Lasers in Dentistry

Advanced Proficiency Case Studies

In this issue of *Wave-lengths*, we will feature more clinical cases from our Advanced Proficiency candidates, who completed the examination process at the 10th Annual Conference in San Destin, Florida in March 2003.

In each case, the Essential Elements of the Clinical Case Studies checklist was precisely followed and each point adequately described, in written form and during the oral presentations.

The Academy is very proud of these doctors and their outstanding efforts in achieving Advanced Proficiency.

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ADACERP Academy of Laser Dentistry
Caries Removal, Minor Gingivectomy, and Gingivoplasty Assisted with Er:YAG and Nd:YAG Lasers

Dr. Hiroshi Umemoto graduated in 1979 from the Tsurumi University School of Dental Medicine in Yokohama, Japan. He received postgraduate training in periodontology from the Tokyo Medical and Dental University in 1979. He has maintained a private practice in Kawasaki since 1982. Dr. Umemoto incorporated use of the Nd:YAG laser in his practice in 1993 and currently utilizes Er:YAG, argon and diode lasers. He is a director and accredited member of the Japan Association for Nd:YAG Laser Dentists. He received his Advanced Proficiency in the Nd:YAG laser wavelength at the 10th Annual ALD Conference in Destin, Florida. Dr. Umemoto may be reached by e-mail at umeden@green.ocn.ne.jp.

Disclosure: Dr Umemoto has no financial relationship with any dental laser manufacturer.

Pretreatment

A. Diagnostic Tests

1. Clinical Examination

This is a case of a 50-year-old female with no significant medical history. Secondary decay was recognized in the composite resin filling of the buccal sides of cervical sites of teeth #6, 11, 21, 22, 27 and 28. One orthopantomograph and four X-ray images were taken. The health condition of the patient was good. There were no particular comments about the patient’s status (Figures 1 and 2).

2. Radiographic Examination

An X-ray examination of the concerned region showed normal trabecular pattern of the alveolar bone. There were no pathological findings.

3. Soft Tissue Tests

Tooth #17 was impacted (Figure 3).

4. Tooth Vitality

There was almost no bleeding due to probing. The depth of the pockets obtained by probing was slightly less than 4 mm for teeth #6, 11, 21, 22, 27 and 28. (Figure 4).

5. Hard Tissue Tests

All teeth in the lower and upper jaws were tested for vital reactions using a pulp tester.

6. Other Tests

Tests were conducted to evaluate the amount of gingiva to be removed. A range which did not affect the biologic width was measured by probing. The result indicated the possibilities that the gingiva was cut in about 1 mm and recontoured.

B. Diagnosis and Treatment Plan

1. Diagnosis

Secondary tooth decay of composite filling at the cervical sites of teeth #6, 11, 21, 22, 27 and 28.

2. Treatment Plan


3. Possible Treatment Alternatives

Correction of the surrounding area of gingiva by means of a conventional method using an electric surgical knife or surgical steel.

4. Indications for Laser Treatment

The Nd:YAG laser has excellent characteristics for cutting and coagulating soft tissue. For example, it has the capacity to seal minute blood vessels of soft tissue due to a photothermal effect. A clear field can be produced due to the reduction of bleeding. It reduces pain during and after operation. The Nd:YAG laser produces “sterilization” due to its wave-
length characteristics. Therefore the procedures can be done the same day rather than waiting for healing with surgical steel. The Er:YAG laser is excellent for caries removal and tooth preparation.

5. Contraindications for Laser Treatment

Excess removal of gingiva due to improper use of a laser device could result in serious gingival damage. Pointing the fiber of the Nd:YAG laser at the root surface causes new damage, and fixing the fiber on the gingiva or irradiating the same spot with the laser for a long time results in heat-build up and causes serious damage on the bone. The Er:YAG laser can interact with both tooth and gingiva, so careful aim of the beam is important so that only the intended target tissue absorbs the laser energy.

6. Informed Consent

The dentist and patient discussed advantages and disadvantages of laser treatment as well as alternative treatment prior to treatment. Written informed consent was obtained for use of the lasers.

**Treatment**

**A. Objective**

The treatment objective was to excise and recontour the gingiva using an Nd:YAG laser in order to expose and clean the decayed region with an Er:YAG laser, obtain a smooth finish line, and ease the reconstruction of the excised region using composite resin.

**B. Laser Operating Parameters**

1. **Excision and recontouring of gingiva**

   Laser: Free-running pulsed Nd:YAG laser (PulseMaster 600IQ, American Dental Technologies, Inc., Corpus Christi, TX)
   Wavelength: 1064 nm
   Output: 1.6 W
   Repetition rate: 20 Hz
   Beam diameter: 320 mm
   Exposure duration: 270 sec

2. **Removal of decayed region**

   Laser: Er:YAG Laser (KEY Laser 3, KaVo Dental GmbH & Co., Biberach, Germany)
   Wavelength: 2940 nm
   Output: 3.6 W (during enamel preparation), 10 W (during dentin preparation)
   Repetition rate: 6 Hz (during enamel preparation), 4 Hz (during dentin preparation)
   Beam diameter: No numerical value is given because it is not a fiber-optic delivery system
   Exposure duration: 300 sec

**C. Treatment Sequence**

1. Maintained a safe environment by restricting operating room access to persons involved in the treatment, posting warning signs, and minimizing highly reflective surfaces.

2. The patient and all staff members working in the above-mentioned safety controlled area wore protective glasses.

3. A high-volume evacuation was used for tissue cooling and removal.

4. A test was conducted by irradiating a laser beam produced by a newly cleaved fiber onto a black sheet.

5. Local anesthesia was not used.

6. In excision and recontouring of marginal gingiva of the cervical areas using the Nd:YAG laser, the fiber was applied parallel with long axis of the tooth (Figures 5 and 6). This is because direct irradiation may damage teeth. Removal of composite resin filling and treatment of decayed teeth were performed using the Er:YAG laser (Figure 7).

7. Etching, bonding and filling using composite resin (3M Corp. Z250, Color A3.5), and polishing were performed after preparation (Figures 8 and 9).

**D. Treatment Record**

Notation in the patient treatment record included: minor gingivectomy and gingivoplasty with a free-running pulsed, fiber-optic-delivered Nd:YAG laser (wavelength 1,064 nm, pulse width 100 ms, and beam diameter of 320 mm); caries removal with an Er:YAG laser (wavelength 2940 nm). Exposure duration was 270 seconds with the Nd:YAG laser and 300 seconds with the Er:YAG laser.

**E. Patient Management**

The patient tolerated the treatment without topical anesthesia and local anesthetic and was not uncomfortable during and after the treatment. The following were prescribed for postoperative pain management: Soleton (nonsteroidal anti-inflammatory drug), 80 mg; painkiller 4 T (to be taken as needed for pain).

**F. Postoperative Instructions**

The following instructions were given...
to the patient postoperatively:
1. Avoid brushing for 12 hours after the operation.
2. Refrain from flossing or ingestion of hot food and liquid for 48 hours after the operation to prevent irritation of the treated tissues.
3. The patient may ingest regular foods and floss beginning 48 hours after the operation.
4. The patient should call dentist at home or at the cellular phone number given with any questions or in case of anxiety.

G. Management of Complications

No unexpected symptoms due to the surgical procedures were observed. Reconstruction under bright field conditions was easily performed without bleeding.

H. Surgical Prognosis

The surgical prognosis was good.

Follow-Up Care

A. Assessment of Treatment

Treatment was assessed at 7 days (Figures 10 and 11), 1 month (Figures 12 and 13), and 3 months (Figures 14 and 15).

D. Healing Assessment

The gingiva and teeth were restored to a harmonized, natural and healthy form and an aesthetic condition is being maintained. The aim of the treatment was achieved and the patient was fully satisfied.

E. Case Documentation

Periodontal probing sheet showing before laser surgery. Written informed consent was obtained.

B. Side Effects and Complications

There were no side effects or complications.

C. Long-Term Results

Long-term results are expected to be good.
Diode Laser-Assisted Frenectomy and Oral Vestibular Extension

Dr. Itaru Yoshida graduated in 1985 with honors from Nippon Dental University, School of Dentistry, Niigata, Japan. He maintains his private practice in Tokyo, Japan, and utilizes diode (810 nm) and Er:YAG (2940 nm) dental lasers. He is continuing his research of pain control by low-level laser therapy (LLLT), and he is in charge of the Workshop for Dentistry at the World Association for Laser Therapy Fourth World Congress. Dr. Yoshida received his advanced proficiency in the diode laser wavelength at the 10th Annual ALD Conference in Destin, Florida. Dr. Yoshida can be reached by his e-mail address at itaru@y-dc.org.

Disclosure: Dr. Yoshida has no financial relationship with any dental laser manufacturer.

Pretreatment

A. Diagnostic Tests

1. Clinical Examination

The clinical examination presents a 22-year-old female patient. No sign of medical abnormalities or concerns. Her chief complaint was hysteresis with root dentin exposure and some tension in her cheeks (near teeth #3, 5, and 6 and #11, 12, and 14) while laughing and smiling (Figures 1 and 2).

2. Radiographic Examination

Radiographs showed no abnormalities, no periapical pathology, and good osseous tissue (Figures 3 and 4).

3. Soft Tissue Status, including pocket depth measurement

There was an inadequate level of gingival attachment that was causing root exposure. The oral vestibule was shallow and there were both large and small frenula (Figures 1 and 2).

4. Hard Tissue Tests

No percussion pain, no mobility, Class 1 occlusion balance. Due to insufficient orthodontic treatment, the occlusion was not tight. Each buccal tooth neck had a dentin exposure.

5. Tooth Vitality

All teeth tested vital, normal response with electric pulp tester.

6. Other Tests

The patient had a labial side orthodontic treatment 1 year previously. Caries were widespread on the lingual surfaces because of insufficient oral hygiene. Composite resin restorations were placed in those areas.

B. Diagnosis and Treatment Plan

1. Diagnosis

Teeth #3, 5, and 6 and #11, 12, and 14 had inadequate buccal attached gingiva and malformation of buccal frenulum.

2. Treatment Plan

Vestibular extension and frenectomy using an 810 nm diode laser to achieve a sufficient level of attached gingival; local anesthesia was used.

3. Possible Treatment Alternatives

Perform conventional apical positioned flap surgery and free gingival grafts with anesthesia and surgical instruments.
4. Indications for Laser Treatment

An indication for use of an 810 nm diode laser is cutting and coagulation of soft tissue. Hemostasis is due to the capacity of laser to seal small blood vessels as a result of the photothermal interaction with the biological tissue.

5. Contraindications for Laser Treatment

If it became necessary to cover the root surface, a laser incision is contraindicated and a free gingival graft would be necessary.

While using the diode laser, care must be taken to avoid applying too much heat to the target and surrounding tissues. The wavelength is deeply penetrating.

6. Informed Consent

Alternative treatments, risks and benefits involved were explained to the patient. Informed consent for treatment was obtained from the patient and written in the chart.

Treatment

A. Objective

The treatment objective was to achieve an acceptable level of attached gingiva and periodontal stability.

B. Laser Operating Parameters

A diode laser (LD-15, Dentek-Lasersystems Produktions, Gaisfeld, Austria) was used.

Wavelength: 810 nm
Power: 5 W maximum peak, 0.29 W average power, 9.9 µJ/pulse
Repetition rate: Gated pulse mode was used. (Duration time: 2 msec; Interval time: 32 msec; approximately 29.4 Hz)
Beam diameter: 400 µm
Exposure duration: 60 sec each side

C. Treatment Sequence

The right and left sides were treated separately on different days. Local anesthesia was given before cutting gingiva. Protective eyewear was worn by the patient, dental assistant, and doctor. High-volume evacuation was provided. The diode laser was test fired. The laser tip was used in light contact for cutting and coagulating the oral vestibule, and good hemostasis was achieved (Figures 6-9).

D. Treatment Records

Notation of the patient treatment was described in the chart: buccal frenum and oral vestibule were incised to achieve a sufficient level of attached gingiva, with an 810 nm diode laser at 5 W, duration 2 msec, interval time 32 msec. Anesthesia was administered. Analgesic drugs were prescribed.

E. Patient Management

The prescribed medication was adequate for controlling postoperative pain.

F. Postoperative Instructions

The patient was told to avoid salty and spicy foods, brush carefully and not touch the surgical area. The patient had the doctor’s office phone number in case the postoperative pain became great enough to require treatment.

G. Management of Complications

There were no complications, and no bleeding was observed. The patient complained of mild spontaneous pain. Analgesic drugs were prescribed.

H. Surgical Prognosis

The surgical prognosis was good.

Follow-Up Care

A. Assessment of Treatment

Figure 6: Laser procedure underway
Figure 7: Laser procedure continuing
Figure 8: Immediately postoperative
Figure 9: Immediately postoperative
Figure 10: Right side, five-day postoperative view
Figure 11: Left side, two-day postoperative view
Photos show the right side at 5 days (Figure 10), and the left side at 2 days (Figure 11).

Both sides are shown at 1 month (Figures 12 and 13).

The right side at 5 months (Figure 14), and the left side is shown at 4 months (Figure 15) after laser application.

B. Side Effects and Complications

Postoperative pain was reported. Analgesic drugs were used.

C. Long-Term Results

The gingival margin healed well. Some frenulum areas had relapsed but attached gingiva was gained. The patient said she could laugh and smile easily.

D. Healing Assessment

The clinical appearance was of a good healing state.

F. Case Documentation

Photos, radiographs, periodontal chart.
Diode Laser-Assisted Gingivectomy, and Diode and CO₂ Laser-Assisted Frenectomy

Dr. Mitch Lomke graduated from the University of Maryland, Baltimore College of Dental Surgery in 1979. He has been in private practice in Silver Spring, Maryland since 1980, emphasizing laser and esthetic dentistry. He has achieved Advanced Proficiency from the Academy of Laser Dentistry in Er:YAG and diode laser wavelengths. Dr. Lomke was awarded status of ALD Educator in 2000. He has lectured throughout the United States on laser clinical applications using argon, diode, erbium and carbon dioxide laser wavelengths. He has recently published articles about Er:YAG lasers.

Disclosure: Dr. Lomke lectures and conducts training for OpusDent, Benco, and Patterson Dental Companies, for which he receives an honorarium. He has purchased certain laser supplies at a reduced fee.

Pretreatment
A. Diagnostic Tests

1. Clinical Examination

A 55-year-old white female CEO of a land surveying firm in Rockville, Maryland presented with severe attrition of the mandibular anterior teeth resulting in short, unaesthetic teeth with undesired diastemata between them (Figure 1). The patient complained of decreased ability to incise and chew food as well as increased sensitivity to sweets and thermal changes. She had a positive history of cigarette smoking and social drinking. She claimed to be in a high-stress occupation.

The patient also stated that she noted increasing recession in this area as she got older. Upon examination, an aberrant mandibular anterior frenum pull was evident (Figure 2). She has also been unhappy with the unaesthetic yellowish brown shade of these lower teeth. Attrition resulted in the loss of up to one-third of the clinical crowns of these teeth. The patient did not want to have teeth #21, 22, 27 or 28 prepped for any restorations, although she was not happy with their darker shade. She did consent to have teeth #23-26 prepped for custom veneers. Due to the short nature of the clinical crowns of these teeth, it was explained to the patient that it would be necessary to gain additional tooth surface area to bond to for stability.

It was agreed that a crown lengthening procedure would be done with the diode laser as well as a frenectomy performed to obviate the frenum pull and stabilize the gingival margin position of the teeth in treatment long-term.

2. Radiographic Examination

There was generalized mild horizontal alveolar bone loss evident on the radiographs. The crown-to-root ratios on the treatment teeth were borderline, unfavorable. No periapical pathology was detected on the radiographs. An intact lamina dura was present in the areas to be treated. The pulp chambers in the teeth appeared to have calcified down just enough to be out of harm’s way during tooth preparation to avoid endodontic therapy.

3. Soft Tissue Status

In general, the gingival tissues were healthy. Pocket readings averaged 3-4 mm with two molar teeth measuring 5 mm. There was no bleeding on gentle probing. The mandibular anterior frenum exerted excessive pull on the marginal gingival tissues in that area. Periodontal probing also determined that there would be adequate biological width remaining after the marginal gingiva was removed.

4. Hard Tissue Status

Tooth Vitality: Teeth #20-28 tested vital to cold testing as well as to electric pulp testing. There was no sensitivity to percussion on all the teeth to be treated. Tooth mobility patterns were generally mild.

5. Other Tests

The patient had Class I occlusion in a skeletal relationship with evidence of bruxism. There was no history of temporomandibular joint disease, the joint exhibited no noise upon palpitation, and the patient had no pain. However, an occlusal splint was included in her treatment plan due to a deep overbite and an impressive bruxism habit.

B. Diagnosis and Treatment Plan

1. Provisional Diagnosis

2. Treatment Plan


3. Possible Treatment Alternatives

Referring the patient to a periodontist for conventional periodontal surgery using a scalpel and sutures. It was determined that the raising of a full thickness flap in this area could induce further alveolar bone loss in an already periodontally compromised area. The patient could have chosen no treatment at all. These alternatives were offered to the patient, but were declined.

4. Indications for Laser Treatment

Given the determination that adequate biological width would remain, indications included:
- to increase the patient’s existing bondable surface area of her lower front teeth
- to be able to lengthen the final tooth length inciso-gingivally and thus improve the esthetics and function of the lower anterior teeth
- to improve the esthetics of the patient’s smile and raise her self-esteem
- to relieve the aberrant frenum pull and prevent further recession.

The diode laser would be able to perform the soft tissue surgery very well, with precise and predictable height of tissue.

5. Contraindications for Laser Treatment

Preservation of biological width is essential for the periodontal health, given that the treated teeth have some compromise. The diode laser must be used with care when in contact with the root surface of the teeth, and prolonged contact with any dental hard tissue must be avoided. The diode wavelength deeply penetrates the soft tissue, and the underlying bone can be thermally damaged if care is not taken.

6. Informed Consent

The patient was informed of the possible need for endodontic therapy on the teeth to be treated, as well as the possible need for further periodontal surgery. The relative risks/benefits and treatment alternatives were also discussed with the patient, who gave verbal informed consent.

Treatment

A. Treatment Objectives

The objectives of this treatment were:
- perform a crown lengthening procedure on the patient’s lower front four teeth (teeth #23-26), thereby increasing the length of the available bondable surface area
- improve the overall esthetics of the patient’s smile
- relieve an aberrant mandibular anterior frenum pull.

B. Laser Operating Parameters

An 830 nm diode laser (Opus 10, OpusDent, Norwood, MA) was used at the repeat pulse setting (0.1 sec on, 0.1 sec off) using a 150-micron quartz fiber at 3.4 W for 2.0 minutes total treatment time (TTT), 3.0 W for 4 minutes TTT, then 2.0 W for 3.0 minutes TTT.

A 10,600 nm CO2 laser (Opus 20, OpusDent, Norwood, MA) with a 90-degree handpiece was used to assist in the frenectomy, using 3 W and a focused lens in the SP mode for 2 minutes TTT.

C. Treatment Sequence

DentiPatches (topical lidocaine) were applied to the area apical to the mucogingival junction bilaterally in the mandibular anterior area for 10 minutes. Local anesthesia was administered (using three carpules of 2% Carbocaine with 1:20,000 Neonorephrine). The diode laser procedure was done under 2.5 magnification with protective lenses. With this technique, the teeth were prepared for the temporary veneers first so as to avoid spewing debris from the tooth structure into the surgical area. Adequate reduction was confirmed using a preoperative omnivac shell.

The laser was first test-fired outside of the patient’s mouth using a power of 1 W, continuous wave (CW). The diode laser gingivectomy technique was then performed to recontour the gingival tissue and expose more tooth surface area for ease of bonding. The diode laser was used initially at 3.4 W in the repeat pulse mode (RPM) at 0.1 sec on and 0.1 sec off using a 360-micron tip. The diode laser was then used at the same RPM setting varying the power up and down, as needed, to reduce pocketing and to recontour various areas. After several passes at the target tissue, it was important to maintain a fresh operative field by using a wet gauze and/or a curette to remove lased tissue. If excessive buildup of this lased tissue were not removed, collateral tissue damage may have occurred due to thermal conduction. It was also important to maintain a freshly cleaved fiber to prevent excessive heat as well as inefficient cutting (Figure 3).

Next, a frenectomy was performed using the carbon dioxide laser at 3 W with a focused lens, using lip traction as a guide as to the proper clearance of the muscle fibers. The diode laser was also used at 2 W CW to assist in clearing stubborn fibers as well as achieving hemostasis (Figure 4). Provisional crowns had already been fabricated and cemented (Figure 5).

D. Patient Management

Figure 3: Laser-assisted gingivectomy procedure underway

Figure 4: Laser-assisted frenectomy procedure underway

Figure 5: Immediately postoperative with provisional crowns cemented
The patient was comfortable throughout the procedure with the local anesthesia. During the healing phase, she was compliant with the use of chlorhexidine gluconate rinses as well as with standard homecare (brushing and flossing).

E. Postoperative Instructions

Avoid eating around the surgical area. Use ice packs for the first 24-48 hours postoperatively. Avoid crunchy or hard foods. Chlorhexidine rinses twice daily. Vicodin or acetaminophen every 4-6 hours as needed for discomfort. Gentle but effective homecare was stressed.

F. Management of Complications

There were no reported complications.

G. Surgical Prognosis

Good to excellent. The patient must be compliant with proper homecare. Maintenance of the gingival health would be greatly enhanced by the use of chlorhexidine-soaked SuperFloss Oral B 3D electric toothbrush.

Follow-Up Care

A. Assessment of Treatment

Treatment outcome was assessed at 12 days (Figure 6), 17 days, 4 weeks, and 6 weeks (Figure 7) postoperatively. The treatment was successful.

B. Side Effects and Complications

The patient was phoned at home as a postoperative check that evening. The patient experienced mild pain and no bleeding.

The available clinical crowns were lengthened safely and effectively. The final veneers were of the desired increased length. The frenum pull was eliminated, thus the gingival margins should remain stable. The patient was extremely satisfied with the result.

C. Long-Term Results

The postoperative healing was complete. Five- and seven-month postoperative examinations (Figure 8) revealed excellent gingival health. The patient was instructed to wear an occlusal splint at night to avoid damage due to parafunctional habits.

D. Healing Assessment

Gingival margins are stable with no bleeding. The final restorations have been placed. The patient’s smile and self-esteem have both been restored.

E. Case Documentation

Photographs, clinical notes, radiographs were included in case documentation.

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Dr. Raleigh Holt is a Professor at the University of Oklahoma College of Dentistry and has been conducting research with lasers for more than 10 years. He has published several articles and made numerous presentations on his laser research. He has recently had an IRB approved for clinical trials for treatment and prevention of root caries at the University of Oklahoma. His focus also includes composite bonding with laser vs. acid-etched technique.

Disclosure: Dr. Holt and the University of Oklahoma College of Dentistry have received discounted equipment and free supplies from BioLase Technologies, Inc. BioLase has also sponsored Dr. Holt for travel to a national meeting.

Pretreatment

A. Diagnostic Tests

1. Clinical Examination

A 70-year-old white female presented with high blood pressure, arthritis, hypothyroid problem, and seasonal allergies. Her medical problems were controlled by medications. She was taking Norvasc, Synthroid, Allopurinol, Lipitor, Extradiol, and Medroxyprog. She had a history of periodontal problems with recurrent root caries.

The patient was missing teeth #1, 2, 4, 14, 15, and 16 on the maxillary arch and teeth #17, 18, 19, 20, 23, 24, 25, 26, 29, 30, 31, and 32 on the mandibular arch. Teeth #3, 13, and 27 had been restored with full porcelain-metal crowns, tooth #3 had a cantilever (mesial) replacement for tooth #4. A mandibular removable partial denture replaced teeth #18, 19, 20, 23, 24, 25, 26, 29, 30, and 31.

Teeth #5, 6, 7, 8, 9, 10, 11, and 12 had receding gingival margin, exposing 2-3 mm of root surface on the facial area. Mandibular teeth #22, 27, and 28 also had receding gingiva exposing 2-4 mm of root surface. These teeth had developing carious areas, which formed food pockets causing chronic gingivitis (Figures 1 and 2).

2. Radiographic Examination

The pretreatment radiographs showed no periodontal bony pockets or interproximal caries. The pretreatment X-rays did not show the periodontal radiolucent lesion, mesial root #3.

3. Soft Tissue Status

Probing depths were 2-3 mm around her remaining teeth except #3 which had a 8 mm mesial pocket, and there was bleeding upon probing in all probing points. The marginal gingival crest covered the apical portions of carious lesions. The gingival tissues appeared inflamed and irritated with plaque. Tooth #3 developed root caries with a fractured mesial root after treatment began. This tooth was extracted.

4. Hard Tissue Status

All teeth were within normal limits for pulp testing except teeth #3 and 21 which had received root canal treatment. Tooth #3 had a radiolucent lesion apical to the mesial root. There was no mobility.

5. Other Tests

Oclusion normal, temporomandibular joint normal.

B. Diagnosis and Treatment Plan

1. Provisional Diagnosis

Root caries facial (at or below gingival margins) of teeth #5, 6, 7, 8, 9, 10, 11, 12, 22, 27, and 28. Acute generalized gingivitis was present.

2. Treatment Plan

Gingival contouring for good periodontal architecture and access to caries. Restoration of carious areas, and preventive fluoride application.

3. Treatment Alternatives


4. Indications for Laser Treatment

Reduce gingival inflammation and recontour tissue properly for access to caries; eliminate carious areas and place properly contoured and sealed restorations.

The Er,Cr:YSGG laser wavelength will allow soft and hard tissue treatment with the same laser instrument. The gingival margins can be contoured slightly above/below the apical margin of the cavity preparation with laser. The gingival apical margins can then be placed above the gingival crest which will reduce the chance of recurrent root caries. Carious areas can be excavated, and root surfaces and enamel margins can be etched...
with the laser. The margins and treatment of subgingival root surfaces can be finished with a resin-fluoride mixture and laser exposure. The root surface margins and the root surface treatment will have an increased resistance to decay. Restoration of these areas should increase the patient's ability to maintain home care at a preventive level for chronic periodontal disease and recurrent caries problems.

5. Contraindications for Treatment

Standard Treatment: Whenever periodontal contouring and tissue removal are involved, attention must be given to the preservation of the biological width. The patient's home care must be very good to establish healthy periodontal tissues and prevent recurrent caries. Past history indicated that standard treatment did not greatly improve control of periodontal or carious activity in these areas.

Laser Treatment: This wavelength easily interacts with both hard and soft tissue, so care must be taken to avoid removal of healthy tissue.

6. Informed Consent

Oral consent with witness was obtained.

Treatment

A. Objective

Use the Er,Cr:YSGG (wavelength 2780 nanometers) to contour gingiva to expose the apical margins of root caries, remove decay, prepare cavity for composite filling materials, and perform preventive treatment to fillings and root surfaces with resin-fluoride application and laser exposure.

B. Laser Operating Parameters

Laser: Erbium, Chromium:yttrium-scandium-gallium-garnet (Er,Cr:YSGG) (BioLase, San Clemente, CA)

Delivery System:
(1) fiber-optic system to a terminal 600-micron diameter sapphire tip with adjustable air-water spray delivered through handpiece
(2) a terminal 750-micron tip with a “defocus hood” to produce an even spot size of 2.5 mm, no air or water
Wavelength: 2780 nanometers
Mode: free-running pulsed
Power: 0.0-6.0 Watts

Beam Diameter: 600 and 750 micrometers
Repetition rate: fixed at 20 Hz.

Laser Settings:
Enamel cutting – 4-4.5 W (75% air, 65% water) 4 W = 200 mj / pulse, 4.5 W = 225 mj/pulse
Enamel etching – 2 W (45% air, 30% water) 2 W = 100 mj/pulse
Dentin cutting – 2.5–3 W (65% air, 55% water) 2.5 W = 125 mj/pulse, 3 W = 150 mj/pulse
Dentin etching – 1.5 W (45% air, 30% water) 1.5 W = 75 mj/pulse (defocus 2-4 mm to seal dentinal tubules and clean cavity)
Gingival contouring – 1.75 W (20% air, 15% water) 1.75 W = 87.5 mj/pulse
Gingival clotting – 0.75 W (11% air, no water) 0.75 W = 37.5 mj/pulse
Preventive treatment
750-micron (3 mm) sapphire tip with the “defocus hood” at 0.75 W (no air or water).

C. Treatment Delivery Sequence

1. Preliminary to patient treatment:
   Secure operating room – place proper laser warning sign
   Set-up laser and test proper laser operation
   Supplies dispensed, equipment and instruments (sterile) arranged
   Patient's information: review charting, X-rays, etc.
   Patient seated – review treatment plan and informed consent
   Safety – eye protection placed for patient and operating personnel.

   NOTE: The patient requested no local anesthesia.

   Each tooth was treated individually with the following settings:
   Soft Tissue: Test fire laser
   Hard Tissue: Laser test-fired into a styliform tray

2. Decay was removed using a 600-micron diameter sapphire tip, with laser settings at 1.75 W, 20% air, 15% water, to contour and remove gingival tissues from the apical margin of the cavity – Time: 3 minutes – reduced settings to 0.75 W, 11% air, no water, defocused beam (to aid in the clotting of the small amount of bleeding – 10-15 seconds).

3. Hard Tissue:
   Laser test-fired into a styliform tray
   Decay was removed using a 600-micron diameter sapphire tip:
   With laser settings of 2.0 W, 65% air, 55% water, the laser was positioned approximately 1 mm from the carious site on the tooth for 1 minute.
   Settings were adjusted to 3.0 W, 65% air, 55% water to complete removal of decay. Time: Approximately 5 minutes

4. Cavity examined for decay – remove any decay, and prepare dentinal cavity walls, if needed – at setting of 2.0 W, 45% air, 30% water, for 2 minutes.

5. Etch enamel coronal margin at 2.0 W, 45% air, 30% water, for 30 seconds.

6. Used a defocused beam (3-4 mm from target tissues) for 10 seconds to increase clotting (Figures 3-6).

The laser was returned to standby position.
Restorative Treatment

The cavity was rechecked for decay (visibly and mechanically), irrigated with water from unit syringes, isolated and restored with Herculine light cure composite resin per manufacturer’s directions. Finished and polished with a series of burs and disks using high- and low-speed dental instruments.

Preventive Treatment

Laser settings:
Used a 750-micron (3mm) sapphire tip with the “defocus hood” at 0.75 W (no air or water) – spot size 2.5 mm.
1. a mixture of light-cure pit & fissure sealant (clear) and sodium fluoride powder (25%) (mixed in a capsule with an amalgamator).
2. a thin coat was applied to the margins of the composite/resin filling and apical to the root surfaces (and into the gingival sulcus).
3. Used a defocused beam of 2.5 mm at a setting of 0.75 W, no air or water, time was approximately 15 seconds to cover the margins and root surface areas. Two applications and two laser exposures were used. The facial (distal-mesial) and lingual root surfaces were also treated with the resin/fluoride mixture and laser energy.

NOTE: The defocused laser beam is always test fired on black photographic paper to confirm the spot size and evenness of the defocused beam.

D. Treatment Records

The treatment record reflects the treatment outlined above.

E. Postoperative Instructions

The patient was instructed to continue home care as in the past. Rinse with Biotene mouthwash twice daily. Floss and brush very gently with a soft tissue brush for 48 hours, return to normal home care. No limitations on eating or drinking. The patient was to call if any problems occurred. Reappointed for one-week recall, 24-hour appointment by phone (older lady who lives out of town) (Figures 7 and 8).

F. Management of Complications

There were no complications.

Follow-Up Care

A. Assessment of Treatment

The patient was assessed at one day, one week, one month, two months, four months and six months.
One Day – no problems – the patient said, “My teeth feel great – so clean.”
One Week – no problems – the patient indicated that her teeth never felt better, she could brush and floss without hurting her gums (Figure 9).
One Month – continued to improve her home care (Figure 10).

Two Months – the patient continued to do very well (Figure 11).
Six Months – the patient reported no

B. Side Effects and Complications

The patient reported no side effects or complications.

C. Long-Term Results

There was no sensitivity, and the fillings were retentive and smooth.

D. Healing Assessment

Prognosis of treatment is excellent, if patient can continue good oral hygiene. She is also pleased with the esthetics.
Er,Cr:YSGG Laser-Assisted Marginal Sealing: A Preliminary Report of In Vitro Research

Dr. Raleigh Holt is a Professor at the University of Oklahoma College of Dentistry and has been conducting research with lasers for more than 10 years. He has published several articles and made numerous presentations on his laser research. He has recently had an IRB approved for clinical trials for treatment and prevention of root caries at the University of Oklahoma. His focus also includes composite bonding with laser vs. acid-etched technique.

Disclosure: Dr. Holt and the University of Oklahoma College of Dentistry have received discounted equipment and free supplies from BioLase Technologies, Inc. BioLase has also sponsored Dr. Holt for travel to a national meeting.

Subject: Preventive treatment:
Sealing of teeth and restoration (composite) surfaces using an Er,Cr:YSGG laser and a mixture of light-cure sealant and sodium fluoride.

The problem of microleakage of root surface composite restorations has two contributing factors. They are microshrinkage of composite material against root surfaces, and recurrent demineralization of the adjacent root surfaces. The theory is that laser energy pushes resin-fluoride mixture into the micro-marginal defect and the adjacent root surface. The accompanying clinical case shows the caries removal and tooth preparations (refer to Figures 3-6 of the clinical case, page 24) with the final step of the laser etching the margins. The photos show the application of the sealant to the finished restorations (Figure 1) and the laser energy applied (Figure 2). As mentioned in the clinical case, a 750-micron sapphire tip with a proprietary defocused hood was used with 0.75 W of power at 50 mJ per pulse for 10-15 seconds, using no air or water.

Laboratory research is ongoing. One project was to complete Class V restorative preparations on opposing sides of extracted human teeth. The apical margins of the restorations were placed on enamel, and gingival margins on the root surface. One side was completed with a high-speed bur and the opposing side was completed with an Er,Cr: YSGG laser. They were filled using either the acid-etched or laser-etched technique for composite restorations. Margin and root surface treatment was completed with laser and sealant fluoride or acid etched and sealant fluoride. The teeth were cycled in an acid solution on a timed scheduled (14, 24, 42, and 60 days). A dye was used to identify microleakage. Scanning electron microscopic examinations were prepared to identify conditions of the marginal areas of the composite fillings before and after acid cycles.

The “post-acid” microscopic view shows damage to the bur-prepared composite margin and adjacent root surface versus little or no defects in the laser-treated side (Figure 3). These two views are examples of specimens cycled in acetic acid, buffer solution to pH 4.63 for 42 days. Analysis showed that there was a significantly less marginal leakage in the laser-prepared and laser-treated margins versus the bur-prepared and acid-etch treated margins.
Periodontal Surgery Using Nd:YAG Laser and Enamel Matrix Derivative

Dr. Douglas Gilio is in private practice limited to periodontics and implants. He is an assistant clinical professor at the University of Southern California School of Dentistry Advanced Periodontal Department. He is also a consultant in periodontics at the Veterans Administration Hospital in Fresno, California and heads the Periodontal Department for the general hospital residency program. Dr. Gilio holds Advanced Proficiency in Nd:YAG and has achieved Educator Status from the Academy of Laser Dentistry. Dr. Gilio may be reached at (559) 625-4911 or dgilio@aol.com.

Disclosure: Dr. Gilio has no commercial or financial interests in any laser companies.

Abstract

The goal of periodontal therapy is to reverse the disease process and return the periodontal attachment apparatus to a healthy state. Ideal therapy should allow the regeneration of the periodontal ligament (PDL) to healthy status. This article demonstrates the combination of recent technologies, the Nd:YAG laser and enamel matrix derivative (EMD), and the benefits of each when used in tandem. This combined procedure is comparable with traditional results, optimizes EMD properties, and reduces patient discomfort and healing morbidity.

Materials and Technique

A new bone graft-replacement product (Endogain®, Biora, Sweden) has recently entered the marketplace. It is an EMD with excellent regenerative potential for use in traditional periodontal surgery. This product is of a fluid nature and lends itself well to the treatment of periodontal pockets. The Nd:YAG laser, which has a long history of use in dentistry, has a wavelength of 1064 nm in the near-infrared range. The emitted laser light is invisible, nonionizing, and therefore nonmutagenic, an important point to remember.

A flexible quartz fiber optic is used with the laser, which is an advantage for ease of oral access. The energy is highly absorbed by periodontal pigmented tissue, and is ideally suited to irradiate the defect site. The contact delivery system allows simultaneous cutting and coagulation of tissue with excellent visualization, requiring minimal flap reflection.

The laser device used in this article is the Pegasus 20 Nd:YAG laser (Premier Laser Systems, Tustin, CA). Unfortunately, as of this writing, the manufacturer is no longer in existence, but the instrument is still in service and is used by many professionals. The aforementioned 1064 nm wavelength is delivered through a 400-micrometer diameter quartz fiber. The power setting is 4 W in a gated pulsed mode of 0.05 seconds. The fiber is held parallel and adjacent to the long axis of the root as the entire sulcus depth is irradiated for approximately 10-15 seconds. Minimal heat buildup occurs during the procedure since the operator uses a rapid sweeping motion and makes parameter adjustments based upon visual fiber-tissue interaction. The root surface is never intentionally irradiated in focal contact as indicated in early periodontal studies. This wavelength is absorbed strongly because of the optical properties of the inflamed red edematous tissue present in periodontal disease, and thus there is minimal transfer of heat to the root surface. The infected tissue absorbs the laser energy effectively.

The laser phase of treatment is followed by conventional debridement, creating an ideal blood-free reservoir for the EMD gel. Therefore the Nd:YAG fiber is an excellent adjunct to periodontal soft tissue treatment, and can be used in combination with traditional surgical techniques. The laser benefits include sealing small sulcular blood vessels, thus creating a drier field; “sterilizing” tissue from heat buildup at the laser-tissue interaction site; and sealing off nerve endings, resulting in reduced postoperative pain.

Presently, many periodontal surgical techniques are utilized to regenerate or increase attachment levels. This is accomplished by treating a previously bacteria-contaminated root surface and the resulting loss of bone and attachment. There are several citations which suggest that the Nd:YAG laser has therapeutic benefits and bacterial elimination potential. The pigments of bacteria found in the diseased sulci or imbedded in the infected periodontal tissue are irradiated by the laser photons as they transmit through the tissues. This photothermal interaction destroys harmful subgingival flora, and has little effect on the surrounding collateral periodontal tissue.

The periodontist’s surgical goal is the regeneration of the periodontal attachment apparatus with new bone, cementum and periodontal ligament. The Nd:YAG laser, using low energy delivery, may possess detoxification potential through vaporization of these harmful bacteria and their products on the contaminated root surface. The key to a successful outcome when treating the periodontal defect is to clean the root surface thoroughly, removing all contaminants. Hand scalers, sonic, ultrasonic, rotary instruments, or combinations can accomplish this.

Next, the smear layer is cleansed from the root surface with a neutrally buffered EDTA (ethylene-diamine tetra-acetic acid) for two minutes. The assistant irrigates the root surface with large quantities of sterile water or sterile saline. At the same time, high-speed suction and air syringe are applied as the EMD gel syringe is held ready. The assistant then ceases the instant root cleansing and drying, and the surgeon expels the gel via a cannula onto the clean and dry root surface.

It is critical that the Endogain be the first protein to contact the freshly cleaned root surface. The smear layer is a combination of bacteria and their toxic products, and is also composed of diseased hypermineralized periodontal ligament, collagen, dentin, and cementum debris spread over the root surface. Several studies indicate the smear layer must be removed so that there is the best chance...
of a predictable surgical result. It is possible that the Nd:YAG laser contributes to the root cleansing process when used at very low energy. Several laser studies have indicated this phenomenon may facilitate healing.

The EMD protein, when combined with surgical advantage of the Nd:YAG laser, is an ideal treatment technique that can produce significantly improved patient comfort during treatment. The laser/EMD combination can also eliminate some of the limitations of EMD, and enhance its versatility compared with the traditional methods.

The laser/EMD combination results appear to be identical to the traditional surgical methods, but with faster recovery and normal function. EMD allows for more predictable periodontal regeneration compared with the normal healing repair process associated with open flap surgery only, or with use of alloplastic, allogeneic, and xenogeneic graft materials. Other graft materials can appear to act as biologic fillers, with connective tissue encapsulation of the graft particles and limited new bone formation.

Those tissues that have healed by repair are more subject to re-infection and continued attachment loss than those generated by surgical procedures designed to produce regeneration. Healing by repair does not result in restoration of the original form (new cementum, periodontal ligament and alveolar bone), nor is the original function of the periodontal attachment apparatus restored. Periodontal regeneration refers to the restoration of all the elements of the periodontium – bone, ligament, cementum – to their original levels before the damage of disease took place. Because true regeneration can only be evaluated histologically, researchers must rely on the various measurements of clinical levels (CALs) and re-entry surgeries in order to evaluate and analyze the results of regenerative periodontal surgery techniques.

Enamel matrix proteins (EMPs) are a group of proteins thought to be important in the development of the dental organ, especially as it contributes to the formation of cementum, PDL, and bone. The potential of employing EMPs in periodontal regeneration therefore does exist. It has been shown that porcine-delivered EMPs enhance the proliferation and protein production of human periodontal ligament cells in vitro. These same EMPs have also been tested as a new periodontal regenerative treatment modality in animals and humans. They have been shown to be safe and effective in improving CAL and radiographic bone fill. Two human biopsy reports revealed that true periodontal regeneration can be demonstrated with topical root application of EMPs. It has been suggested that one of the potential limitations inherent in the EMPs is related to their viscous consistency after reconstitution of the EMP and carrier. Because of the EMPs’ semi-fluid and viscous nature, these products do not have the capability of making and maintaining space, as is associated with solid or particle-type graft materials such as decalcified freeze-dried bone allograft (DFDBA) from human bone or bovine mineral.

Mellonig has reviewed use of a collagen/DFDBA combination using collagen fragments of less than 1 mm, which is added to the EMP gel before placement. However, care is required not to suture the wound too tightly, since the collagen has tendency to swell, and may cause tissue necrosis and wound dehiscence. The concerns with the viscous consistency of Emdogain are eliminated or reduced by the laser uni-flap procedure. The single flap reflection allows for opposite side fixation of the reflected flap. This secure suture technique provides predictable coronal flap positioning. The flexible fiber-optic fiber allows for minimal flap reflection and opening, creating a small, clean, osseous crypt site ideal for the EMD viscous gel to enter, filling its space via cannula syringe. Minimal bleeding, which is vital for visual assessment, is facilitated by laser coagulation on the flap connective tissue underside site and coagulation by sulcular irradiation, which ensures a clean dry root surface for coating with EMD.

**Case 1**

The patient was a 50-year-old Caucasian male, nonsmoker, in excellent health. There was a defect between teeth #2-3 and a large palatal defect on tooth #3. The probing was 9 mm distal and palatal on #3 (Figure 1). One year postoperatively, the probing depth was 3 mm, giving a probing depth reduction of 6 mm, and a clinical attachment gain of 5 mm. The 18-month radiograph showed moderate osseous fill (Figures 2, 8, 9). The surgical technique is shown in Figures 3-7.
Case 2

Radiographic response is very positive in this case of a 52-year-old male following Nd:YAG laser and EMD treatment. The postoperative radiograph was taken 18 months post-treatment (Figures 10, 11).

Case 3

This patient was referred for treatment, a hopeless prognosis had been rendered for tooth #28, and an implant was recommended (Figure 12). This 80-year-old woman did not want an extraction. Figures 13, 14 and 15 show the EMP treatment, following the protocol specified above. The treatment was successful, and 24 months postoperatively the tooth is serving as an abutment for a partial denture (Figures 16, 17).

Figure 6: Emdogain (enamel matrix protein) material is dispensed with a cannula into the cleaned mesiofacial osseous site.

Figure 7: Palatal view of the surgical site closed with sutures.

Figure 8: One-year postoperative probing, palatal view, of the healed site showing pocket depth reduction.

Figure 9: One-year postoperative facial view of the healed site.

Figure 10: Radiograph showing large osseous periodontal defects around both upper right molars.

Figure 11: One-year postoperative radiograph showing significant improvement of bone around both molars.

Figure 12: Preoperative facial view of tooth #28, showing severe inflammation of the soft tissue.

Figure 13: Facial view of the elevated soft tissue, showing both an osseous defect and an area of external resorption on the root of tooth #28.

Figure 14: Facial view of the root and bone tissue debridement completed.

Figure 15: View of the cannula dispensing Emdogain material onto the root and into the osseous defect.

Figure 16: Facial view, two years postoperative, showing the tooth and tissue in a healthy and stable condition.
Figure 17: Facial view of the tooth supporting a partial denture, two years postoperatively.

Conclusion

The cases in this report are presented to demonstrate the efficacy of combining Nd:YAG laser and EMD to treat periodontal defects. The laser wavelength and its bacterial reduction effects provide a key to tissue healing and regeneration.

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