Comparison of Gingival Troughing by Laser and Retraction Cord

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This study was aimed at comparing the most common two methods for gingival troughing: presaturated cord and lasers (including diode, Nd:YAG, and Er:YAG). A total of 108 anterior teeth (58 maxillary and 50 mandibular) in 50 patients were included in this study. Gingival treatment was carried out in the following four groups: presaturated cord, diode laser, Nd:YAG laser, and Er:YAG laser. The gingival width and gingival recession (GR) were measured at different times (at the time of treatment, after 1 week, and after 4 weeks). The presaturated cord resulted in significantly higher (P < .05) GR than lasers and narrower gingival sulci. Er:YAG laser resulted in the quickest and most uneventful wound healing when compared to diode and Nd:YAG lasers. Int J Periodontics Restorative Dent 2018;38:527–532. doi: 10.11607/prd.3551

The gingival trough is defined as the narrow space between the free gingival margin of the epithelium and the adjacent enamel of a tooth.\textsuperscript{1} Methods used for retraction of the gingival trough include but are not limited to mechanical, chemomechanical (retraction cord), and surgical (knife, rotary curettage, electrosurgery, and lasers).\textsuperscript{2,3} It has been reported that a crevice width of at least 0.15 mm at the level of the finish line is needed for accurate impressions.\textsuperscript{4} Conventional gingival retraction cord technique may injure the healthy epithelial lining and result in postoperative gingival recession.\textsuperscript{5} The recommended time for placement of the cord in the sulcus is 5 to 15 minutes after tooth preparation.\textsuperscript{6} When the cord is left too long or placed with too much force, damage such as gingival recession may occur.\textsuperscript{7} Besides discomfort and bleeding, gingival inflammation has been reported due to medications in the cords.\textsuperscript{8} Hence, techniques that avoid using retraction cords, such as an electrosurgical techniques, have been suggested.\textsuperscript{9} Unfortunately, this approach has also been linked to gingival recession after treatment.\textsuperscript{10,11} Because of this, tools such as dental lasers have been proposed. Currently, nearly 20% of US dentists use lasers to perform gingival troughing to obtain a precise impression.\textsuperscript{7} Diode,
Nd:YAG, Er:YAG, and Er,Cr:YSGG lasers have all been used for gingival troughing.\(^{12-14}\) Rather than displacing gingival tissue as in the retraction cord technique, lasers remove the epithelial lining from the sulcus without causing damage to the basal cell and connective tissue layers.\(^{15,16}\) This may minimize future gingival recession. Hence, lasers have been suggested as a substitute to conventional gingival displacement techniques. It was the purpose of this study to compare gingival recession between the conventional cord placement technique and the newly proposed approach of using lasers (eg, diode, Nd:YAG, and Er:YAG) to remove the lining.

### Materials and Methods

After signed informed consent was provided, a total of 50 patients with 108 anterior teeth (58 maxillary and 50 mandibular) in need of all-ceramic fixed restorations were included in this study. Patients were aged 18 to 38 years and were recruited through the Department of Prosthetic Dentistry, Xiamen Medical College, China. As part of preliminary treatment, all patients attended the dental hygiene program to make sure the treatment locations were free of active periodontal inflammation and had minimal plaque accumulation (Plaque Index < 1), 1- to 2-mm gingival sulcus depth, ≥ 1-mm gingival biotype, and no bleeding on probing (BOP) before preparation. Patients were then randomly assigned to one of four groups: presaturated cord, diode laser, Nd:YAG laser, and Er:YAG laser. Each group included 14 maxillary and 12 mandibular anterior teeth. Baseline data before tooth preparation was obtained via CEREC Omnicam: the unprepared teeth, the adjacent mesial and distal teeth, and the occlusal plane were scanned (Fig 1).

For the clinical procedure, the tooth was initially prepared above the gingival level without gingival retraction. A provisional crown was made with acrylic resin and inserted. A gingival finish line was then prepared, with caution to avoid injuring the gingival tissue. After tooth preparation, the presaturated gingival troughing with #1 cord (8% epinephrine, Ultrapak) was inserted around each abutment using a cord packer and left in situ for 10 minutes before taking the digital impression. The cords were removed, and chairside scanning was performed immediately (Fig 2). For each of the laser groups, the gingival troughing was carried out using diode laser (XD-2, Fotona), Nd:YAG laser, and Er:YAG laser (LightWalker AT Fidelis, Fotona). The characteristics of each laser based on the information provided by the manufacturer are presented in Table 1.

The operating staff and the patients wore special laser-protective
glasses for the laser procedures, and all fiber-optic tips were prepared by repeated penetration of dark blue articulator paper (Shofu). The troughing procedure was carried out using a fiber-optic tip in contact with the gingival sulcus to remove sulcular epithelium. The laser power was set at 0.7 W and could increase to a maximum of 2 W if needed. All procedures were performed by a well-trained laser dentist (X.T.). The fiber-optic tip, using the tooth surface as a guide, was angled toward the soft tissue and kept away from the prepared tooth to prevent laser side effects such as tissue charring. The laser tip had to be constantly cleaned with hydrogen peroxide or a wet cotton pellet to remove tissue tags. Local anesthetic was not administered for any of the abutments in this study. After the troughing was completed, final margin impressions of the abutment were made slightly subgingival on the facial and at equigingival margins on the palatal side using CEREC Omnicam chairside scanning computer-aided design/computer-assisted manufacture with version 4.2 software (Sirona). Geomagic Qualify 2013 software (Geomagic Studio) was used to compare the chemomechanical procedure with the three kinds of laser irradiation in terms of gingival morphologic changes before and after troughing. Figures 3 to 6 show the results of gingival displacement and troughing using the various methods. All data were decrypted into STL format for matching purposes using Qualify 2013 software. The gingival width (GW) and amount of gingival recession (GR) were determined by measuring the distance from the tooth to the crest of the gingiva in the horizontal plane on sections of the models using the software. Mesio-buccal, mid-buccal, and distobuccal regions were selected for measurement of the trough (Fig 7). Mean value in three regions for each abutment was calculated. The GW and GR in different times were analyzed for each traced abutment (Fig 8).

### Table 1 Significant Parameters of the Three Kinds of Lasers Used

<table>
<thead>
<tr>
<th>Laser</th>
<th>Wavelength (nm)</th>
<th>Mode</th>
<th>Power (W)</th>
<th>Frequency (Hz)</th>
<th>Tip (μm)</th>
<th>Cool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diode</td>
<td>810</td>
<td>Continuous pulse</td>
<td>2</td>
<td>20</td>
<td>320</td>
<td>No</td>
</tr>
<tr>
<td>Nd:YAG</td>
<td>1064</td>
<td>Short pulse</td>
<td>2</td>
<td>15</td>
<td>320</td>
<td>No</td>
</tr>
<tr>
<td>Er:YAG</td>
<td>2940</td>
<td>Very long pulse</td>
<td>2</td>
<td>15</td>
<td>500</td>
<td>Air and water</td>
</tr>
</tbody>
</table>

Two datasets were generated. First, differences in GW immediately after troughing among lasers and presaturated cord were assessed. Second, the amount of GR for all four groups was measured immediately after troughing (GR₀), at 1 week (GR₁), and at 4 weeks (GR₄) and evaluated, and the differences in gingival recession at the same time points among the three laser groups were determined. Data was analyzed for statistical significance.
using one-way analysis of variance followed by Newman-Keuls test for multiple comparisons ($\alpha = .05$).

**Results**

Table 2 shows the differences in GW among the four methods tested immediately after troughing. The GW of presaturated cord troughing was significantly narrower than that of three types of lasers ($P < .05$). However, no differences were noted among the three laser troughing approaches. Table 3 presents the differences in GR among groups at different times ($GR_0$, $GR_1$, and $GR_4$) after gingival treatment. Significant differences in GR were seen between presaturated cord and each laser group after finishing at all times ($P < .05$), except for presaturated cord and Er:YAG laser at 1 week ($P > .05$). Significant changes in GR were detected in the four groups at all time points ($P < .05$), with the exception being Er:YAG laser troughing between $GR_1$ and $GR_4$ ($P > .05$).

### Table 2

<table>
<thead>
<tr>
<th>Group</th>
<th>GW (mean ± SD, mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retraction cord</td>
<td>0.32 ± 0.09</td>
</tr>
<tr>
<td>Diode</td>
<td>0.55 ± 0.15*</td>
</tr>
<tr>
<td>Nd:YAG</td>
<td>0.60 ± 0.17*</td>
</tr>
<tr>
<td>Er:YAG</td>
<td>0.65 ± 0.14*</td>
</tr>
</tbody>
</table>

*Statistically significant difference ($P < .05$) between lasers and retraction cord methods.

### Table 3

<table>
<thead>
<tr>
<th>Group</th>
<th>$GR_0$ (mean ± SD, mm)</th>
<th>$GR_1$ (mean ± SD, mm)</th>
<th>$GR_4$ (mean ± SD, mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retraction cord</td>
<td>0.42 ± 0.11</td>
<td>0.10 ± 0.09*</td>
<td>0.24 ± 0.08*</td>
</tr>
<tr>
<td>Diode</td>
<td>0.30 ± 0.10*</td>
<td>0.21 ± 0.07*</td>
<td>0.13 ± 0.08*</td>
</tr>
<tr>
<td>Nd:YAG</td>
<td>0.32 ± 0.11*</td>
<td>0.22 ± 0.08*</td>
<td>0.14 ± 0.07*</td>
</tr>
<tr>
<td>Er:YAG</td>
<td>0.29 ± 0.12*</td>
<td>0.13 ± 0.08*</td>
<td>0.10 ± 0.06*</td>
</tr>
</tbody>
</table>

*Statistically significant difference ($P < .05$) between laser and retraction cord methods. No difference was noted only at 1 week between Er:YAG and retraction cord. *Statistically significant decrease when compared to previous time points. The only exception is between 1 and 4 weeks for the Er:YAG laser-treated group.
Discussion

This study demonstrated that GW among groups immediately after troughing groups at once was wider than the clinically acceptable value of 0.15 mm. The result indicated that it is easier for impression material to flow around the finish line in such cases, because a larger sulcular width minimizes the incidence of voids and tearing of impression materials and therefore a more accurate impression in terms of marginal line is expected. Furthermore, the mean measurement immediately after gingival troughing with lasers was higher compared to with presaturated retraction cord, but the differences among three different lasers were not statistically significant. Fazekas et al. found GW close to < 0.2 mm within 60 seconds of removal of the presaturated retraction cord for 8 minutes. When an impression of multiple abutments is made, the horizontal displacement of the tissue may close considerably before the impression material has flowed into it. In such clinical conditions, a simple and fast conventional impression or laser troughing is recommended.

Previous histologic studies reported that presaturated retraction cord with different medicaments resulted in various degrees of gingival inflammation. Gabbar and Abo-ulazm showed, in the histologic specimen, that Nd:YAG laser gingival troughing resulted in faster healing (within 2 weeks) and less inflammation than the common presaturated retraction cord. Diode laser (980 nm) gingival troughing achieves instant hemostasis and moisture control with soft tissue healing after 15 days. Results from this study showed that the amount of GR in presaturated cord recovered from 0.42 ± 0.11 mm to 0.10 ± 0.09 mm in 1 week and to 0.24 ± 0.08 mm in 4 weeks, which suggested that the inflammation noted at 1 week after gingival displacement probably resulted from gingival edema. Significant discrepancies in GR were found between presaturated retraction cord and each group of lasers after troughing. This implied that laser troughing resulted in less gingival recession and inflammation compared to presaturated retraction cord.

The present results are in agreement with Gherlone et al. and Scott, who reported satisfactory outcomes when diode, Nd:YAG, and Er:YAG lasers were used for gingival troughing. In general, laser troughing resulted in less gingival bleeding and recession when compared to presaturated retraction cord or electrosurgical techniques. However, Stuffken and Vahidi reported similar recession (0.26 mm) for the cord technique and an 810-nm diode laser. This difference was probably due to the double retraction cords used in the study. The Er:YAG laser–treated group had the same amount of gingival recession at GR1 and GR4 and less at GR1 when compared to diode and Nd:YAG lasers. These findings suggest that the Er:YAG laser achieved better wound healing at 1 week compared to the other two lasers. This can be attributed to the photonic energy of diode and Nd:YAG lasers for soft-tissue ablation, which is in the near-infrared spectrum (approximately 800 to 1,100 nm) and is easily and selectively absorbed in parts of hemoglobin and tissue pigment.

The diode and Nd:YAG lasers have similar interactions with soft tissues but differ in emission mode. The Nd:YAG lasers offer a free-running pulse (ie, short-duration pulses), and diode lasers are applied in a continuous-wave mode, which means laser energy is emitted constantly. The diode and Nd:YAG lasers belong to the deep penetration type of lasers, which may cause some soft tissue damage. No water spray and air flow cooling are needed for diode and Nd:YAG lasers, which sometimes results in thermal side effects around the gingiva. The pulsed Er:YAG laser has the highest absorption into water, which minimizes thermal side effects during irradiation. Water spray and air flow cooling were used during ablation to prevent thermal damage. Data from this study demonstrated faster and more favorable gingival wound healing in Er:YAG laser–treated gingivae compared with the presaturated retraction cord, diode, and Nd:YAG lasers, which suggests that Er:YAG laser is a safe and suitable tool for gingival troughing.

Conclusions

Within the limitations of this study, the following conclusions could be drawn: gingival troughing using dental lasers resulted in wider gingival sulci, less posttreatment gingival recession, less inflammation, and more patient comfort when compared to
conventional retraction cord; and Er:YAG laser results in fast and un-eventful wound healing when compared to diode and Nd:YAG lasers.

Acknowledgments

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References