THE JOURNAL OF PROSTHETIC DENTISTRY

CLINICAL RESEARCH

Preimpression troughing with the diode laser: A preliminary study

Marguaritha Stuffken, DDS[a] and Farhad Vahidi, DMD, MSD[b]

ABSTRACT

Statement of problem. The mechanical-chemical technique and the use of a laser are methods for displacing the gingiva to make an accurate impression of the preparation for a complete crown. The tissue needs to be displaced and the hemorrhage controlled to capture the prepared finishing line in the impression. The degree of undesirable gingival recession after these displacement techniques is unknown.

Purpose. The purpose of this pilot study was to clinically monitor and compare the regeneration of the gingival tissue by using 2 methods of gingival displacement in the same participant: the mechanical-chemical technique with double cords impregnated with aluminum chloride and the 810 nm diode laser (Odyssey; Ivoclar Vivadent AG).

Material and methods. A total of 6 participants needing 2 crowns on natural teeth were included in this study. At the first visit, the teeth were prepared with a 0.5-mm subgingival finishing line and interim crowns were fabricated. One of the teeth was randomly assigned to the double cord technique with 2 (# 000 and # 1) impregnated 5% aluminum chloride cords and the other to the 810 nm diode laser. An adjacent tooth served as a control. A device was made that would function as a fixed reference point for the measurements at different time intervals. A notch was created on the device to position the digital ruler between the occlusal notch and the free gingival margin to measure the distances. The measurements were recorded for each patient before displacement of the gingiva and at the time of cementation of the definitive crowns. The patients were followed at 1 week, 3 weeks, and 8 weeks after cementation of the definitive crowns.

Results. The amount of recession with the cord impregnated with aluminum chloride was 0.26 mm 8 weeks after cementation of the definitive crowns with a range between 0.00 mm and 0.72 mm. The diode laser showed an average recession of 0.27 mm with a range between 0.01 mm and 0.68 mm.

Conclusions. This study found an average loss of gingival height of 0.26 mm for the double cord technique and 0.27 mm for the laser. The amount of recession was considered not clinically significant. (J Prosthet Dent 2015;■:■-■)

The preparation for a complete crown often requires subgingival placement of the finishing line because of caries, existing restoration, esthetic demand, or need for additional retention.[1] The crown should precisely seal the margin of the preparation, and in order to achieve this goal, a detailed impression is necessary.[2] Gingival displacement laterally and/or vertically and in conjunction with adequate moisture control is often necessary to capture the prepared finishing line in the impression.[3] The space must be wide enough to accommodate elastomeric impression materials of sufficient thickness and strength[4] to avoid tearing the material during removal of the impression and to resist distortion when it is poured with a die stone.[2] The critical crevice width for making the impression should be approximately 0.2 mm.[5] Mechanical, mechanical-chemical, electrosurgical, and laser methods are used to displace the gingiva with uneventful outcomes.[6]

The conventional method of obtaining gingival displacement is the mechanical method. This involves the physical displacement of the gingival tissue by placing a cord into the gingival sulcus. These displacement cords are available in varying thicknesses and may be plain or braided or in other configurations.[3]

Nonmedicated cords placed in the sulcus have only a limited effect in controlling hemorrhage or seepage of liquid.[1] The use of a cord impregnated with a

[a]Private practice, Alkmaar, The Netherlands.
[b]Associate Professor, Department of Prosthodontics, New York University College of Dentistry, New York, NY.

Clinical Implications

Recession of the gingival margin should be avoided when an accurate impression of a subgingival finishing line is required for a fixed prosthesis. This pilot study showed comparable recession between the mechanical-chemical technique and the use of a diode laser 8 weeks after cementation of the definitive crowns. For more conclusive results, further clinical investigations using a larger sample and histological evaluations are necessary.

medicament is the most common method of displacing the tissue.[7] The advantage of an impregnated cord, compared to a nonmedicated cord, is that it better controls hemorrhage. Histological specimens have shown that 24 hours after use of a displacement cord, the sulcular epithelium was present but disrupted. The junctional epithelium displayed intracellular hydropic degeneration, stripping, and desquamation of the epithelium and in some situations was even missing.[8,9]

Any method used for gingival displacement must be effective, safe, and able to prevent irreversible tissue damage. Placement of the cord in the sulcus for too long a period or the application of an inappropriate amount of force during cord placement can cause recession of the gingiva.[11] The recommended times for the cord to be held in the sulcus are 5 to 15 minutes.[10] The impregnated chemical of the displacement cord can influence the polymerization time of the impression material.[12] Displacement cords may also cause discomfort, postoperative inflammation of the tissue, and bleeding.

A significant number of practitioners use a cordless technique to displace the gingiva.[7] By using electrosurgery to deflect the gingiva, the inner lining of the sulcus is removed to provide space for the impression material and simultaneous coagulation. Klug et al[13] showed that, in dogs, the loss of the sulcal epithelium immediately after troughing was followed by complete regeneration of the tissue within 30 days. A permanent loss in gingival height ranging from 0.1 to 0.6 mm was also noted.[8,13,14] Any violation of the attachment apparatus can cause the loss of the connective tissue attachment and apical migration of the junctional epithelium. Other undesirable collateral side effects are burning of cementum and necrosis of the alveolar bone. Electrosurgery cannot be used in close proximity to metal restorations because of the possibility of an electric shock. The use of electrosurgery has been reduced with the introduction of laser treatment.

The first dental laser was introduced in 1990. The US Food and Drug Administration has approved approximately 24 clinical indications for the use of lasers in dentistry, including biopsy, gingivoplasty, frenectomy, and exposure of dental implants in second stage surgery.[15,16] A laser is used to displace the gingiva in order to make an impression by 20% of US dentists.[7]

The diode laser was first used for dental procedures in 1995. Diode lasers are solid-state aluminum gallium arsenide (AlGaAs) semiconductor lasers, which efficiently convert electrical energy into coherent light energy. The diode laser has wavelengths of between 800 and 980 nm. This wavelength range is well absorbed by pigmented tissue and hemoglobin and vaporizes water, which leads to ablation. The laser is used for cutting and coagulating gingiva and mucosa and is therefore a soft-tissue laser.

The diode laser has been used for displacing gingiva to make a definitive impression. Rather than displacing gingival tissue, it removes the epithelial lining from the sulcus.[17] The superficial layers of cells from the inner lining of the gingival sulcus should be removed to a depth just below the finishing line of the preparation.[11] Hemostasis will eliminate any seepage of fluid and blood in the sulcus and, therefore, enhance the quality of the final impression.[18,19] A diode laser will cause minimal collateral tissue damage if used at the correct power. Removing the superficial layers of the sulcular epithelium without damaging the basal cell layer and connective tissue cells will prevent shrinkage of the gingival tissue.[20] The negative side effects of the diode laser may be pain, postoperative inflammation, and recession of the tissue.[21]

Limited information is available regarding the application of neodymium-doped yttrium aluminum garnet (Nd:YAG) laser treatment. Histological findings of these studies showed that gingival tissues healed faster with less hemorrhage and inflammatory reactions than with the mechanical-chemical technique.[22] A few clinical case reports regarding troughing with the diode laser have been reported, but the long-term effects and histopathological evaluation after gingival troughing with this type of laser are not available.[17] Effects of the laser action on adjacent and underlying tissues must also be evaluated, as there may be specific collateral or thermal effects.

The hypothesis of this pilot study was that the gingival margin would regenerate to the preoperative level after troughing with either the displacement cord or diode laser method. The study clinically monitored and compared regeneration of the gingival tissue following the 2 methods of displacement in the same participant: the mechanical-chemical technique using double cords impregnated with aluminum chloride and the use of an 810-nm diode laser (Odyssey; Ivoclar Vivadent AG).

MATERIALS AND METHODS

The study population consisted of 6 volunteers from New York University College of Dentistry. Participants

Figure 1. Tooth preparation.

Figure 2. Interim crowns.

were healthy adults who needed crown restorations for 2 natural teeth. The teeth involved could not have any pocket exceeding 3 mm. Optimum gingival health was a prerequisite of treatment. The selected participants had oral hygiene with a Loe and Silness gingival index of 0.[23]

Exclusion criteria were individuals with decisional incapacity. Individuals with a history of systematic disease or the presence of periodontal disease and with poor existing restorations that might have violated the biological width were also excluded.

Four white, 1 African American, and 1 Asian participant were selected, ranging from 18 to 75 years of age. They all required 2 crown restorations on natural teeth. The study was approved by the Institutional Review Board of New York University and was audited during the study period.

The first visit involved preparation of the teeth as seen in Figure 1. The type of preparation was a deep chamfer placed approximately 0.5 millimeter apical to the gingival margin. Autopolymerizing acrylic resin interim crowns with concealed margins and an appropriate emergence profile were fabricated and cemented as shown in Figure 2. One tooth was selected for the double-cord technique and the other for the laser treatment.

For the double-cord technique, a number 000 cord (Ultrapak; Ultradent Products Inc) soaked in 5% aluminum chloride (Hemodent; Premier Dental Products Co) was placed at the base of the gingival crevice, followed by a soaked number 1 cord.[25] A blunt-ended instrument was used to gently place the cord into the crevice, ensuring that the entire finishing line could be clearly seen. Cord placement did not cause hemorrhage or lacerations of the gingival attachment. After 5 to 10 minutes, 1 cord (number 1) was removed, and the gingival sulcus was washed with water and air dried.

For the second preparation, the gingiva was troughed using the 810-nm diode laser (Odyssey; Ivoclar Vivadent AG). The fiber tip was initiated by holding it on articulator paper (Accu Film II; Henry Schein) before starting the procedure. The procedure always began with the laser at the lowest power to displace the tissue. The diode laser was set at a continuous wave of 0.7 W and, depending on the tissue, the power could be increased to a maximum of 2 W if necessary. Tissue charring is an undesirable effect of laser use and may occur either because too much power is used or the tip is moved too slowly.

The optic fiber tip, which was angled toward the soft tissue and away from the prepared tooth, was passed along the gingival sulcus to remove the sulcular epithelium. Constant and steady short brushing strokes gently removed the lining of the sulcus in order to achieve a full 360-degree trough. The tip was constantly cleaned with a gauze sponge wetted with hydrogen peroxide to remove debris and to eliminate potential bacterial contamination. Sufficient epithelium was removed to place the impression material and visualize the finishing line. The tissue was kept moist with water during the procedure.[24]

Figure 3 shows the tooth preparations and gingival displacement with the double-cord technique and with the laser. The impression, seen in Figure 4, was made after gingival displacement with a polyether impression material (Impregum; 3M ESPE). The impression was then poured with die stone (DieKeen; Heraeus Kulzer US) and lithium disilicate crowns (e.max; Ivoclar Vivadent AG) were fabricated. Figure 5 shows an example of a cemented definitive crown.

Study casts were made during the initial phase of the study. A resin device was fabricated to establish a fixed reference point on the casts, as shown in Figure 6. This device covered the occlusal surfaces of the unprepared adjacent teeth. A groove was then created in an occlusal apical and a mid-buccal direction with a number 556

Figure 3. Troughing with diode laser for maxillary right central incisor. Displacement of gingiva with cord for maxillary left incisor.

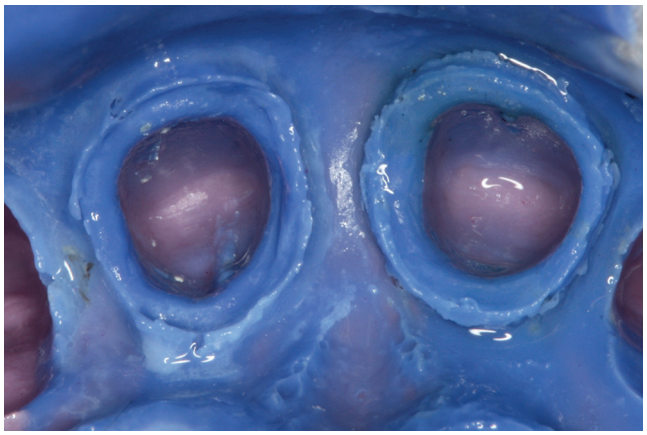

Figure 4. Definitive polyether impression.

Figure 5. Definitive lithium disilicate crowns.

Figure 6. Resin device in place with measurement ruler at fixed reference point.

fissure bur on the 2 teeth to be treated and on an adjacent tooth, the control site. These grooves and their direction served as a guide for placement of the device. A notch was created on the device to position the digital ruler for the measurement.

Distances between the occlusal notch to the free gingival margin were measured with a digital ruler (Ironside).[10] All measurements were recorded to the nearest 0.01 mm by the same operator (M.J.S.) to minimize interexaminer error. Similar measurements were carried out on the facial surface of the adjacent control site. Three measurements were made on a tooth at each visit, and the average was calculated. The measurements were recorded for each participant before displacement of the gingiva and at the time of cementation of the definitive crowns. The participants were followed at 1, 3, and 8 weeks after cementation of the definitive crowns.

The time between making the impression and inserting the definitive crowns was 2 weeks to allow for laboratory procedures. Thus the final measurements after definitive cementation were made at 10 weeks, giving sufficient time for the tissue to regenerate after the gingival displacement. Photographs were made of the prepared teeth before displacement of the gingiva, with interim crowns, and 8 weeks after cementation of the definitive crowns for documentation.

Table 1. Amount of gingival recession (mm) 8 weeks after gingival displacement

Participant	Mechanical-Chemical Technique (Double Cord)	Diode Laser	Control
1	-0.72	-0.13	-0.08
2	-0.01	-0.13	-0.08
3	0.00	-0.01	-0.01
4	-0.13	-0.66	-0.02
5	-0.67	-0.68	-0.13
6	-0.03	-0.02	0.02
Average	-0.26	-0.27	0.00

RESULTS

The amount of recession with the mechanical-chemical technique was 0.26 mm 8 weeks after cementation of

the definitive crowns, with a range of 0.00 mm to 0.72 mm. The diode laser treatment showed an average of 0.27 mm recession, with a range of between 0.01 and 0.68 mm (Table 1).

DISCUSSION

An average loss of gingival height of 0.26 mm for the double-cord technique and 0.27 mm for the laser was found in this study. This amount of recession was not clinically significant. The results approximate the findings of the study by Coelho et al,[14] who found an average of 0.23 mm of loss with the use of electrosurgery. Cordless, laser, and electrosurgery techniques remove the inner sulcular epithelium lining for troughing. The control teeth verified the accuracy of the measurement technique in this study. Measurements at the control site showed no recession.

The use of the laser unit with lower power can cause a dragging cutting action, which shreds the tissue. A higher power should provide a better and smoother trough around the preparation. However, excessive power, which results in necrosis of the tissue, should be avoided. Troughing always started with a continuous wave power of 0.7 W. If this power was insufficient or dragging of the tissue was noted, the power was increased. African American participants had more deeply pigmented tissue (melanin), which absorbed more laser energy, and therefore the power was not increased. The maximum power used in this study to get a sufficient trough was 1.6 W with a continuous wave.

Krishna et al[20] reported that gingival troughing with the diode laser achieved greater than the minimum required sulcular width of 0.2 mm. This research confirmed that the impression with the diode laser was consistently accurate. Gabbar et al[24] showed faster healing within 2 weeks and less inflammatory reaction with the Nd:YAG laser than with the medicated cord to displace the gingiva in the histological specimen. In this study, the healing process was clinically comparable for both techniques, with minimal inflammatory reactions. !!

Various factors can affect the amount of recession, including the tissue thickness (biotype), marginal accuracy of the interim crown, and amount of keratinized tissue. A thick biotype consists of more connective tissue than a thin biotype and therefore is more resistant to loss of gingival height. In this study, the interim crowns had well-adapted, polished margins with appropriate emergence profile. Poor, bulky, or rough margins can cause irreversible tissue recession. A study by Donaldson[25] noted that some gingival recession may be expected when a provisional crown is cemented. He reported that, after delivery of the definitive crowns, one third fully recovered from this recession and 10% demonstrated more than 1 mm recession at a recall visit.

Stetler et al[26] reported higher gingival scores in participants with less than 2 mm of keratinized tissue with subgingival margin crowns in comparison with those with more than 2 mm of keratinized tissue. Keratinized tissue is more resistant to recession than nonkeratinized tissue. In this study, all the prepared teeth had at least 2 mm of keratinized tissue.

Further clinical investigations using larger samples and histological evaluations are necessary to compare these methods of gingival displacement and to achieve more conclusive results. The use of the diode laser may be beneficial for making impressions in digital technology.

CONCLUSION

Eight weeks after the cementation of definitive crowns, comparable recession was found with mechanical-chemical gingival displacement and a diode laser. The amount of recession may not be clinically significant.

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Corresponding author:
Dr Marguaritha Stuffken
Centrum Implantologie Parodontologie
Alkmaar Kennemerstraatweg
Alkmaar 128 1815 LD
The Netherlands
Email: mjstuffken@gmail.com

Acknowledgment
The authors thank Ivoclar Vivadent AG for providing the Odyssey diode laser and Marotta Dental Laboratory for fabricating the crowns.