LUTRONIC CO_2 Laser Clinical Papers

This packet contains abstracts relating to the CO_2 wavelength. It is not the intention of Great Plains Technologies, Inc. to imply a specific manufacturer's laser was utilized in any of the studies contained in this packet, but rather to demonstrate the efficacy and relevance of the CO_2 wavelength.

Please contact your local representative if you would like more information on CO_2 laser technology.

Section 1: Periodontics

3-4 Laser de-epithelialization for enhanced guided tissue regeneration. A paradigm shift?

5 Use of the carbon dioxide laser in retarding epithelial migration: a pilot histological human study utilizing case reports.

6 Effects of CO_2 laser treatment on fibroblast attachment to root surfaces. A scanning electron microscopy analysis.

7 Root surface morphological changes after focused versus defocused CO_2 laser irradiation: a scanning electron microscopy analysis.

8 Periodontal tissue regeneration in beagle dogs after laser therapy.

9 Effect of the carbon dioxide laser on the clinical parameters and crevicular IL-1beta when used as an adjunct to gingival flap surgery.

Section 2: Endodontics

10 The carbon dioxide laser as an aid in apicoectomy: an in vitro study.

11 Histological changes induced by CO_2 laser microprobe specially designed for root canal sterilization: in vivo study.

Section 3: Desensitization

12 Long-term effects of CO_2 laser irradiation on treatment of hypersensitive dental necks: results of an in Vivo study.

13 The advantage of CO_2-treated dental necks, in comparison with a standard method: results of an in vivo study.

Section 4: Pulp Capping

14 Advantages of a pulsed CO_2 laser in direct pulp capping: a long-term in vivo study.

15 The CO_2 laser as an aid in direct pulp capping.

Section 5: Carries Prevention

16 Prevention of caries by pulsed CO_2 laser pre-treatment of enamel: an in-vitro study.

17 Artificial caries removal and inhibition of artificial secondary caries by pulsed CO_2 laser irradiation.

18 The use of carbon dioxide laser in pit and fissure caries prevention: clinical evaluation.

Section 6: Implant Care

19 Per-implant care of ailing implants with the carbon dioxide laser.

20 Local induction of calcium phosphate formation on TiO2 coatings on titanium via surface treatment with a CO_2 laser.

21 Titanium deposition after peri-implant care with the carbon dioxide laser.

Section 7: Oral Surgery

22 Application of a CO_2 laser for oral soft tissue surgery in children in Sri Lanka--introduction of a laser through activities of aid to a developing country.

23 Surgical management of premalignant lesions of the oral cavity with the CO_2 laser

24 Use of the carbon dioxide laser in the treatment of leukoplakia.

25 Treatment of big oral leukoplakias using the CO_2 laser

Laser de-epithelialization for enhanced guided tissue regeneration. A paradigm shift?

Dental Clinics of North America. 44(4):793-809, 2000 Oct.
Rossmann JA. Israel M.
Department of Periodontics, Baylor College of Dentistry, Texas A&M University System Health Science Center at Dallas, USA. jrossman@ont.com

The rationale for laser de-epithelialization stems from the attempts to block the down-growth of epithelium into the healing periodontal wound after surgery and prevent formation of a long junctional epithelial attachment. This concept has seen numerous techniques for accomplishing the blockage of epithelium. The advent of GTR was an offshoot of this concept and led Gottlow et al [table: see text] to examine the effects of selectively blocking certain cell types from contacting the root surface during periodontal wound healing. The use of a CO_2 laser to de-epithelialize the gingival flaps is an attempt to exclude this cell type from the healing wound and has been used with and without the benefit of GTR membranes. In a study on beagle dogs, the histologic results of using membranes and the laser procedure enhanced the wound healing and regeneration of new bone, cementum, and connective tissue attachment when compared with paired defects using the membranes alone. The results from the human studies and case reports combined with the animal studies indicate a positive benefit in wound healing because of the laser de-epithelialization technique. The use of an osseous graft in treatment of periodontal defects has been shown to stimulate new bone growth effectively and to regenerate new attachment. It has been speculated that the additional benefit of an osseous graft in GTR procedures is the organization of the blood clot at initial healing, which may tend to maintain the space needed for regeneration and to provide a matrix for the fibrin clot to retard epithelial down-growth. Studies comparing the results of osseous grafting with flap debridement always have shown that the amount of new bone formation and clinical new attachment favor the grafted sites versus paired nongrafted sites. The effects of removal of the pocket epithelium at the time of periodontal surgery have been studied by several authors, and these studies generally shown an incomplete removal of the sulcular epithelium by the inverse bevel incision. Epithelial excision was studied by Centty et al, who compared the removal of sulcular epithelium by the CO_2 laser technique with conventional methods. Their results confirm that (1) a more complete removal of sulcular epithelium was obtained by laser than by knives, and (2) the technique effectively removes the oral and sulcular epithelium from a gingival flap without damaging the viability of the flap during wound healing. The technique as described in this article was used by Israel et al to verify further the ability to maintain a viable gingival flap during multiple laser deepithelialization procedures in humans during the first 30 days of healing. [table: see text] The concept of laser de-epithelialization as an adjunct to regenerative periodontal procedures

currently is being studied in a multicenter university setting using a parallel study in controlled clinical trials. The first of these reports was mentioned previously (Araujo et al, unpublished data) and shows the enhanced wound healing of periodontal defects through use of the laser de-epithelialization technique. The authors believe that this technique has shown significantly better results than those obtained through conventional osseous grafting alone and appears to be comparable to the results reported for GTR procedures with barrier membranes. This concept provides a paradigm shift from the conventional use of GTR therapy by acknowledging the difficulty in controlling epithelium during the early wound healing. It also allows a more comprehensive therapy for treating periodontal disease that addresses the generalized nature of the disease, with multiple lesions being treated concurrently in an economical manner. The patient presenting with generalized advanced periodontal disease could have several defects definitively treated in one quadrant using the laser deepithelialization technique without the need for multiple membrane therapy. (ABSTRACT TRUNCATE)

Use of the carbon dioxide laser in retarding epithelial migration: a pilot histological human study utilizing case reports.

Journal of Periodontology. 66(3):197-204, 1995 Mar.
Israel M. Rossmann JA. Froum SJ.
Department of Implantology and Surgical Sciences, New York University Dental Center, NY, USA.

Predictable regeneration of tooth-supporting tissues lost to periodontal disease is the aim of periodontal therapy. Often the result of conventional treatment is healing with a long junctional epithelium along the root surface and little regeneration of the complete attachment apparatus. The purpose of this pilot study was to evaluate whether de-epithelialization with a CO_2 laser at the time of flap surgery and at 10-day intervals over the first 30 days of healing has the potential to enhance the formation of a connective tissue attachment. Six mandibular incisors in two patients were selected for the study. Each patient received oral hygiene instruction and initial therapy prior to surgery. The teeth were splinted together, open flap debridement was performed on all teeth, a notch was placed on the roots at the height of the crest of the alveolar bone, and the flaps were sutured in place. The test side received controlled de-epithelialization of the outer (oral) gingiva with the carbon dioxide laser, and the inner gingival flap. The de-epithelialization was repeated on the test side at 10, 20, and 30 days postsurgically. Controls received open debridement only. Block sections were taken at 90 days and processed for histologic analysis. The results showed that for both patients, junctional epithelium (JE) was formed on both test and control teeth. In all control teeth, the JE extended the entire length of the root to the base of the reference notch.(ABSTRACT TRUNCATED AT 250 WORDS)

Effects of CO_2 laser treatment on fibroblast attachment to root surfaces. A scanning electron microscopy analysis.

Journal of Periodontology. 73(11):1308-12, 2002 Nov.
Crespi R. Barone A. Covani U. Ciaglia RN. Romanos GE.
Department of Medical and Dental Science and Biotechnologies, School of Medicine, University of Genova, Genova, Italy.

BACKGROUND: The aim of this study was to analyze the CO_2 laser effects on root surfaces affected by periodontal disease in comparison to scaling and root planing for fibroblast attachment.

METHODS: Thirty single-rooted human teeth extracted because of advanced periodontal disease were included in this study. A total of 60 specimens, obtained from all selected teeth, were randomly assigned to 3 groups: 1) control (untreated); 2) hand scaling and root planing (SRP); or 3) laser (CO_2 defocused pulsed) and ultrasonic scaling. All the specimens were incubated in Petri dishes with fibroblast suspension, and then observed by scanning electron microscopy (SEM).

RESULTS: The control group showed the lowest number of attached cells, with no tightly attached fibroblasts. The laser plus scaling group showed the highest number of attached fibroblasts, with the tightly attached fibroblast prevailing. The laser-treated and scaled root specimens did not show any damage or morphologic alteration of the root surfaces.

CONCLUSION: CO_2 laser treatment in defocused, pulsed mode with a low power of 2W combined with mechanical instrumentation constitutes a useful tool to condition the root surface and increase fibroblast attachment to root surfaces.

Root surface morphological changes after focused versus defocused CO_2 laser irradiation: a scanning electron microscopy analysis.

Journal of Periodontology. 73(4):370-3, 2002 Apr.
Barone A. Covani U. Crespi R. Romanos GE.
School of Dental Medicine, University of Genoa, Italy.

BACKGROUND: Many studies have observed damages to root surfaces treated by CO_2 laser in continuous mode with a focused beam. The morphologic changes observed were always associated with temperature increase induced by high energy release.

METHODS: The purpose of this study was to analyze by scanning electron microscopy (SEM) the effects of CO_2 laser in 2 different modes on root surfaces. Study samples consisted of 30 extracted single-rooted periodontally compromised human teeth. Root specimens were randomly assigned to 3 groups: group A (12) treated with CO_2 laser in continuous mode with a focused beam of 0.8 mm; group B (12) treated with CO_2 laser in pulsed mode with defocused beam of 4 mm; and group C (6), untreated controls.

RESULTS: Group A (continuous mode) showed severe damages to dentin surfaces such as craters and fissures. Group B (defocused mode) did not result in any damages to the root surfaces, showing flat and smooth surfaces with apparent fusion of the smear layer and dentinal tubules almost completely sealed. The untreated control group was characterized by irregular and amorphous surfaces with several shallow depressions.

CONCLUSIONS: Although both laser modes resulted in changes to the treated root surface specimens, the changes resulting in a smooth surface from use of defocused pulsed beam may present an advantage in periodontal treatment.

Periodontal tissue regeneration in beagle dogs after laser therapy.

Lasers in Surgery & Medicine. 21(4):395-402, 1997.
Crespi R. Covani U. Margarone JE. Andreana S.
Hospital S. Raffaele, Milan, Italy.

BACKGROUND AND OBJECTIVE: Class III periodontal furcations still represent a challenge for the periodontist. Aim of this study was to test the effect of CO_2 laser on the treatment of class III furcation defects.

STUDY DESIGN/MATERIALS AND METHOD: Class III furcation defects 3 mm deep were surgically induced on mandibular premolars on six male Beagle dogs, for a total of 36 defects. After 6-8 weeks of plaque accumulation, the mean depth was 6.8 mm. Quadrants were randomly assigned to a) CO_2 laser therapy (laser), b) Guided Tissue Regeneration (GTR) procedure using Gore-Tex Membranes, (Gore Tex, Flagstaff, Arizona, USA) and c) Scaling and Root planing (Sc/Rp). CO_2 laser beam (El.En, Florence, Italy) was applied to the root surfaces in defocused pulsed mode at 2W, 1 Hz and a duty cycle of 6%, and on periodontal soft tissues at 13W, 40 Hz, and a duty cycle of 40%. Control quadrants received either GTR procedure or Sc/Rp. Mechanical oral hygiene was provided. At 6 months the animals were sacrificed.

RESULTS: The laser group showed new attachment formation averaging 1.9 mm (sd +/- 0.5), whereas GTR and Sc/Rp showed 0.2 mm (sd +/- 0.4) and 0.2 mm (sd +/- 0.5) respectively, being the differences statistically significant between the laser group and both GTR and Sc/Rp groups ($p < 0.005$).

CONCLUSION: CO_2 laser treatment of class III furcation induced formation of new periodontal ligament, cementum and bone.

Effect of the carbon dioxide laser on the clinical parameters and crevicular IL-1beta when used as an adjunct to gingival flap surgery.

Journal of the International Academy of Periodontology. 6(1):29-36, 2004 Jan.
Choi KH. Im SU. Kim CS. Choi SH. Kim CK.
Department of Periodontology, Research Institute for Periodontal Regeneration, College of Dentistry, Yonsei University, Seoul, Korea.

OBJECTIVE: This study evaluated the effect of a carbon dioxide (CO_2) laser treatment on the clinical parameters and crevicular Interleukin-1 (IL-1beta) levels when used in combination with gingival flap surgery.

METHODS: Twelve patients with moderate to advanced periodontitis were selected for this study. Three quadrants in each patient were randomly assigned to one of the following study groups: 1) flap surgery only as the (control); 2) flap surgery and laser treatment using an energy level of 0.8 W as (group 1); 3) flap surgery and laser treatment using an energy level of 0.5 W as (group 2). The gingival crevicular fluid (GCF) was collected at the baseline and biweekly for 6 weeks and the amount of IL-1beta concentration in the sulcular fluid was measured using an enzyme-linked immunosorbent assay. The clinical parameters such as the probing pocket depth, the clinical attachment level, the gingival recession and the bleeding on probing were recorded at the baseline, 3, 6 months.

RESULTS: Marked reductions of the bleeding on probing, the probing pocket depth, the clinical attachment level and a reduction in the crevicular IL-1beta concentration were found in all groups. However, the differences between the groups in terms of bleeding on probing and the probing pocket depth were not significant ($p<0.05$). The clinical attachment level and the crevicular IL-1beta level were significantly lower in group 1 (0.8 W) than in the control ($p<0.05$).

CONCLUSION: The additional use of a carbon dioxide laser on the root surface during gingival flap surgery may enhance the clinical attachment and reduce the crevicular IL-1beta concentration.

The carbon dioxide laser as an aid in apicoectomy: an in vitro study.

Journal of Clinical Laser Medicine & Surgery. 15(4):185-8, 1997.
Moritz A.; Gutknecht N.; Goharkhay K.; Schoop U.; Wernisch J.; Pohn C.; Sperr W.
Department of Conservative Dentistry, Dental School, University of Vienna, Austria.

OBJECTIVE: To achieve the required goal of optimally sealing the apical section and the root-canal when performing an apicoectomy, the authors decided to use the CO_2 laser as an additional aid.

SUMMARY BACKGROUND DATA: The CO_2 laser has previously shown to have an excellent sealing effect on dentin surfaces.

METHODS: In this in vitro study, the authors examined the effects of CO_2 laser application in apicoectomies with the help of color penetration tests and scanning electron microscopic (SEM) examinations. Sections and root canals were irradiated with low power (0.5 W) in continuous wave mode for totally 20 sec. The thermal stress for the adjacent tissues attaching thereto is moderate as shown by infrared-spectroscopy.

RESULTS: A comparison with nonirradiated samples revealed that CO_2 laser irradiation reduced color penetration at the section to a minimum. Also, irradiation of the root-canal wall resulted in satisfactory sealing of the surface. These findings were supported by the results of the SEM examinations.

CONCLUSIONS: CO_2 laser treatment optimally prepares the tooth for final intraoperative filling because of sealing of the dentinal tubules, the resultant elimination of niches for bacteria and the sterilizing effect of the laser.

Histological changes induced by CO_2 laser microprobe specially designed for root canal sterilization: in vivo study.

Journal of Clinical Laser Medicine & Surgery. 16(5):263-7, 1998 Oct.
Kesler G. Koren R. Kesler A. Hay N. Gal R.
Dental Clinic Center, Hasharon Hospital, Petah Tikva, Israel.

OBJECTIVE: Until now, no suitable delivery fiber has existed for CO_2 laser endodontic radiation in the apical region, where it is most difficult to eliminate the pulp tissue using conventional methods. To overcome this problem, we have designed a microprobe that reaches closer to the apex, distributing the energy density to a smaller area of the root canal and thus favorably increasing the thermal effects.

METHODS: A CO_2 laser microprobe coupled onto a special hand piece was attached to the delivery fiber of a Sharplan 15-F CO_2 laser. The study was conducted on 30 vital maxillary or mandibulary, central, lateral, or premolar teeth destined for extraction due to periodontal problems. Twenty were experimentally treated with pulsed CO_2 laser delivered by this newly developed fiber after conventional root canal preparation. Temperature measured at three points on the root surface during laser treatment did not exceed 38 degrees C. Ten teeth represented the control group, in which only root canal preparation was performed in the conventional method.

RESULTS: Histological examination of the laser-treated teeth showed coagulation necrosis and vacuolization of the remaining pulp tissue in the root canal periphery. Primary and secondary dentin appeared normal in all cases treated with 15-F CO_2 laser. Gram stain and bacteriologic examination revealed complete sterilization. These results demonstrate the unique capabilities of this special microprobe in sterilization of the root canal, with no thermal damage to the surrounding tissue.

CONCLUSIONS: The combination of classical root canal preparation with CO_2 laser irradiation using this special microprobe before closing the canal can drastically change the quality of root canal fillings.

Long-term effects of CO_2 laser irradiation on treatment of hypersensitive dental necks: results of an in Vivo study.

Journal of Clinical Laser Medicine & Surgery. 16(4):211-5, 1998 Aug.
Moritz A. Schoop U. Goharkhay K. Aoid M. Reichenbach P. Lothaller MA. Wernisch J. Sperr W.
Department of Conservative Dentistry, School of Dentistry, University of Vienna, Austria.

OBJECTIVE: The present in vivo study was performed to examine the long-term effects of combined CO_2 laser treatment and fluoridation on hypersensitive dental necks.

SUMMARY BACKGROUND DATA: Attempts have been made to treat dental hypersensitivity by sealing exposed dentinal tubules, primarily using fluoride preparations, strontium chloride, and hydroxyapatite. However, these treatment methods have the disadvantage that the preparation is effective only for a limited period of time and must be applied repeatedly, at short intervals. The CO_2 laser has been shown to have an excellent sealing effect on hypersensitive dentinal surfaces.

METHODS: Test subjects suffering from dentinal hypersensitivity were recruited from the patients of the Department of Conservative Dentistry, School of Dentistry of the University of Vienna, Austria and treated with combined laser irradiation and fluoridation with stannous fluoride gel. The patients were followed up for a period of 18 months. In vivo examinations were supplemented by atomic absorption spectroscopy (AAS) of tiny dentin samples obtained from the dental necks 6 weeks and 18 months after laser treatment and by scanning electron microscopy (SEM).

RESULTS: Compared to conventional fluoridation, combined laser irradiation and fluoridation was shown to be effective in the treatment of hypersensitive dental necks. When success was defined as complete freedom from pain, the success rate in the laser group was 96.5%. Furthermore, examinations of irradiated teeth under the scanning electron microscope still revealed complete closure of the dentinal tubules four and six months after laser treatment. AAS showed that tin was present in the samples, which indicates that combined laser treatment and fluoridation result in permanent integration of fluoride in the dentin surface.

CONCLUSIONS: Based on these results, the CO_2 laser can be recommended as an ideal tool for desensitization of dental necks.

The advantage of CO_2-treated dental necks, in comparison with a standard method: results of an in vivo study.

Journal of Clinical Laser Medicine & Surgery. 14(1):27-32, 1996 Feb.
Moritz A. Gutknecht N. Schoop U. Goharkhay K. Ebrahim D. Wernisch J. Sperr W.
Department of Conservative Dentistry, School of Dentistry, University of Vienna, Austria.

Various methods are used for treatment of hypersensitive dental necks. They all aim to seal exposed dentinal tubules, which are open toward the oral cavity and transmit stimuli to the sensitive nerve endings of the tooth pulp. The main sealing materials are fluoride preparations, strontium chloride, and hydroxyapatite. However, these materials must be applied periodically to achieve permanent freedom from pain. Since the introduction of laser technology into dentistry, efforts have been made to treat dentine hypersensitivity with the laser. An in vitro study revealed that CO_2 laser irradiation results in almost complete closure of the dentinal tubules in the dental neck region. In the present in vivo study, the efficacy of laser treatment was examined in 72 patients with dentine hypersensitivity and 72 control patients over a period of 12 weeks. When success was defined as complete freedom from pain, the success rate in the laser group was 94.5%; when marked pain relief was included in the definition of treatment success, 98.6% of the patients were treated successfully. Treatment of the control group with conventional dental neck fluoridation resulted in no marked improvement. Laser Doppler measurements of pulpal blood flow immediately before and after treatment revealed no effects of laser irradiation on pulpal blood flow. Dentine samples were obtained from the dental necks 6 weeks after laser treatment and examined with atomic absorption spectroscopy (AAS). Tin was present in the samples, which suggests that the combined laser treatment and fluoridation result in permanent integration of fluoride in the dentine surface.

Advantages of a pulsed CO_2 laser in direct pulp capping: a long-term in vivo study.

Lasers in Surgery & Medicine. 22(5):288-93, 1998.
Moritz A. Schoop U. Goharkhay K. Sperr W.
Department of Conservative Dentistry, School of Dentistry, University of Vienna, Austria.

BACKGROUND AND OBJECTIVE: A previous study [Moritz et al., Z Stomatol 1996; 93:451-454] had shown that favourable results in direct pulp capping could be achieved using a continuous wave CO_2 laser in addition to the conventional calcium hydroxide dressing technique. In this study, these results are compared to those achieved using a CO_2 laser working in superpulsed mode.

STUDY DESIGN/MATERIALS AND METHODS: A total of 260 direct pulp capping procedures were carried out; 130 were performed with a superpulsed CO_2 laser, followed by a calcium hydroxide dressing, and 130 conventionally by applying only a calcium hydroxide preparation. Recall examinations were performed after 1 week and monthly for 18 months after treatment. A final examination was carried out 2 years after treatment. Thermal tests were used for vitality assessments and laser Doppler flowmetry for direct measurement of pulpal blood flow.

RESULTS: In the group of pulps treated with the superpulsed CO_2 laser, the last recall examination at 2 years revealed that 93% of the teeth had remained vital. In the control group, the success rate was considerably lower (66.6%). Exposure site sizes and average patient age were nearly identical in both groups.

CONCLUSION: The CO_2 laser seems to be a valuable aid in direct pulp capping; the efficiency of laser treatment can be increased by using a pulsed CO_2 laser.

The CO_2 laser as an aid in direct pulp capping.

Journal of Endodontics. 24(4):248-51, 1998 Apr.
Moritz A. Schoop U. Goharkhay K. Sperr W.
Department of Conservative Dentistry, School of Dentistry, University of Vienna, Austria.

Two hundred direct pulp capping procedures were conducted in the present study. One hundred of them were performed with the CO_2 laser, and 100 were conducted conventionally as a control by using a calcium hydroxide preparation. Follow-up examinations were performed after 1 wk and monthly for 12 months after treatment. Thermal tests were used for vitality assessments and laser Doppler flowmetry for direct measurement of pulpal blood. In the group of pulps treated with the CO_2 laser, the last recall examination at 12 months demonstrated that 89 teeth remained vital, corresponding to a success rate of 89%. In the control group, the success rate was considerably lower (68%). Exposure sizes and mean patient age were nearly identical in both groups. The CO_2 laser seems to be a valuable aid in direct pulp capping.

Prevention of caries by pulsed CO_2 laser pre-treatment of enamel: an in-vitro study.

Journal of the Indian Society of Pedodontics & Preventive Dentistry. 19(4):152-6, 2001 Dec.

Lakshmi A. Shobha D. Lakshminarayanan L.
Department of Conservative Dentistry and Endodontics, Saveetha Dental College and Hospital, Chennai.

The aim of the study was to assess the caries inhibitory potential of carbon dioxide laser and explore the effect of the number of pulses used to correlate caries inhibition. Caries free human mandibular molars were irradiated with carbon-dioxide laser of wavelength 10.6 microm at 5, 15, 25, 50 and 100 pulses. Simulated caries lesions were allowed to form by immersing the teeth in artificial caries medium for three weeks. Thin sections of 75 microns were obtained by using hard tissue microtome. These sections were observed under polarizing microscope, caries lesions were identified and their depth was measured. These values were subjected to statistical analysis. The results showed that carbon-dioxide laser irradiation can inhibit caries like lesion upto 82.7% and it was optimal at 25 pulses.

Artificial caries removal and inhibition of artificial secondary caries by pulsed CO_2 laser irradiation.

American Journal of Dentistry. 12(5):213-6, 1999 Oct.
Konishi N. Fried D. Staninec M. Featherstone JD.
Department of Operative Dentistry, Dental School, Okayama University, Japan.

PURPOSE: To investigate the inhibition of artifical secondary caries around restorations placed after removal of artificial caries by pulsed CO_2 laser irradiation and by mechanical means.

MATERIALS & METHODS: Beveled cavities were prepared mechanically on the facial surfaces of extracted human molars. Each cavity was subsequently exposed to an artificial caries (demineralizing) solution (pH 5.0) for 7 d to generate a demineralized zone approximately 100-200 microns thick on the cavity surface. The artificial carious/demineralized zones of the cavities were removed by a pulsed CO_2 laser operating at a wavelength of 9.3 microns with pulse duration of 100 microseconds and an irradiation intensity of 5 J/cm2. Artificial control caries were removed mechanically with a carbide bur in a slow speed handpiece. The cavities were slightly undercut and restored with a resin-based composite without etching and bonding and the restored teeth were subjected to pH cycling solutions for 10 d as follows: Demineralization solution, pH 4.5 for 6 hrs, followed by remineralization solution, pH 7.0 for 18 hrs. Cycled teeth were sectioned through the restorations and the resulting lesions were analyzed in thin section using polarized light and Knoop microhardness.

RESULTS: Mean microhardness delta Z values, indicating mineral loss were: 549 (SD 191) for control, and 140 (SD 127) N = 11. This difference is significant with t = 5.543 and P = 0.000 (Paired t-test). Caries penetration: Control side--231 microns (SD 71), Laser treated side: 123 microns (SD 79) N = 6. This difference is significant with t = 5.198 and P = 0.003 (Paired t-test). The results show that the laser treatment not only removed artificial caries, but also inhibited decalcification of the cavity wall in a subsequent artificial caries challenge by as much as 81% compared to control samples. No etching and bonding was used in this pilot study, which might have influenced the results. Future studies should address the inhibition effect of the laser treatment as compared to adhesive techniques, fluoride treatments and fluoride release restorative materials.

CONCLUSION: Caries removal by a pulsed lambda = 9.3 microns CO_2 laser produces a cavity surface morphology with marked resistance to artificial secondary caries as compared to mechanical removal.

The use of carbon dioxide laser in pit and fissure caries prevention: clinical evaluation.

Journal of Clinical Laser Medicine & Surgery. 15(2):79-82, 1997.
Brugnera Junior A. Rosso N. Duarte D. Pinto AC. Genovese W.
Laser Centre, Camilo Castelo Branco University, Sao Paulo, Brazil.

In this 4-year follow-up in vivo controlled study, 112 human permanent first molars from children between 6 and 11 years old were used to investigate the viability of the carbon dioxide (CO_2) laser in promoting caries-free occlusal surfaces in permanent molars as an isolated form of treatment or associated with conventional fissure sealants. The findings suggest that occlusal caries prevention only by means of CO_2 laser irradiation is not effective; that the utilization of photoactivated sealants, as well as its association with CO_2 laser, applied over the occlusal fissures, are effective means of preventing occlusal caries, and that the application of CO_2 laser over occlusal fissures prior to the application of a photoactivated fissure sealant improves the retention of the sealant.

Peri-implant care of ailing implants with the carbon dioxide laser.

International Journal of Oral & Maxillofacial Implants. 16(5):659-67, 2001 Sep-Oct.
Deppe H. Horch HH. Henke J. Donath K.
Department of Oral and Maxillofacial Surgery, University of Technology, Munich, Germany. hd@mkg.med.tu-muenchen.de

One of the many applications for which lasers have been proposed in implant dentistry is for the decontamination process. The purposes of this study were to assess possible alterations in titanium implants in vitro and in vivo by use of the carbon dioxide (CO_2) laser and to determine whether new bone formation can occur on previously contaminated implants. In vitro, temperature changes at the bone-titanium implant interface were recorded during use of a CO_2 laser-scanning system (Swiftlase). Additionally, the effects of laser irradiation on titanium implants at various power settings were examined. In 6 beagle dogs, a total of 60 implants and bony defects resulting from plaque accumulation were treated by air-powder abrasive (the conventional treatment), laser irradiation, or both. Depending on the parameters chosen, melting and other surface alterations were seen in vitro, especially in the superpulse mode. Otherwise, no alterations were found, even at high power settings in the continuous mode. In vivo, corresponding histologic examination of 4-month sections showed evidence of new direct bone-to-implant contact after laser-assisted therapy, especially when the implants had been treated concomitantly with submerged membranes. These results support the hypothesis that peri-implant defects can be treated successfully by laser decontamination without damaging the surrounding tissues in the dog model. Nevertheless, further investigations will be required to determine the clinical efficacy of the treatment.

Local induction of calcium phosphate formation on TiO2 coatings on titanium via surface treatment with a CO_2 laser.

Journal of Biomedical Materials Research. 65A(1):9-16, 2003 Apr 1.
Moritz N. Jokinen M. Peltola T. Areva S. Yli-Urpo A.
Institute of Dentistry & Biomaterials Research, University of Turku, Turku, Finland. niko.moritz@utu.fi

Sol-gel-derived TiO(2) coatings are known to promote bonelike hydroxyapatite formation on their surfaces in vitro and in vivo. Hydroxyapatite integrates into bone tissue. In some clinical applications, the surface of an implant is simultaneously interfaced with soft and hard tissues, so it should match the properties of both. A new method is introduced for treating the coatings locally in a controlled manner. The local densification of sol-gel-derived titania coatings on titanium substrates with a CO(2) laser was studied in terms of the in vitro calcium phosphate-inducting properties. CO(2)-laser-treated multilayer coatings were compared with furnace-fired coatings prepared with the same recipe and previously shown to be bioactive. Additionally, local areas of furnace-fired multilayer coatings (previously shown to be bioactive in vitro) were further laser-treated to achieve various properties in the same implant. Topological surface properties were examined with atomic force microscopy. The formation of hydroxyapatite was studied with Fourier transform infrared and scanning electron microscopy energy-dispersive X-ray analysis. The results show that calcium phosphate formation can be adjusted locally by laser treatment. Calcium phosphate is a bonelike hydroxyapatite. The local treatment of sol-gel-derived coatings with a CO(2) laser is a promising technique for creating implants with various properties to interface different tissues and a possible way of coating implants that do not tolerate furnace firing.

Titanium deposition after peri-implant care with the carbon dioxide laser.

International Journal of Oral & Maxillofacial Implants. 17(5):707-14, 2002 Sep-Oct.
H. Greim H. Brill T. Wagenpfeil S.
Department of Oral and Maxillofacial Surgery, University of Technology, Munich, Germany. hd@mkg.med.tu-muenchen.de

PURPOSE: Titanium endosseous implants are becoming increasingly important in dentistry because of their excellent long-term results. However, it has been reported that these implants may lead to higher concentrations of titanium, especially in the lungs and kidneys. The purpose of this study, therefore, was to determine whether CO_2 laser-assisted decontamination of exposed implant surfaces is associated with an increase in titanium release.

MATERIALS AND METHODS: In 6 beagle dogs, a total of 60 implants were placed. After osseointegration and second-stage surgery, peri-implantitis was induced by cotton floss ligatures for 12 weeks. Surgical treatment consisted of granulation tissue removal, including decontamination of the implant surface with 3 different methods. Twenty implants were decontaminated conventionally by an air-powder abrasive for 60 seconds. Another 20 implants were decontaminated by laser treatment alone. The last 20 implants were treated conventionally by air-powder abrasive and then lased. Four months later, fresh tissue samples of various tissues were evaluated by histologic and chemical analysis. RESULTS: Quantitative analysis indicated that titanium accumulation could be detected, especially in the spleen, liver, oral mucosa, regional lymph nodes, lung, and kidney in the beagle dog model.

DISCUSSION: The concentrations found did not exceed those previously reported in the literature.

CONCLUSION: These results support the hypothesis that CO_2 laser-assisted therapy of ailing implants will not result in excessive titanium concentrations in tissues. Accordingly, CO_2 lasers appear suitable and safe for peri-implant gingival surgery.

Application of a CO_2 laser for oral soft tissue surgery in children in Sri Lanka--introduction of a laser through activities of aid to a developing country. (Japanese)

Kokubyo Gakkai Zasshi - the Journal of the Stomatological Society, Japan. 69(1):34-8, 2002 Mar.
Kato J. Jayawardena JA. Wijeyeweera RL. Moriya K. Takagi Y.
Department of Orofacial Development and Function, Graduate School, Tokyo Medical and Dental University.

The objective of this study was to clarify the effect of CO_2 laser irradiation on oral tissue problems in children in Sri Lanka, through the activities of aid to a developing country by the Japan International Cooperation Agency. This study took about six months, during two times periods: from November 2000 to February 2001, and from July 2001 to October 2001, in the paedodontic clinic of the Faculty of Dental Science, University of Peradeniya, in Sri Lanka. A CO_2 laser was used on 48 subjects (51 cases), aged between 1 and 15 years, having main indications for labial frenectomy, frenectomy in ankyloglossia, and excision of mucocele. The results indicated that the CO_2 laser had the following advantages. 1. Soft tissue cutting was efficient, with no bleeding, giving a clear operative field during operation. 2. There was no need to use sutures. 3. The surgery itself was simple and less time-consuming. Hence, there was no need for general anesthesia for such cases as tongue tie operation in small children. 4. There was no postsurgical infection. As a result, there was no need for analgesics or antibiotics, as post-surgical pain and infection were prevented. 5. Wound contraction and scarring were decreased or eliminated. Considering the above advantages, the use of a CO_2 laser proved to be very safe and effective for soft tissue surgery, especially for children in developing countries such as Sri Lanka.

Surgical management of premalignant lesions of the oral cavity with the CO_2 laser.

Brazilian Dental Journal. 7(2):103-8, 1996.
Pinheiro AL. Frame JW.
Departamento de Protese e Cirurgia Buco-Facial, Universidade Federal de Pernambuco, Recife, PE, Brasil.

The management of patients with premalignant and malignant lesions of the oral cavity can present problems. The potentially invasive nature of premalignant lesions together with their large extent influences the treatment. The common modalities of treatment of these lesions are surgical excision, cryotherapy, electrosurgery and radiotherapy. Recently, CO_2 laser surgery has become available. Less pain, little bleeding, minimal post-operative edema, reduced risk of infection, and low recurrence rates were advantages observed following CO_2 laser surgery in the mouth when compared to other modalities of treatment. Healing following CO_2 laser surgery progressed well with little postoperative scarring and re-epithelialization was complete after 4-6 weeks. The newly formed epithelium appeared normal and was soft on palpation.

Use of the carbon dioxide laser in the treatment of leukoplakia. (Hungarian)

Fogorvosi Szemle. 83(3):65-9, 1990 Mar.
Gaspar L. Szabo G.
Semmelweis Orvostudomanyi Egyetem Szajsebeszeti es Fogaszati Klinika.

Experiences obtained in the course of laser surgical treatment of 126 mouth cavity leukoplakias are summarized. The elaborated, differentiated method ensures, besides safe removal of tissues infected by leukoplakia, a possibility for significantly preserving the functions of the mouth cavity. In case of simplex leukoplakia coagulation by means of defocused laser beam of 5 W energy, in case of verrucosus vaporization by means of focused beom of 10 to 15 W, and in erosiv cases excision in carried out by means of focused beom of 20 to 25 W energy. After laser treatment out of 126 patients 118 were free of symptoms. After operation emberging pain, oedema are minimal. (As a rule, the patients are capable of work the other day.) It is stated that the leucoplakias represent one of the most important fields of the oral surgical employment of the CO_2 laser beam.

Treatment of big oral leukoplakias using the CO_2 laser.

G.E. Romanos, S. Banihashemi, G.H. Nentwig
Dental Scholl Frankfurt (Carolinum), Dept. of Oral Surgery, Therodor-Stern-Kal 7, 60590 Frankfurt a.M.

Oral leukoplakia is a white patch on the oral mucosa which will not rub or strip off. Conventional treatment or cryosurgery lead very often to wound healing disorders, i.e. sear tissue formation. In our study we treated 30 patients with 46 leukoplakia lesions of the oral cavity. The localization of the lesions was in 9 cases on the cheek mucosa, 11 on the tongue, 15 in the alveolar ridge, 5 on the palate and 6 on the mouth floor. At the beginning of treatment we removed a small biopsy in order to confirm clinical diagnosis. We removed the leukoplakias only in cases without any dyspiasia using the CO_2 laser and topical or local anesthesia. The modus of the laser the continuous wave with a power setting of 4-7 Watts (mean: 4W). One, four weeks after surgery and later after 3, 6, 12, 24 months all the patients were controlled in order to find any possible recurrence in the same area. The mean follow-up control of our patient group was: 27 months.

All of the cases were treated without any intraoperatve or postoperative complications. According to the size of the lesion the oral mucosa was reepithelialized 2 to 4 weeks after surgery. No scar tissue formation could be observed. In only 8 areas we were able to find a recurrence (new leukoplakia formation) after surgery, which we had to remove later. This represents a success rate of 82.60%. According to the reduced recurrence rate and the excellent wound healing without complications, the CO_2 laser application is the best alternative for the treatment of big oral leukoplakia