0.045</td>
<td>0.052 ±0.031</td>
<td>0.107 ±0.087</td>
<td>2.416</td>
<td>0.082</td>
</tr>
<tr>
<td>80</td>
<td>0.140 ±0.064</td>
<td>0.151 ±0.056</td>
<td>0.069 ±0.033</td>
<td>0.134 ±0.104</td>
<td>2.888</td>
<td>0.049</td>
</tr>
<tr>
<td>100</td>
<td>0.167 ±0.079</td>
<td>0.175 ±0.059</td>
<td>0.077 ±0.031</td>
<td>0.147 ±0.114</td>
<td>3.371</td>
<td>0.029</td>
</tr>
<tr>
<td>120</td>
<td>0.183 ±0.085</td>
<td>0.197 ±0.060</td>
<td>0.090 ±0.032</td>
<td>0.152 ±0.118</td>
<td>3.517</td>
<td>0.025</td>
</tr>
<tr>
<td>140</td>
<td>0.209 ±0.107</td>
<td>0.217 ±0.066</td>
<td>0.098 ±0.034</td>
<td>0.165 ±0.128</td>
<td>3.573</td>
<td>0.023</td>
</tr>
<tr>
<td>160</td>
<td>0.237 ±0.131</td>
<td>0.239 ±0.070</td>
<td>0.102 ±0.037</td>
<td>0.167 ±0.127</td>
<td>3.433</td>
<td>0.011</td>
</tr>
<tr>
<td>180</td>
<td>0.259 ±0.143</td>
<td>0.256 ±0.081</td>
<td>0.104 ±0.038</td>
<td>0.168 ±0.126</td>
<td>4.733</td>
<td>0.007</td>
</tr>
</tbody>
</table>

**Table 3.** Mean ±SD picas of closure of gingival sulcus in different groups at different time intervals (transitional line angle)

<table>
<thead>
<tr>
<th>Time Interval</th>
<th>Group U</th>
<th>Group S</th>
<th>Group E</th>
<th>Group T</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>0.078 ±0.101</td>
<td>0.020 ±0.013</td>
<td>0.013 ±0.013</td>
<td>0.022 ±0.015</td>
<td>3.368</td>
<td>0.029</td>
</tr>
<tr>
<td>40</td>
<td>0.102 ±0.107</td>
<td>0.044 ±0.019</td>
<td>0.023 ±0.015</td>
<td>0.038 ±0.024</td>
<td>3.805</td>
<td>0.018</td>
</tr>
<tr>
<td>60</td>
<td>0.124 ±0.108</td>
<td>0.068 ±0.026</td>
<td>0.032 ±0.014</td>
<td>0.057 ±0.036</td>
<td>4.381</td>
<td>0.010</td>
</tr>
<tr>
<td>80</td>
<td>0.138 ±0.114</td>
<td>0.086 ±0.023</td>
<td>0.043 ±0.016</td>
<td>0.069 ±0.043</td>
<td>4.099</td>
<td>0.013</td>
</tr>
<tr>
<td>100</td>
<td>0.157 ±0.125</td>
<td>0.105 ±0.032</td>
<td>0.050 ±0.024</td>
<td>0.079 ±0.046</td>
<td>4.273</td>
<td>0.011</td>
</tr>
<tr>
<td>120</td>
<td>0.171 ±0.128</td>
<td>0.117 ±0.038</td>
<td>0.058 ±0.021</td>
<td>0.084 ±0.047</td>
<td>4.636</td>
<td>0.008</td>
</tr>
<tr>
<td>140</td>
<td>0.180 ±0.132</td>
<td>0.139 ±0.055</td>
<td>0.066 ±0.022</td>
<td>0.088 ±0.044</td>
<td>4.593</td>
<td>0.008</td>
</tr>
<tr>
<td>160</td>
<td>0.189 ±0.143</td>
<td>0.149 ±0.064</td>
<td>0.076 ±0.026</td>
<td>0.088 ±0.044</td>
<td>4.131</td>
<td>0.013</td>
</tr>
<tr>
<td>180</td>
<td>0.206 ±0.164</td>
<td>0.157 ±0.072</td>
<td>0.077 ±0.027</td>
<td>0.092 ±0.041</td>
<td>4.148</td>
<td>0.013</td>
</tr>
</tbody>
</table>
gingival displacement cord; however, it appeared clinically to reverse itself in 2 weeks. De Gennaro et al. also reported fewer inflammatory changes in cord impregnated with aluminum sulfate than with other agents. However, this contrasts with the clinical study done by Al Hamad et al., who reported that Expasyl had the highest GI compared with cord after the first day and showed slower healing.

No bleeding was noticed in group E at any time interval. At day 0, Ultrapack (group U) had the maximum score, whereas groups E and T had the minimum, indicating the advantage of gentle tissue management with cordless materials over cords. This was similar to findings reported by Yang et al. and Al Hamad et al.

CONCLUSIONS

This clinical study investigated the closure, gingival displacement, and gingival inflammation of the gingival crevice after removing the cord and cordless materials. All materials showed adequate sulcal width up to 60 seconds. However, among all groups, Expasyl showed minimum sulcal width at all intervals. Cords showed better gingival displacement than cordless. All groups had a faster closure rate at the transitional line angle than at the mid-buccal area. The GI and BI were maximum for Ultrapack and minimum for Expasyl.

REFERENCES


Corresponding author:
Dr Sumi Chandra
4 /41 “Aetha” Vishal Khand-4.Gomti Nagar
Lucknow, Uttar Pradesh
INDIA
Email: drsumichandra@gmail.com

Acknowledgments
The authors thank Dr B. K. Tandan, MDS, for valuable guidance and support and Mr Ravi Kapoor for his assistance in photography.

Copyright © 2016 by the Editorial Council for The Journal of Prosthetic Dentistry.