CASE STUDIES

Lasers in Dentistry

ADVANCED PROFICIENCY CASE STUDIES

In this issue of *The Journal of the Academy of Laser Dentistry*, we feature case studies from our Advanced Proficiency candidates who completed their examinations during the 10th Annual Conference in San Destin, Florida in March 2003 and the 11th Annual Conference in Indian Wells, California in March 2004.

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

**HIGHLIGHTS**

Treatment of Acute Marginal Gingivitis Incipient Periodontitis
Utilizing the Nd:YAG Soft Tissue Laser
Julie Brister, RDH
Socorro, New Mexico

Clinical Applications of CO2 Laser and Er:YAG Laser in Frenectomy, Vestibuloplasty, and Removal of Mandibular Bony Protuberances
Glenda Payas, DMD
Tulsa, Oklahoma

Clinical Application of the Er:YAG Laser in Periodontal Surgery
Pablo Schilman, DDS
Ramat Hasharon, Israel

810 nm Diode Laser-Assisted Frenectomy and Gingivectomy
Itaru Yoshida, DDS
Tokyo, Japan

2004 Source Conference Sessions
Now Available on Videotape and DVD!

Couldn’t go to Indian Wells? Or did you go and now want a videotape or DVD of the proceedings for reference?

Videos are also available from past ALD conferences.

Videotapes and DVDs are now available by contacting Joyco MultiMedia, LLC at (303) 421-0093, fax (303) 403-9112, or www.joycomultimedia.com.
TREATMENT OF ACUTE MARGINAL GINGIVITIS INCIPIENT PERIODONTITIS UTILIZING THE Nd:YAG SOFT TISSUE LASER

Julie Brister is a laser dental hygienist practicing in Socorro, New Mexico. Julie received her Bachelor of Science degree from the University of Louisiana at Monroe. Julie achieved her advanced proficiency standing in the Nd:YAG laser with the ALD at the 11th annual conference held in Palm Springs, California. Julie may be reached by e-mail at drbeers@sdc.org.

Disclosure: Julie Brister has no affiliation with any commercial organizations relevant to this article.

CASE STUDY

Julie Brister, RDH
Socorro, New Mexico

Pretreatment

A. Diagnostic Tests

1. Clinical Examination

A 25-year-old male presented with a primary complaint of tooth pain on the maxillary left side. He indicated that his medical history was negative for abnormalities.

Dental History: This patient was new to the office and uncertain of his last dental visit. The patient claimed to have brushed once a day but had never flossed. He indicated that his gums were tender, swollen, and that they bled.

Oral Examination: The examination revealed that this patient had no existing restorations. Decay was detected on teeth #14, 15, 16 (large carious lesion), 18, 19, 30, and 31. The patient was described as having acute marginal gingivitis based on the condition of his gingival tissue: a scalloped zone of tissue bright red in color, loss of stippling, heavy bleeding, and bulbous papilla, especially maxillary teeth #5, 6, 7, 8, 9, 10, 11, and 12, and mandibular teeth #22, 23, 24, 25, 26, and 27. A pretreatment periodontal charting was performed. The patient had periodontal pockets ranging from 3 to 4 millimeters. No tooth mobility or furcation involvement was detected.

2. Radiographic Examination

Full mouth and panoramic radiographs were taken revealing decay on teeth #14, 15, 16, 18, 19, 30, and 31. Apical pathology was noted on tooth #16. Teeth #1, 17, and 32 were impacted. Incipient vertical bone loss was detected on teeth #3, 4, 5, 6, 10, 14, 20, 22, 26, 27, 29, 30, and 31.

3. Soft Tissue Tests

Doctor Examination: Acute marginal gingivitis, early periodontitis, generalized purulent exudate, and excessive plaque presence on coronal and free tissue surfaces were noted.

Hygiene Examination: Acute marginal gingivitis and early periodontitis indicated by: gingival gingival zone of redness, enlarged papilla, loss of stippling, smooth and shiny surface. Gingival tissue appeared soft and spongy: bleeding occurred spontaneously when pockets were probed. Full mouth periodontal probing was utilized to determine tissue and bone topography. Teeth #1, 16, 17, and 32 were not charted because extractions of these teeth were planned. Charting results indicated that inflammation was beginning to affect the bony support of some teeth (#3, 4, 5, 6, 10, 14, 20, 22, 26, 27, 29, 30, and 31). Out of 28 teeth, he had 84 sites that bled upon probing: recession was noted on one tooth, #25. His plaque score yielded 99 total sites that had plaque and minimal calculus, 54 interproximal sites, 24 lingual sites, and 21 buccal sites. There was no furcation or mobility involvement. Due to ubiquitous plaque, oral hygiene instructions were reviewed with the patient, emphasizing the importance of effective brushing twice daily and flossing once daily.

4. Hard Tissue Tests, Tooth Vitality

Decay was detected on teeth #14, 15, 16, 18, 19, 30, and 31; all teeth except #16 were vital. Fluorosis and green stains were present on maxillary incisors. Teeth #1, 17, and 32 were impacted.

5. Other Tests

The occlusion was evaluated to be Angle’s class III tendency. The TMJ was healthy within normal range of motion.

B. Diagnosis and Treatment Plan

1. Provisional Diagnosis

A provisional diagnosis of Acute Marginal Gingivitis with signs of Early Periodontitis Type II was made.

2. Treatment Plan Outline

The treatment plan would involve four quadrants of scaling and root planing with micro-ultrasonics and conventional hand instrumentation. The bacterial reduction and de-epithelialization/soft tissue curetage would be completed by using a free-running pulsed Nd:YAG laser. The patient would be scheduled for two appointments (two quadrants per visit) and approximately two weeks between visits. The purpose of subsequent visits/treatments was to allow the reduction of bacterial counts, thus helping the tissue heal for a good overall result. At the end of each appointment oral hygiene instructions were given with recommendations including avoiding foods with seeds and/or hulls, take medication (ibuprofen) for pain if needed, and apply chlorhexidine gluconate 0.12% mouth rinse. The patient was advised to use salt water rinses for 24 hours to reduce inflammation. The final appointment involved evaluation of tissue response, checking oral hygiene habits, and encouraging the patient to continue three-month recall visits. The three-month appointment involved probing, periodontal maintenance, and oral hygiene review with encouragement for continued success.

3. Treatment Alternatives

The possible alternative treatment for this patient could be traditional root planing without the adjunctive use of the laser combined with continuous oral hygiene instruction.

4. Indications for Laser Treatment

The Nd:YAG laser operates at a wavelength of 1064 nm, which has a good depth of penetration, bactericidal properties, and promotes coagulation. The use of a quartz fiber-optic delivery system allows the clinician easy access to the diseased site. The selected laser complies with the...

5. Contraindications for Laser Treatment

The specific absorption of this wavelength is by pigmented soft tissue and blood. However, due to heat damage potential, the clinician must be careful to avoid contact with tooth and bone structure. Laser energy leaving the fiber vaporizes biological tissue and metal restorations; therefore the clinician must be aware of this potential danger.

6. Informed Consent

The patient was informed of the treatment plan, augmented by utilizing a “Casey” educational DVD on scaling and root planing, brochures on laser periodontal treatment, and the American Dental Association’s brochure on periodontal disease. The patient then gave his verbal consent.

**Treatment**

A. Treatment Objective

The main objective was to restore the oral tissues of this patient to a normal healthy state. The patient was instructed on therapeutic plaque control measures, including motivating and encouraging the patient on the benefits of a healthy mouth.

B. Laser Operating Parameters

The laser chosen was the American Dental Laser dLase 300, free-running pulsed Nd:YAG Dental Laser System manufactured by Sunrise Technologies, Fremont, California.

1. Wavelength: 1064 nm
2. Emission mode: Free-running pulsed
3. 320-micron diameter fiber
4. Pulse rate adjustable from 10 to 30 Hz
5. Pulse energy variable from 30 to 100 mJ per pulse at 10 Hz; up to 3 Watts maximum average power at higher repetition rates (see below for actual parameters used)
6. The aiming beam for the laser is HeNe at 632.8 nm wavelength
7. Laser Operating Parameters for bacterial reduction include fiber in contact mode; 10 Hz, 100 mJ per pulse, maximum average power 1.0 Watt, 20 seconds per site
8. Laser Operating Parameters for de-epithelialization include fiber in contact mode; 20 Hz, 100 mJ per pulse, maximum average power 2.0 Watts, 25-40 seconds per site

This laser requires patient and all personnel to wear laser-specific eyewear for protection.

C. Treatment Delivery Sequence

Traditional hand instrumentation, micro-ultrasonics, and root planing with Nd:YAG laser curettage; 4 one-hour appointments. Septocaine 4% with 1:100,000 epinephrine was the anesthetic used. The laser was test fired and the fiber cleaved according to manufacturer’s specifications.

The fiber was calibrated to the depth of the pocket minus 1 mm. The lasing procedure was started at the crest of the gingival margin. The fiber was placed in contact with the target tissue, moving from the top of the pocket in a continuously horizontal and vertical direction, progressing down the pocket wall to the depth of the measured fiber. The laser energy was always directed away from the tooth and toward the target tissue. Observation of the fiber tip was made often for removal of accumulating granulation tissue. The lasing procedure was considered to be complete when fresh bleeding occurred at the delivery site. Following instrumentation, the Nd:YAG laser was used again at the bacterial reduction settings. The laser was used at the parameters indicated above for de-epithelialization and for bacterial reduction. High-speed evacuation was used to suction the toxic plume and cool the tissue surface temperature. Chlorhexidine gluconate 0.12% was used to irrigate after laser therapy was complete. Total time for treatment was 6 hours.

D. Treatment Records

All notes concerning the treatment were included in the patient’s chart.

E. Postoperative Instructions

The postoperative instructions given to the patient included warm salt water rinses, ibuprofen as needed, and no spicy or seed-type foods for 24 hours. The patient was advised to use chlorhexidine gluconate 0.12% rinses twice daily.

F. Management of Complications

There were no complications encountered during any of the procedures or postoperatively.

G. Prognosis

The prognosis was good if patient were to maintain good oral hygiene habits.

**Follow-up Care**

A. Assessment of Treatment Outcome

The patient was first assessed at one day. He was advised to use ibuprofen if needed and continue oral hygiene care. The patient was assessed again at 1 week, 2 weeks, 1 month, 3 months, 5 months, 6 months, 7 months and 9 months. The gingival tissues appeared much pinker and healthier. The 5-month assessment of the gingival tissue at sites #6-11 and #22-27 needed retreatment with the Nd:YAG laser at bacterial reduction settings listed above. The patient was gently probed at 6 months and data showed no bleeding on probing and some reduction of gingival pocketing. Oral hygiene instructions were reviewed at each appointment and the patient was encouraged to continue regular three-month recare visits.

B. Complications

The patient had no complications during or after any procedure.

C. Long-Term Results

The long-term results were felt to be good with continued three-month recare visits and meticulous oral hygiene habits.

D. Long-Term Prognosis

Assuming this patient complies with oral hygiene care instructions and regular professional examination appointments, his prognosis should be excellent. ✯
Figure 3: Incipient vertical bone loss

Figure 4: Incipient vertical bone loss

Figure 5: Probing mesial of tooth #4, 4 mm pocket depth.

Figure 6: Maxillary peri chart, pretreatment

Figure 7: Mandibular peri chart, pretreatment

Figure 8: Calibrating the fiber at 3 mm

Figure 9: Fiber prior to insertion into periodontal pocket

Figure 10: Laser initiated in 4 mm pocket

Figure 11: Eight-week postoperative view, right side only treated

Figure 12: Three-months postoperative view

Figure 13: Seven-months postoperative view

Figure 14: Maxillary peri chart, 9 months post-treatment

Figure 15: Mandibular peri chart, 9 months post-treatment
Clinic Applications of CO₂ Laser and Er:YAG Laser in Frenectomy, Vestibuloplasty, and Removal of Mandibular Bony Protuberances

Dr. Glenda Payas graduated in 1982 from the Oral Roberts University School of Dentistry in Tulsa, Oklahoma. She has maintained a private practice in Tulsa since 1990. Dr. Payas has been incorporating the use of lasers in her practice since 1991 and is a charter member of the Academy of Laser Dentistry. Dr. Payas has completed her Advanced Proficiency in CO₂ laser. Dr. Payas can be reached by e-mail at gpayas@tulsaonmail.com

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

Pretreatment

A. Diagnostic Tests

1. Clinical Examination

The patient, an 85-year-old female, presented complaining of not being able to wear her denture. She wanted a denture that would stay in her mouth while she ate and talked. She had had all of her maxillary teeth extracted two years previously and an immediate denture placed. She had not worn her denture for 2 years due to the frustration of the denture falling down. Upon clinical examination, the maxillary buccal frenum attachments were observed to have healed at the height of the maxillary ridge. She had a shallow maxillary vestibule. There was generalized plaque on all remaining teeth with horizontal gingival recession. The mandible had periodontally involved lower anterior teeth #23-26 with periapical radiolucencies. The mandible had periodontally involved lower anterior teeth #23-26 with periapical radiolucencies.

2. Radiographic Examination

Periapical radiographs revealed generalized horizontal bone loss. The interproximal areas of teeth #23-26 had vertical bone loss and periapical radiolucencies due to periodontal disease and pulpal pathosis.

3. Soft Tissue Status

The soft tissue was within normal limits for the lymph nodes, lips, hard palate, soft palate, oropharynx, floor of mouth, tongue, and salivary glands. The buccal mucosa had a high labial frenum attachment and a shallow buccal vestibule. There were periodontal pockets ranging from 8-10 mm due to extensive bone loss in teeth #23-26. The gingival tissue was edematous and displayed extensive bleeding upon probing.

4. Hard Tissue Status, Tooth Vitality

Clinical examination revealed that teeth #1-16, #17-18, and #30-32 were missing. Teeth #23-26 were mobile (Grade 3) and tender to percussion. The patient was informed of hopeless prognosis for these teeth. Teeth #19-22 and #27-28 had severe multiple surface carious lesions. Tooth #29 had a deep carious lesion on the distal without any sensitivity to heat, cold or percussion. A pulp test indicated a necrotic pulp.

5. Other Tests

No other tests were performed.

B. Diagnosis

1. Provisional Diagnosis

High maxillary buccal and labial frenum attachments with decreased vestibule height were present throughout the maxillary arch causing an inability to retain a maxillary denture. Teeth #23-26 were periodontally and endodontically involved. All remaining teeth had carious lesions.

2. Final Diagnosis

Maxillary buccal and labial frenum attachments high on the ridge causing displacement of the denture. After initial treatment, following the extractions of teeth #23-26 and during healing, bony protuberances resulted from the residual interproximal bone on the mesial of tooth #23 and the distal of tooth #26 and caused discomfort secondary to the fragile tissue over the sharp bone.

3. Treatment Plan Outline

In the initial treatment phase, the mandibular teeth #23-26 would be extracted and all carious lesions restored with composites. Tooth #29 would be restored with endodontic therapy, buildup, and porcelain-fused-to-metal crown.

During the second phase, a new mandibular denture with extended buccal flanges would be made. The Er:YAG laser would be used for the initial incision to perform a
frenectomy on the labial and buccal frenae and a vestibuloplasty to deepen the vestibule and release the muscle traction. The CO₂ laser would be used to further relax and deepen the frenal attachments and deepen the vestibule. The CO₂ laser would then be used for blood management with cauterezation and coagulation.

In the mandible, the Er:YAG would be used to remove the bony protuberances resulting from the extractions during the initial treatment phase. The CO₂ laser would then be used for cauterezation and coagulation of the soft tissue. A new removable partial denture would be fabricated.

4. Indications for Laser

The pulsed Er:YAG laser can cut and ablate tissue with excellent surgical precision and does not create excessive heat or collateral thermal injury while incising the tissue. This Er:YAG laser wavelength (2940 nm) would be used for initial incisions to guard against thermal tissue damage. Because little collateral thermal injury is produced, relatively little hemostasis is provided in the soft tissue when using the free-beam erbium laser energy. The CO₂ laser (10,600 nm) is excellent for precisely cutting or vaporizing soft tissue with hemostasis, but can build up excessive heat. It also allows for excellent blood management through cauterezation and coagulation. For these reasons, two wavelengths would be utilized for the frenectomy and vestibuloplasty to maximize the advantages of both wavelengths and not add excessive heat damage to the buccal mucosa. Using the combined wavelengths of Er:YAG and CO₂ lasers at moderate energy settings offers a predictable result with a very low risk of complications.

5. Contraindications for Laser

Previous negative experience with the laser, esthetic concerns, and compromised patient home care are potential contraindications. In this case, it was considered that there were no contraindications.

6. Treatment Alternatives

Use of traditional conventional instruments, i.e., scalpel and use of electrotcature to perform soft tissue frenectomy and vestibuloplasty, is an alternative to treatment with the lasers. These methods could cause more traumatic postoperative results (sutures and multiple appointments) as well as more bone loss associated with full flap surgery.

7. Informed Consent

Written and verbal consent were obtained from the patient.

### Treatment

A. Treatment Objectives Strategy

Frenectomy and vestibuloplasty would be performed using both Er:YAG and CO₂ lasers. The Er:YAG would be used to make an incision without excessive laser energy applied to the tissue. The CO₂ laser would be used for further incision of the frenal and buccal areas. The CO₂ laser would then be used for blood tissue management through cauterezation and coagulation providing hemostasis. A maxillary frenectomy with extended flanges would be immediately placed. The removal of the bony protuberances would be performed with the Er:YAG laser through the mucosa, and coagulation of the blood with the CO₂ laser. A removal partial denture would be made in the future.

B. Laser Operating Parameters

1. **Opus Duo EC: CO₂ Laser (OpusDent, Israel)**
   - Wavelength: 10,600 nm
   - Emission mode: Super-pulsed continuous
   - Delivery System: Hollow waveguide
   - Beam: Focused spot size 400 microns
   - Power: 1.5-3.0 Watts average power
   - Time Taken: 16 minutes
   - Handpiece: 90-degree angled focusing

2. **Opus Duo EC: Er:YAG Laser (OpusDent, Israel)**
   - Wavelength: 2,940 nm
   - Emission mode: Free-running pulsed
   - Delivery System: Hollow waveguide
   - Energy Level: 500 mJ per pulse
   - Pulse Rate: 12 Hz
   - Power: 6.0 Watts maximum average power
   - Water Spray: Starts 2 seconds before laser emission, continues for 2 seconds after laser emission ceases
   - Water Volume: 280 ml
   - Time Taken: 7 minutes
   - Handpiece: Angled with 800 microns HPX conical sapphire tip in contact

C. Treatment Delivery Sequence

In the initial treatment phase, the mandibular teeth #23-26 were extracted and all carious lesions restored with composites. A pulp test revealed a necrotic pulp on tooth #29 which was restored with endodontic therapy, a buildup, and porcelain-fused-to-metal crown.

During the second phase, a permanent denture with extended buccal flanges was prepared by the laboratory a week before surgery. The patient was not taking any medication prior to the surgery. Buccal and palatal local infiltration was given using 6 carpules of 2% Lidocaine 1:100,000 epinephrine and 3 carpules Marcaine 0.5% 1:200,000 epinephrine.

Figures 1-12 and accompanying commentary present the treatment delivery sequence.
D. Postoperative Instructions

Postoperative instructions were given to the patient. The patient was instructed to take ibuprofen if needed for discomfort, rinse with warm salt water, and maintain good oral hygiene. No significant bleeding occurred and the patient left with the new denture in place. No antibiotics were prescribed.

E. Management of Complications

During healing after the initial treatment, the patient complained of tender areas on the lower anterior. Bony protuberances had resulted from the extraction of teeth #23-26. The soft tissue had healed over the protrusions and were causing discomfort. The treatment plan outline was adjusted to include removal of the bony protuberances during the second phase of treatment.

The patient was called the evening after the second treatment phase. She was comfortable but reported some pain. Twenty-four hours after treatment, the patient still reported some discomfort. One week after treatment, the patient presented for a postoperative evaluation, indicating no pain and showing signs of good healing. However, she was having difficulty getting accustomed to her new denture since she had not worn a denture for 2 years.

F. Surgical Prognosis

Prognosis is very good.

G. Treatment Records

Treatment records were completed in the patient’s file noting the operating parameters of the lasers.

Follow-Up Care

A. Assessment of Treatment Outcome

Figures 13-17 provide a summary of treatment outcome assessment.
B. Side Effects and Complications

Following the initial phase of treatment, bony protuberances resulted. These were removed during the second phase of treatment. Immediately after the second phase of treatment, the patient reported no unusual side effects or complications.

C. Long-Term Results

At 3 months, the soft tissue remained healthy and no bony protuberances were observed. The radiographs revealed the bony tissue had recontoured over the area where the teeth had been extracted. The tissue healing remained relatively the same through the postoperative period. The gingival tissue looked healthy.

D. Long-Term Prognosis

Excellent healing was demonstrated for both the soft tissue and bony tissue. The combination of these two laser wavelengths, 10600 and 2940 nm, provided excellent results for frenectomy, vestibuloplasty, and removal of bony lesions.
**Clinical Application of the Er:YAG Laser in Periodontal Surgery**

Dr. Pablo Schilman graduated from the University Colegio Odontologico Colombiano in 1984. He has been in private practice in Israel since 1986. His practice in Ramat Hasharon emphasizes the laser, periodontics, implantology, and esthetic dentistry. He is a diplomat of the International Congress of Oral Implantologists. He has achieved Advanced Proficiency from the Academy of Laser Dentistry in Er:YAG and diode laser wavelengths. He has lectured internationally on laser applications using diode, Er:YAG, CO2, and Nd:YAG laser wavelengths. Dr. Schilman may be reached by e-mail at drsch@bezeqint.net

**Disclosure:** Dr. Schilman lectures and conducts training for DEKA and other laser manufacturers, for which he receives an honorarium.

**Case Overview**

Periodontal disease in the pre-maxilla represents an aesthetic problem when gingival and bone resorptions are involved.

**Pretreatment**

A. Diagnostic Tests

1. Clinical Examination

A 48-year-old female presented with complaints with her upper anterior aesthetics. Upon clinical exam, it was determined that gingival retraction was present between the right lateral incisor and the right frontal incisor. In addition, there was retraction in both premolar areas with old porcelain-fused-to-metal (PFM) restorations.

Medical History: No abnormalities, very light smoker.

Dental History: PFM restorations in all four quadrants, fair-to-poor oral hygiene, generalized periodontal pocketing with generalized recession, mobility on several teeth. Class I occlusion with no signs of temporomandibular joint dysfunction or neuromuscular disorder. The patient had lost three lower molars and an upper premolar, and they were rehabilitated with PFM crowns and bridges.

2. Periodontal Examination

Periodontal pocket depth charting revealed pockets to be between 3-10 mm with localized gingival beading. Recession was between 1-5 mm with mobility greater then normal.

3. Radiographic Examination

Periapical radiographs revealed that vertical bone loss was present at the interproximal areas of teeth #5-7, #12-15, and in the lower jaw at #23 due to periodontal disease. All the teeth under PFM had endodontics and the rest were vital. The endodontics were fair, but the patient did not want to correct the ones that were not good because they were asymptomatic.

4. Soft Tissue Status

- Soft tissue had areas of retraction in tooth #7 because of malposition and deep pockets ranging from 7-10 mm in three quadrants. High frenum attachment was present in the lower jaw.

5. Hard Tissues Status

- Teeth #4, 18, 19 and 30 were missing but prosthodontically rehabilitated with fixed PFM. Vertical bone loss was present in three different quadrants.

6. Other Tests

- TMJ was healthy with normal range of motion. No pain or joint noises were present.

**B. Diagnosis and Treatment Plan**

1. Provisional Diagnosis

Severe periodontitis, inadequate oral hygiene, and poor aesthetics of upper PFM.

2. Treatment Plan

Periodontal surgery with adjunction of Emdogain® gel to eliminate pockets and repair the intrabony defects. PFM change for aesthetics with Procera®.

3. Treatment Plan Outline

- Scaling, root planing, prophylaxis (ProphyJet® and rubber cup polishing), oral hygiene instructions, and suggestions for home care improvements were completed by the hygienist. Impressions for temporary aesthetic crowns were taken.

- The treatment plan called for removal of all granulation tissues and smear layer in the intrabony defects and elimination of the high frenum attachment in the lower jaw. Each quadrant to be treated individually and PFM changes were to occur after evaluation of surgical success.

4. Treatment Alternatives

Treatment alternatives included conventional scaling and root planing treatment for a long period of time, conventional surgical techniques.

5. Laser Indications

The Er:YAG laser is well absorbed by water, a constituent of all soft tissue. This laser is an excellent scalpel providing a wet surgical site that collaborates to promote gingival healing. It also helps eliminate the smear layer. Changing tips allows different spot sizes to be easily achieved.

6. Contraindications for Laser

The contraindication for laser treatment is the risk of damage to any tooth structure during the periodontal incision, which could be reduced by using the angled handpiece with a thin tip inside the sulcus and parallel to the tooth structure.

7. Informed Consent

Written and verbal consent was obtained.

**Treatment**

A. Treatment Objective

The treatment objective was the selective removal of granulation tissues in the intrabony defects to stimulate the bone growth using only an Er:YAG laser.

B. Laser Operating Parameters

- Opus 20 Er:YAG laser (OpusDent, Israel)
  - Angled handpiece, hollow waveguide
  - Wavelength: 2940 nm
  - Energy per pulse: 100-500 mJ
  - Pulse width: 400 msec
  - Spot size: 200-600 microns
  - Repetition rate: 7-12 Hz
  - Peak power on tissue: 9000 W/cm²
  - Fluence: 16 J/cm²
  - Maximum Average Power: 0.7-6.0 Watts, depending on energy/repetition combinations
C. Treatment Delivery Sequence

The laser was test fired. The patient was then seated and appropriate safety equipment was utilized. Local anesthesia was obtained using topical 20% benzocaine, followed by infiltrative 3.6 cc 4% articaine hydrochloride with 1:20,000 epinephrine to the right upper quadrant. The laser was used to perform an intrasulcular incision from teeth #2-8, from both vestibular and palatal. Initially the power was set at 3.5 Watts (350 mJ, 10 Hz). A 200-micron sapphire tip in the angled handpiece was used perpendicular to the teeth. A periosteal elevator was used to separate the tissues. The tip was changed to a 600-micron sapphire and the energy adjusted to 1.0 Watt (100 mJ, 10 Hz) to irradiate all granulation tissue which was removed with a curette. Calculus was removed with an ultrasonic device. The roots and bone of the intrabony defects were then irradiated with a 600-micron beveled tip at 1.0 Watt to help eliminate the smear layer. A 24% EDTA was applied to the roots for 2 minutes for conditioning and rinsed with sterile saline. Emdogain TS was applied in all the defects and the flap was sutured with 3/0 Vicryl rapide (Ethicon). Postoperative checks were done every week for the first month and once a month for the next 6 months. No complications were reported during surgery.

D. Treatment Record

Completed. Use of the laser was noted at the operating parameters specified above.

E. Postoperative Instructions

Verbal and written postoperative instructions were given to the patient. The patient was instructed to take etodolac 400 mg if needed for any discomfort, rinse with chlorhexidine, and a special soft toothbrush was given.

F. Management of Complications

There were no complications. The patient reported no discomfort at all.

G. Surgical Prognosis

Prognosis is very good. The final soft tissue health was excellent during the postoperative period. The mobility was reduced dramatically. It is indicated to continue treatment in all other quadrants.

Follow-Up Care

A. Assessment of Treatment

The patient returned for a one-week follow-up. The soft tissue had healed beautifully without incidents. The mobility was reduced. There were indications to continue treatment in all other quadrants. At the six-week check-up, the hygienist resumed treatment. At the six-month checkup, no periodontal pockets were present and another periapical set was taken. Between the 4-6 month checkups the upper crowns were changed.

B. Complications

No complications occurred during treatment. The patient could not believe how frightened she was before, and how much she appreciates the new technology now.

C. Long-Term Results

The soft and hard tissues appeared healthy at the 6-month and 1-year postoperative examinations.

D. Long-Term Prognosis

Excellent healing. Ideal combination of Er:YAG laser and Emdogain.
Dental Laser Texts and Journals

Special Rates to ALD Members

Be sure to indicate you are an Academy of Laser Dentistry member when ordering.

- *Journal of Oral Laser Applications*, Quintessence Publishing Co., Inc., 551 Kimberly Drive, Carol Stream, IL 60188-1881 USA, Telephone (800) 621-0387, (630) 682-3223, Fax (630) 682-3288, Web site www.quintpub.com. (4 issues annually, the special ALD member rate is $98.40, compared with the nonmember rate of $123.00. To secure the special rate, please contact Quintessence Publishing.

- The text *Lasers in Dentistry*, edited by Leo J. Miserendino and Robert M. Pick (1995) is also published by Quintessence. ALD members may order the book for $78.40, a 20% discount off the regular price of $98.00. To secure the special rate, please contact Quintessence by phone or e-mail. See above.

- *Journal of Clinical Laser Medicine and Surgery*, published six times per year by Mary Ann Liebert, Inc., 2 Madison Avenue, Larchmont, NY 10538, telephone (800) M-LIEBERT, (914) 834-3100, fax (914) 834-1388, Web site www.liebertpub.com. (6 issues annually, ALD member rate is $89 plus $16.00 postage and handling, a 40% discount off the regular $188 rate.)


Pre-treatment

A. Outline of case

1. Full Clinical Description

A 55-year-old female presented for assessment and treatment. Her concern was to receive a new removable partial denture in the upper jaw. She had a functional complement of natural teeth in the lower jaw, but the only remaining teeth in the upper jaw were #9, 10. These teeth were in urgent need of treatment. Her general medical history was uneventful (Figures 1, 2).

2. Radiographic Examination

Periapical radiograph of the upper teeth revealed root fillings in both teeth. There was some widening of the periodontal space, but both roots had sufficient bone support, and were of normal density (Figure 3).

3. Soft Tissue Status

With specific regard to teeth #9, 10, the gingival tissue surrounding the root margins had become hyperplastic and had encroached onto the root margins. Consequently, it was not possible to record pocket depth measurement due to the presence of gingival polyps. The gingival margins were inflamed and bled easily. The presence of a thick midline frenulum would compromise the placement of a new denture. All other soft tissues appeared normal.

4. Hard Tissue Status, Tooth Vitality

Both upper teeth were nonvital and percussion tests were negative. Tooth mobility was Grade 1. Subgingival caries was present in both roots. The occlusion was Class II div 2, with increased overbite. There was no evidence of any TMJ dysfunction and the path of closure was normal.

5. Other Tests

No other diagnostic tests were carried out or deemed necessary.

B. Diagnosis

1. Provisional Diagnosis

A provisional diagnosis was made as to the need for a new upper prosthesis. The retained roots at #9, 10 would require treatment to remove the gingival hyperplasia and caries. In addition, the midline frenulum was compromising the fit of the new partial denture.

2. Treatment Plan Outline

Upper lip frenectomy and #9, 10 gingivectomy using an 810 nm diode laser to achieve enough level of attached gingiva and exposure of the remaining tooth, with anesthesia.

3. Treatment Alternatives

The periodontal and frenum correction could be accomplished with conventional scalpel and suture surgery. Surgical curettage or antibiotic therapy could be used for the localized periodontitis, and electro-surgery could be used for the frenectomy.

4. Indication for Laser

The use of an 810 nm diode laser in cutting and coagulation of soft tissue is accepted. Hemostasis is due to the capacity of the laser to shrink and cauterize small blood vessels as a result of photothermal interaction with the biological tissue. The nature of the surgery and target tissue would make the use of this wavelength ideal, using correct power parameters.

5. Contraindication

It is felt that, due to the limited amount of attached gingiva in the area, care would be needed to avoid the removal of too much tissue. A possible alternative to gingivoplasty would be apical repositioned flap or free-grafting procedures. With all the precautions considered, there was no contraindication for the chosen wavelength.

6. Informed Consent

Alternative treatments, risk and benefits involved were explained to the patient. Informed consent was obtained from the patient and recorded in the notes.
Treatment

A. Treatment Objectives

It was considered necessary to establish exposure of the root surfaces, without excessive removal of attached gingival tissue and to reduce the midline frenulum attachment to enhance prosthetic stability.

B. Laser Operating Parameters

The DENTEK LD-15 laser was used, with the following parameters:
1. Wavelength: 810 nm
2. Power: 5 W maximum peak, 0.29 W average power, 9.9 mJ/pulse
3. Repetition rate: Gated pulse mode was used
4. Beam diameter: 400 µm, using quartz fiber delivery. Contact mode
5. Exposure duration: Tooth margin exposure: 60 sec. Frenectomy: 40 sec

C. Treatment Sequence

The laser was test-fired to establish correct operation. Local anesthesia infiltration (2% lignocaine, 1:80,000 epinephrine) was administered. Protective eyewear was worn by the patient, assistant and doctor. High-volume evacuation was provided.

During laser surgery, the fiber was used in a light contact mode. A cutting mode perpendicular to the target tissue was used, and the gingival margins of each root were reduced to expose the softened dentine tissue. Softened and carious dentine was then removed with rotary instrumentation and each root orifice restored with a direct composite resin. The frenectomy was then carried out, using a similar light contact mode, with the fiber perpendicular to the tissue (Figures 4, 5, 6, 7).

D. Management of Complications

There were no complications since proper precautions and planning were undertaken. Only the intended tissues were involved and there was no bleeding and no charring when the patient was discharged. She was contacted the next day and there was no swelling or bleeding. Although the midline frenum area was reported to be sore, no pain medication was required.

E. Surgical Prognosis

For both procedures, only the intended tissues were selectively removed, leaving the surrounding healthy structures relatively untouched. Complete haemostasis was achieved at both sites. The prognosis was excellent.

F. Treatment Records

Treatment data, such as the type of anesthetic used, the laser operating parameters, 35 mm color photographs, periodontal charting, postoperative instructions, study models, and periapical radiographs were recorded, along with the written documentation.

G. Postoperative Instructions

The patient was instructed to stay on a soft diet, and to start rinsing her mouth after each meal and at night with the chlorhexidine mouthwash provided by our office. If needed, she could take regular analgesics. For any related complication, she was advised to call the office.

Follow-Up Care

A. Side Effects and Complications

The patient reported some pain during the immediate postoperative period.

B. Assessment of Treatment

Follow-up care was performed 1 day (Figure 8), 14 days (Figure 9), 1 month (Figure 10), and 3 months (Figures 11, 12) after laser application.

At the one-week recall, the gingiva around #9, 10 was healthy and free of infection. The healing at the frenectomy site was satisfactory, in that there was no swelling, no bleeding, and only mild soreness was reported.

At the one-month recall, the periodontal conditions around the anterior teeth continued to improve, while the surgical healing at the labial frenum was complete.

At the three-month and six-month
C. Long-Term Results

The treatment objectives were accomplished and the long-term result is very good.

D. Long-Term Prognosis

The long-term prognosis for the remaining teeth and the extended labial frenum is excellent.

In his clinical case involving the clinical application of an Er:YAG laser in periodontal surgery (page 19), Dr. Pablo Schilman identifies the ability of the laser to help eliminate the smear layer.

Among the earliest studies to investigate the effects of lasers on the smear layer specifically was the report published in 1987 (Tani Y, Kawada H. Effects of laser irradiation on dentin. I. Effect on smear layer. Dent Mater J 1987;6(2):127-134). Their investigation used Nd:YAG and CO2 lasers.

Most subsequent studies involving the effect of lasers on the smear layer relate directly to endodontic applications. Among the laser wavelengths investigated in this area are various excimer lasers, argon, frequency-doubled Nd:YAG, Nd:YAG, Nd:YAP, Er:Cr:YSGG, Er:YAG, and CO2.

The following four abstracts describe the effects of various lasers on the smear layer in nonendodontic applications. It should be stressed that these studies are to be considered investigational. Clinicians are advised to review the specific indications for use of their lasers and to review their operator manuals for guidance on operating parameters before attempting similar techniques.

Effect of a Carbon Dioxide Laser on Periodontally Involved Root Surfaces

Vivek Misra
K.K. Mehrotra
J. Dixit
S.C. Maitra

King George’s Medical College, Lucknow, U.P., India

J Periodontol 1999;70(9):1046-1052

Background: The purpose of this in vitro study was to evaluate the effect of CO2 laser on the periodontally involved root surface, and to compare its efficacy with citric acid, EDTA and hydrogen peroxide in removal of root surface smear layer after root planing. Methods: The study was conducted on 50 periodontally involved single-rooted human teeth with poor prognosis. Immediately after extraction the teeth were scaled and root planed with Gracey curets; 50 specimens were obtained from the proximal side of each tooth which were assigned randomly to 1 of the 4 groups. Group A (35 specimens) was divided into 7 subgroups of 5 specimens each and irradiated with CO2 laser using a defocused mode at 3-Watt power for 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, or 1.4 seconds, respectively. Groups B, C, and D (5 specimens each) were treated with 6% hydrogen peroxide, EDTA solution (pH 7.4), or saturated citric acid solution (pH 1), respectively for 3 minutes. The specimens were then fixed and scanned using SEM. Results: It was observed that surface smear layer was present on root surfaces of teeth that were root planed; the CO2 laser was not able to remove the smear layer on the sites that were irradiated for 0.2, 0.4, or 0.6 seconds at 3 W power. Irradiation time of 0.8 seconds at 3 W power was able to remove the smear layer, but the dentinal tubules were partially exposed. The surface irradiated for 1 second showed a flat appearance with many clear orifice of dentinal tubules. No change in diameter of exposed dentinal tubules was observed and their diameter was nearly equal that of normal dentinal tubules. Irradiation time of 1.2 and 1.4 seconds produced surface charring and carbonization and was totally ineffective in exposing the dentinal tubules; 6% hydrogen peroxide did not remove the smear layer completely and the exposed dentinal tubules orifice was not clear. EDTA (pH 7.4) and citric acid (pH 1) were found to be effective in remov-
ing the smear layer and exposing the dentinal tubules, which showed funnel-shaped widening. Conclusions: Surface smear layer was present on root surfaces of teeth that were root planed. Laser irradiation of 1 second at 3 W completely removed the smear layer with minimal change in the diameter of the dentinal tubules. EDTA and citric acid were also effective in removing smear layer, but the exposed dentinal tubules showed funnel-shaped widening.

Copyright 1999 The American Academy of Periodontology

Topographical Characteristics and Shear Bond Strength of Tooth Surfaces Cut with a Laser-Powered Hydrokinetic System

Sean Lin
Angelo A. Caputo
Lewis R. Eversole
Ioana Rizoiu

University of the Pacific School of Dentistry, San Francisco, California

Statement of Problem: Erbium lasers, specifically Er:YAG and Er,Cr:YSGG that emit in the near red wavelengths, cut both enamel and dentine. Bonding to these cut surfaces with composites has not been assessed for all laser systems. Purpose: This investigation assessed the shear bond strength of composite bonded to tooth structure treated with an Er,Cr:YSGG-powered hydrokinetic system (HKS, Millennium system) and then was compared with surfaces treated with a carbide bur. Material and Methods: Extracted human molars were cut into enamel and dentine with both systems. Nonetched and acid-etched subgroups were evaluated. Shear bond strength was measured with an Instron test machine with a knife-edged loading head. In addition, SEMs were evaluated. Results: There were no significant differences in shear bond strength between etched bur-cut (23.3 +/- 4.5 MPa), and nonetched laser-cut enamel (20.5 +/- 2.8 MPa). For nonetched enamel, bond strength values for laser-cut surfaces were significantly higher than the bur-cut surfaces (8.7 +/- 4.3 MPa). Bond strength differences for dentin between bur (14.3 +/- 1.7 MPa) and laser cuts (11.5 +/- 4.3 MPa) were not significant (P = .03). SEM revealed that laser cutting of enamel did not cause formation of a smear layer. Conclusion: There were no significant differences in shear bond strength between etched bur-cut, etched laser-cut, and nonetched laser-cut enamel. With nonetched enamel, bond strength values for nonetched laser-cut surfaces were significantly higher than for the bur-cut surfaces. No bond strength differences between bur and laser cutting existed for dentin. Similar topography was observed for bur- and laser-prepared surfaces of etched enamel and nonetched dentin.

Copyright 1999 Mosby

Removal Effects of the Nd:YAG Laser and Carisolv™ on Carious Dentin

Yoshishige Yamada, DDS, PhD
Mozammal Hossain, BDS, PhD
Takeshi Joe, DDS
Tako Kawanaka, DDS
Junichiro Kinoshita, DDS
Koukichi Matsumoto, DDS, PhD

Showa University School of Dentistry, Tokyo, Japan

Objective: The purpose of this study was to investigate the removal effect of the Nd:YAG laser irradiation and Carisolv on carious dentin. Background Data: Many previous studies have reported several simple and alternative techniques, such as lasers and chemical, for caries removal. Methods: Carisolv was applied on the surface of 20 extracted human anterior and molar teeth for 1 min and then the Nd:YAG laser was irradiated with a continuous water spray for another 1 min. The energy densities were varied from 2 to 6 W with a repetition rate of 20 pps. As caries removal progressed, the cavity was carefully assessed by DIAGNOdent. Each lesion was photographed before and after treatment, and the treated cavity was observed microscopically using a stereoscope and with scanning electron microscope (SEM). Thermal change at the time of laser irradiation was measured by thermovision. Results: Our results revealed that application of Carisolv followed by Nd:YAG laser irradiation at 4-6 W pulsed energy effectively removed dentin caries. The total procedure was usually repeated once or twice for complete caries removal. From the SEM study, it was found that the cavity surface treated with the laser revealed various patterns of microirregularity, often accompanied by microfissure propagation. There was also no smear layer. Conclusions: It was revealed that Nd:YAG laser and Carisolv could provide an alternative technique for caries removal instead of the conventional mechanical drilling and cutting.

Copyright 2000 Mary Ann Liebert, Inc.
Objective: This present study was performed to compare the compositional changes of human dentin and Knoop hardness of the cavity floor prepared by Er:YAG laser irradiation with that of the conventional bur cavity. Background Data: There are still no reports on the compositional changes of dental hard tissues and microhardness of the cavity floor prepared by Er:YAG laser irradiation. Materials and Methods: Fifteen laser and 15 bur cavities were cross-sectioned and subjected to atomic analysis by SEM-EDX and Knoop hardness testing. Statistical analyses were performed using the Mann-Whitney U test; a value of p < 0.01 was considered significant. Cross sections of the remaining five laser and five bur cavities were examined by light microscopy and then by SEM. Results: The results showed that the quantities of Ca (Ca weight %) and P (P weight %) were increased significantly in the laser cavities, but no significant differences were found between the Ca/P ratio and Knoop hardness number of laser and bur cavities. The results of SEM observation revealed that the lased cavity surface was irregular, and there was also the absence of a smear layer; the orifice of dentinal tubules was exposed. Conclusion: Er:YAG laser device produces minimal thermal induced changes of dental hard tissue compositions; Ca/P ratio and Knoop hardness of the lased cavity floor was almost similar to the bur cavities.

Copyright 2003 Mary Ann Liebert, Inc.