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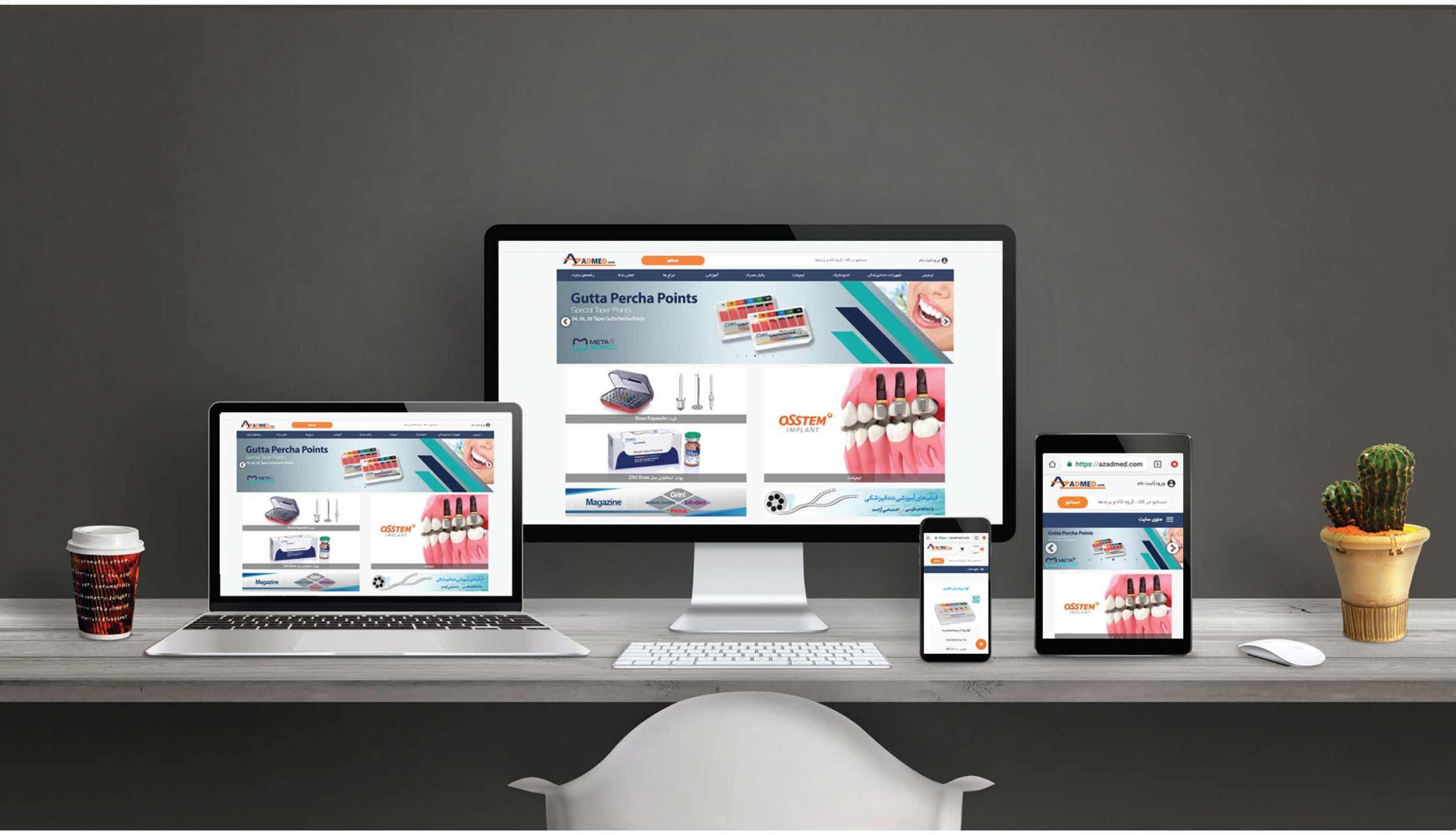

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| **research**
Clinical comparison of two laser wavelengths

| **case report**
A concept of laser-assisted treatment of periimplantitis

| **interview**
Laser-assisted treatment—Questions and answers

oemus


Preserved collagen fibrils of the intertubular dentin at the entrances to the dentinal tubules.

Prof Dr Norbert Gutknecht
WFLD President
Editor-in-Chief

It's show time!

_**The world greatest dental exhibition**, IDS 2011 in Cologne, is just ahead. A lot of speculations and expectations are in the air. Everybody is curious to know what is new in the dental world, so do I. It is not only a curiosity to know what kind of new products, instruments and equipment are presented, but it is also of special interest to see what kind of developments have been taking place in the field of laser dentistry.

If I believe the speculations, which have been shared with me, I am sure that we will find a number of highlights in this area. New technical features, new treatment concepts, new biophysical ideas and new wavelength combinations will be presented, explained and demonstrated to the visitors.

I hope therefore that a big number of interested visitors will be stimulated to find out more about the beneficial use of a laser supported dental treatment concept.

Finally I wish all laser exhibitors within this dental show a very good success in promoting their products.

Prof Dr Norbert Gutknecht
Editor-in-Chief


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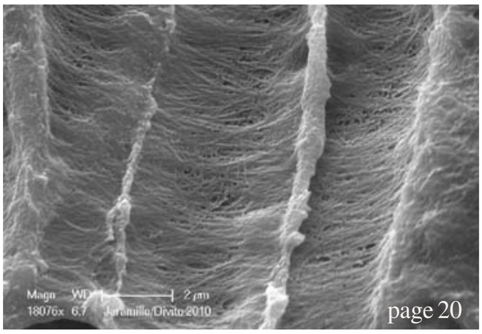
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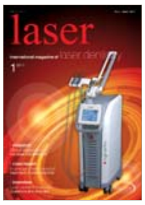

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Express
your mastery

Diode laser surface decontamination in periodontitis therapy

15 years of incorporating

Author_Dr Georg Bach, Germany

_**We don't always have the opportunity** to provide long-term dental treatment for patients with a profound marginal parodontopathy who have undergone resective surgical therapy, at times including reconstructive work. Correspondingly, there is only a limited amount of literature available due to the aforementioned fact. The number of published studies/other publications is even more limited as regards new therapy concepts or adjuvant treatments to complement a proven therapy regimen. In 1995, the first diode laser (wavelength 810 nm) was presented at IDS in Cologne. This device—initially as a prototype—had been used within the scope of a test phase since 1994. At the end of 1994 patients were treated with this "new" laser wavelength for the first time, which had not been used in dentistry up until that time. The Freiburg laser work group led by Krekeler and Bach, who were the first ones to deal with the integration of diode laser light in dentistry, noticed the considerable advantages of this new technology.

High-performance diode lasers emit monochromatic coherent light at a wavelength of 810 nm. This light is absorbed particularly well by dark surfaces. Thus the injection laser (= diode laser) is ideally suited to perform cuts, as are com-

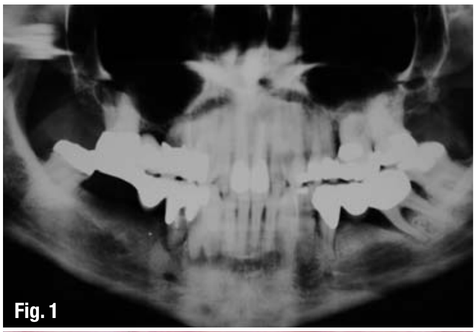


Fig. 1


Fig. 2


Fig. 3


Fig. 4


Fig. 5a

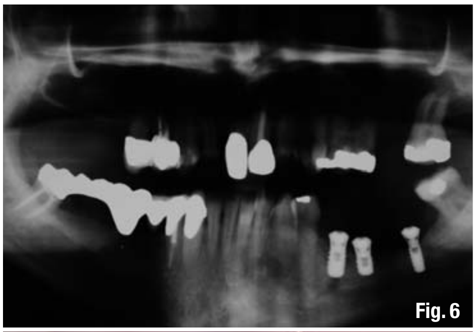

Fig. 5b

CASE 1

Fig. 1_Panoramic tomography (emergency service) dating back to 1995—immediately prior to commencement of treatment.

Fig. 2-4_Baseline findings in 1995.

Fig. 5a & b_Tooth 37 was not conservable in spite of hemisection (August 1995), resulting in a large edentulous space in the third quadrant (November 1995).



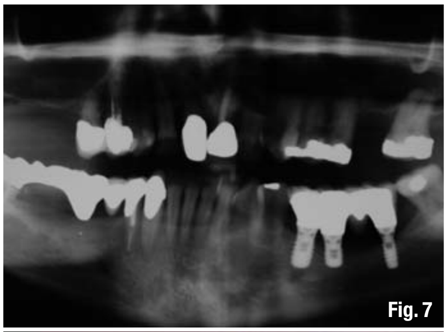


Fig. 6_Orthopantomogram after insertion of 3 short implants ("shorties") in the atrophied left half of the mandible.
Fig. 7_6-year follow-up in 2001.
Fig. 8–11_Clinical findings in 2009, shortly prior to restoration of the maxilla (general view and details).

mon in dental surgery, as well as for the removal of benign tumors in the oral cavity, for exposing implants and for use in mucogingival surgery. This excellent cutting performance of the diode laser can be attributed to the exceptional absorption of the laser light by the hemoglobin in the tissue. Aside from an application in soft-tissue surgery, the diode laser is also used for decontaminating surfaces that are colonized by germs (on implants and teeth). It was proven in these applications that especially a gram-negative, anaerobic germ spectrum is sufficiently damaged by the laser light.

The following paper describes—by means of three selected patient cases—our "Freiburg" experience of incorporating laser light decontamination in the therapy of marginal parodontopathies.

_Material and methodology

We are presenting treatment results for three patients who received dental treatment over a period of 15 years (12/94-04/10). Initially, these three patients suffered from a profound parodontopathy with inadequate degeneration of supportive tissue. The course of treatment for these three patients proceeded according to the following regimen:

1. Initial therapy (12-1994 through 01-1995)
_Motivation and instruction of the patient
_Cleaning and polishing
_Application of disinfecting agents

2. Resective phase (01-1995 and/or 02-1995)
_Creation of a mucoperiosteal flap
_Removal of granulation tissue
_Decontamination with diode laser light ($p = 1.0$ Watt; $t_{max} = 20$ sec)
_Apical shifting of soft tissue

3. Reconstructive phase (01-1995 and/or 02-1995)
_Bone augmentation, if required
_Mucogingival corrections, if required

4. Recall phase (from 05-1995 to present)
_After 4 weeks, 6 months, 1 year and then annually: complete survey of clinical evidence, X-ray diagnosis, repeated decontamination with diode laser light of exposed root areas, if required.

_Imaging procedures

As a general rule, the orthopantomogram (panoramic tomography) and in special cases/as a supplementary measure dental film images as a parallel technique were the applied imaging procedures.

A-scan and B-scan ultrasonography was also used in a few cases of exacerbated inflammations. An orthopantomogram was taken preoperatively and immediately post-operatively, and a panoramic tomography every three years thereafter.

The distinct advantage of an orthopantomogram is its panoramic view of all teeth, the osseous limbus alveolaris and important adjacent anatomic structures. By comparison, dental film images as a parallel technique provide information about the progression and stagnancy of the issue degeneration, because they enable statements about the behavior of the limbus alveolaris.

_Microbial diagnostics

At the time of diagnostic radiology (see above), germ extractions of the affected areas were also performed. This was not done by way of the conventional microbial examination technique (germ extraction—cultivation—pure cultures—microscopic specimen—gas chromatography—sensitivity to antibiotics and color test strips); instead, DNA-RNA hybridization tubes were used.

The advantage of these hybridization tubes was that no live material from the probed areas was required for cultivation, thus reducing work in the dental practice. In addition, the results were available much faster than with the classic microbial examination. The disadvantage of these rapid tests is a relatively high price and the fact that the employed product only detects special marker germs so that not all microbial organisms in the sulcus can be identified.

The area where a germ extraction was planned had to be carefully dried with a cotton swab. The paper tip was then put in place and, after an exposure time of 10 seconds, was immediately packaged in a sterile container and forwarded to the manufacturer for germ identification. The manufacturer identified the germs and evaluated the so-called marker germ values.

The result was considered negative if less than 0.1 % was identified as a marker germ. The result was considered to be low if 0.1–0.99 % was identified as a marker germ. The result was considered to be medium if 1.0–9.9 % was identified as marker germ and high if more than 10 % was identified as marker germ.

_Laser light decontamination

Decontamination was an essential part of the overall therapy:

It was achieved with diode laser light of 810 nm wavelength, 1 watt of power and an application time of 20 seconds per tooth and implant under fiber contact in continuous wave mode. When adhering to these parameters (time limitation and power limitation) it can be guaranteed that the germ spectrum causing the disease can be sufficiently damaged and at the same time that pulpa and/or peri-implant or periodontal tissue structures do not suffer any thermal damage (Bach and Krekeler [1994]).

_Three patient cases 1995/2010

Three patients are presented from the original patient group of the “diode laser basic study” (25 patients) from 1995 (Krekeler/Bach, Department of Parodontal Surgery of the University Dental Clinic, Freiburg/Breisgau) who showed “typical progression patterns” and whose treatment illustrates the advantage of integrating diode laser light application into a proven therapy regimen for the treatment of marginal parodontopathies.

_1st Case (Figs. 1–14)

The holding therapy case

Female patient, born in 1954.

Medical history

The patient went to the Sunday emergency service at the Freiburg dental clinic because of pain in tooth 37. A profound parodontopathy was diagnosed there, and the patient came to our department on the following Monday requesting treatment. She had received a complete fixed restoration from her dentist 6 months ago, but without a preprosthetic X-ray diagnosis. Ms. D. is a healthy and very health-conscious physiotherapist.

Clinical baseline findings (1995)

Abutment tooth 17 showed a degree of loosening of 2, as did tooth 26 and tooth 45. Mesial probing resulted in profuse, hard to arrest bleeding. BOP and high probing depths were found in general. The interdental spaces had soft deposits, also under the pontics.

X-ray diagnosis (1995)

The panoramic tomography (orthopantomogram) shows severe horizontal and vertical bone le-

Fig. 12_The periodontal lesions (vertical bone degeneration) on teeth 15, 14, 24, 25 are so advanced that these teeth can be considered non-conservable.

Fig. 13 & 14_There are essential modifications in comparison with the baseline findings regarding the maxilla. Some teeth have to be extracted. Furthermore, a removable bridge (telescopic bridge) was inserted.

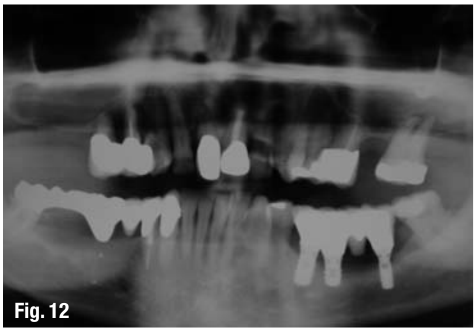
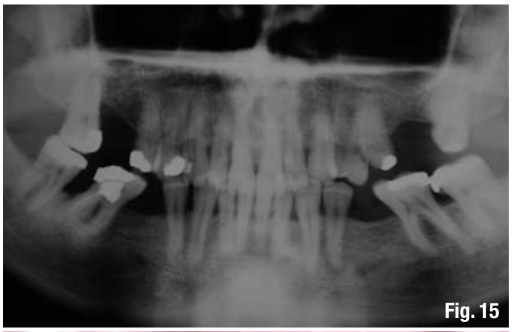
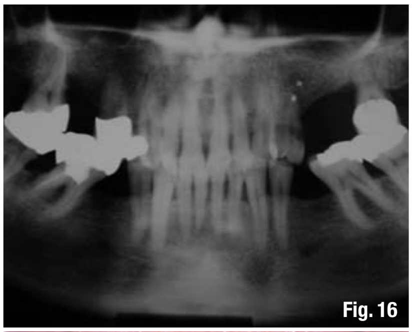


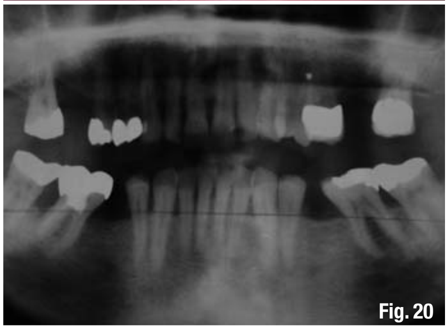
Fig. 12

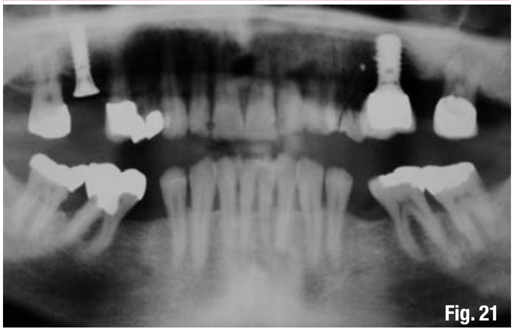
Fig. 13

Fig. 14









CASE 2

Fig. 15_Panoramic tomography dating back to 1994—prior to commencement of treatment.

Fig. 16_Initial X-ray image taken in 1995.

Figs. 17–19_Baseline findings in 1995.

Fig. 20_Four-year follow-up 1999.

Fig. 21_Panoramic tomography taken in 2004; dental implants were inserted to increase the number of abutment teeth.

sions. Teeth 35 and 26 have dish-shaped defects. Trifurcation 34 is opened radiologically.

Diagnosis

Most severe form of adult marginal parodontitis having portions with a fast-course component.

Course of treatment 1995–2010

Tooth 37 was extracted within the scope of initial pain treatment, as were teeth 26, 17 and 35. Removable immediate prostheses were incorporated because all three pontic reconstructions had to be destroyed during the extraction therapy. The pretreatment phase proved to be unproblematic; the patient was very motivated and eager to learn the oral hygiene techniques as instructed.

From June to August 1995 the remaining teeth were treated with open curettement. She had no recurrence for a long time. She received implants in the third quadrant while the remaining maxillary side teeth received fixed prostheses. The edentulous space in the second quadrant remained at the patient's request; in the first quadrant, the principle of a shortened row of teeth was realized (up to 5' to 5th).

This condition was maintained from the end of 1996 to 2008. The patient conscientiously observed all recall appointments. Aside from the usual cleaning, motivation and instruction steps, a diode laser light application was always performed. Special emphasis was placed on the periodontally severely damaged premolars and the remaining molar 27.

First re-inflammations of the marginal parodontopathy were noticed in 2009; a curettement of teeth 14, 15 and 27 was performed once again. Due to subliminal but latent discomfort, teeth 15, 14 and 27 were removed at the beginning of 2010 and a new concept for treatment of the maxilla was developed.

A removable telescopic prosthesis (cuspids are abutment teeth) was incorporated. The prosthesis on the mandible, which has been in place for 15 years, is still there, and there are no signs of a degeneration of the supportive tissue on the natural and artificial abutment teeth.

Epicrisis

Very remarkable in this patient was the considerable amount of trust she had—in spite of bad experiences in the past—in the new laser-assisted therapy concept, which was out of the ordinary at the time. Her compliance was exceptionally good for the entire 15 years. Because of her conscientious oral hygiene and strict adherence to the recall system she remained recurrence-free for more than a decade. This still holds true for the mandible, while the antecedent massive degeneration of supportive tissue required the removal of three maxillary teeth. Thanks to the diode laser assisted periodontal therapy and the continuous recall, the patient was able

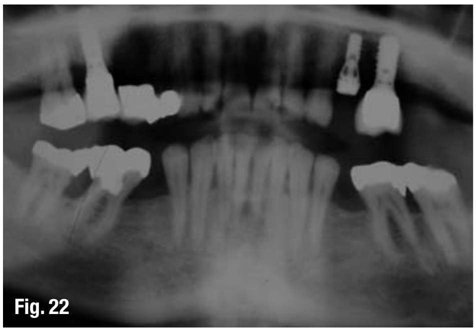


Fig. 22

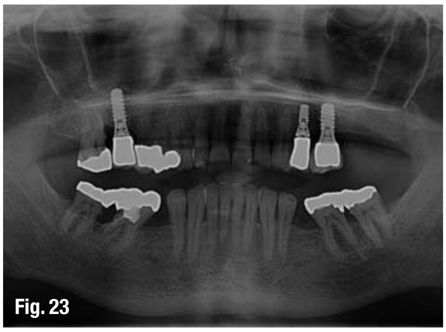


Fig. 23


Fig. 24

Fig. 22_The principle of increasing the number of abutment teeth is still being pursued twelve years after commencement of treatment (OPG dating back to 2007).
Fig. 23_Current panoramic tomography taken in 2010.
Figs. 24_Clinical images taken in 2010: In the frontal view as well as in the lateral views and both jaw views conditions without irritations prevail for the most part.

to retain the majority of her teeth in the maxilla and the fixed prostheses for a longer period of time. It was only recently that this concept in the maxilla had to be modified in favor of a removable one; however, this occurred 15 years after a similar suggestion (removable prosthesis) had been made by her attending dentist at the time.

_2nd Case (Figs. 15–24)

Success due to (laser-assisted) recall case
Male patient, born in 1938.

Medical history
This patient had been treated since childhood by a dentist who passed away in 1991. For some time the patient had been complaining of toothaches and bleeding of the gums, the latter also occurring spontaneously.

He consulted the successor of his former dentist at the dental practice. However, this dentist did not pay much attention to his descriptions (discomfort) and only remarked once that "there is nothing that can be done!". The patient had obtained the last OPG that had been taken and brought it to the initial examination at our clinic, but he refused (three months later at our clinic) a new X-ray diagnosis, stating that he was completely healthy.

Clinical baseline findings in 1995
Teeth 27 and 37, 38 showed a degree of loosening of I–II. The side teeth showed high probing depths, and a BOP was detected in general. The front mandible was found to be without irritation. The interdental spaces had soft deposits. There were edentulous spaces 16, 25, 26, 27, 45, 46, 35, 36.

X-ray diagnosis (1995)
The panoramic tomography (orthopantomogram) shows an adult dentition with general horizontal bone loss and profound vertical bone lesions on the following teeth: 17, 24, 27, 47 and 48. The patient had received primarily cast restorations. Tooth 24 shows two apical radiopaque structures on the root apex and a discrete periapical translucent zone.

Diagnosis
Adult marginal periodontitis.

Course of treatment 1995–2010
The entire pre-treatment phase proved to be without complication due to the patient's initially high compliance. The teeth of the maxilla and the mandible were treated with a mixed open (side-tooth area) and closed (front-tooth area) curettement in the subsequent surgical phase. The surgical part of the periodontal treatment was completed in April of 1995. Since then the patient has been in the recall system, which he took very seriously initially and which helped him to remain recurrence-free for four years after the surgical treatment. From 1999 to 2003 the recall started to become difficult because the patient did not show up in spite of appointments or rescheduled appointments on short notice. At the beginning of 2003 increased probing depth were found on 23, 24 and 27 and three additional teeth exhibited bleeding when probed. Another curettement with laser light decontamination resulted in a decrease of the inflammation; however, 27 could not be saved and had to be extracted, as did tooth 24 (condition after root apex resection), which fractured subgingivally. The resulting free-end situation starting with tooth 23 in the left half of the maxilla and the existing edentulous space in the right half of the maxilla, which had been there for a longer period of time, were treated with three implants that received crowns after a three-month osseointegration period. We arranged with the patient that he should participate in a quarterly recall and make a new appointment upon completion of the respective recall. He has been recurrence-free since then.

The X-ray images showed a marked tendency for reduction of the osseous supportive tissue on tooth 24. (Note: This tooth was also extracted.) None of the other teeth showed any substantial changes in the course of the osseous limbus alveolaris. The implants also did not show any changes of the periimplant osseous condition from insertion up to the present day.

Epicrisis

Our prognosis after removal of the non-conservable teeth and the systematic increase of abutment teeth is very favorable. The patient's compliance—after variations in the medium observation period—is stable and good. The long recurrence-free interval is also very gratifying.

_3rd Case (Figs. 25–34)

The "completely delightful long-term patient"

Male patient, born in 1952.

Medical history

This patient had been with the same dentist for many years, whom he consulted for check-ups on a regular basis. The patient was surprised to find that his teeth 12 and 11 were "loose" and had to be extracted. He was then referred to our clinic. The patient was quite obviously unhappy with the loss of two teeth and the referral ("I feel pushed off"). He is a physical education teacher at a high school and stated that he was completely healthy.

Clinical baseline findings (1995)

Almost all teeth revealed increased probing depths, and probing on the gums in the side-tooth area resulted in bleeding. The smooth surface cleaning was very good; however, deposits were found in the interdental spaces. The dental necks of the maxillary premolars showed wedge-shaped defects. The patient had received primarily cast restorations.

X-ray diagnosis (1995)

In the maxilla, the osseous limbus alveolaris has a considerably reduced level. The alveolar ridge in the area of the tooth gap 12, 11 is severely atrophied. Bone mass in the mandible is also reduced, although not as extensively as in the maxilla. Tooth 45 had received a root canal treatment. The crown edges of the cast restorations do not align perfectly with the contour of the teeth and mostly have an overhanging design.

Diagnosis

Severe adult marginal periodontitis.

Course of treatment 1995 to present

Our most difficult task initially was to appease the patient's dissatisfaction because he felt he "had been taken for a ride." After we had successfully done that, the patient eagerly followed our instructions and followed a frequent and sufficient oral hygiene regime. He grew especially fond of interdental cleaning which had never been mentioned to him before. In May 1995 we started the corrective phase, which was completed in July. We carried out lobe surgery with apical soft tissue fixation in all quadrants. The patient received two implants in regions 12, 11 and, after their osseointegration, two blocked crowns. Due to the severe bone degeneration and the patient's wish to forego augmentation, we arrived far below the cement-enamel junction of the adjacent teeth in one oral implant; however, this did not pose a problem due to the patient's extremely deep-set upper lip. The patient has been in our recall system for 15 years now; he has not missed one recall appointment and has been recurrence-free ever since. A successive prosthetic re-treatment of some single (component) crowns, which had become insufficient, was carried out over the course of several years.

CASE 3

Fig. 25_X-ray image dating back to 1994 (requested by a previous dentist).
Fig. 26_Panoramic tomography taken in 1995 (commencement of treatment).
Fig. 27 & 28_Initial clinical images dating back to 1995.
Fig. 29_Follow-up X-ray image taken in 2001 (6-year follow-up).
Fig. 30_11-year follow-up in 2006.

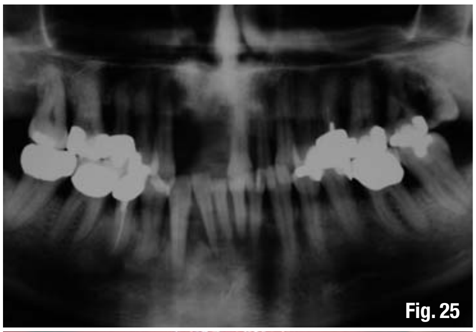


Fig. 25

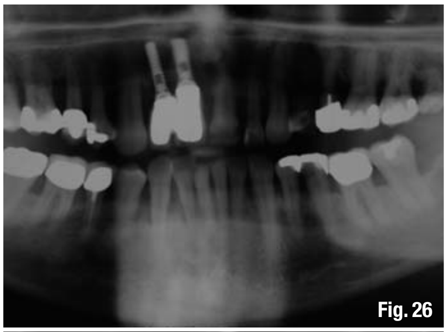


Fig. 26


Fig. 27


Fig. 28

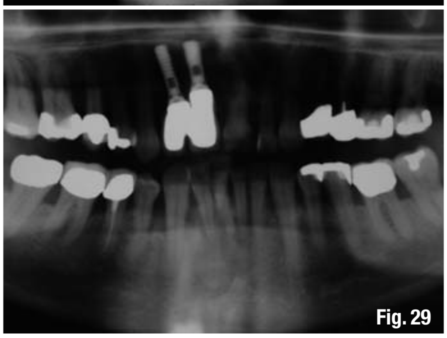


Fig. 29

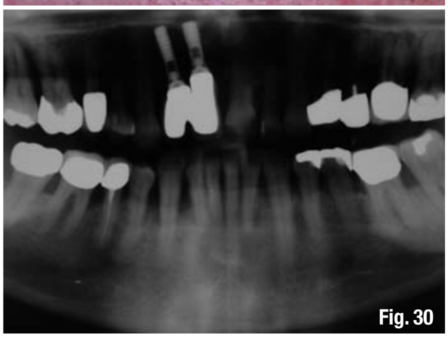


Fig. 30

Fig. 31_The panoramic tomography taken in 2010 does not show any signs of progressive degeneration of the supportive tissue; the image rather shows a "stable osseous condition."

Figs. 32–34_Clinical images 2010 (comprehensive and detail views) showing "reduced" but overall stable conditions. The condition of the mandible also appears normal, which is confirmed by the detail view of the frontal mandible.


Fig. 31


Fig. 32


Professor Dr Gisbert Krekeler

I would like to dedicate this paper to my academic instructor, Professor Dr Gisbert Krekeler (†). We owe it to his initiative that the option of diode laser decontamination and the introduction of diode laser into dentistry in general were made possible!

Epicrisis

I feel that—on the "credit side"—we have the patient's excellent cooperation, which has not diminished to this day, and the long recurrence-free period. In this context, one should not forget the extent of the previous periodontitis. These aspects leave a very satisfying impression.

_Discussion

The diode laser decontamination study (Krekeler/Bach; University Dental Clinic, Freiburg/Breisgau) that started in 1994 and 1995 was made up of 25 patients, of which seven are still receiving treatment. The extremely long examination period (15 years) naturally limited the number of patients we could examine and treat. Some of the patients, who are no longer in our recall system, have unfortunately passed away in the meantime, while others have moved away or found a different dentist who is located closer to their new residence (usually a care home). Over the years, three "patient types" have emerged—the "holding therapy" type, the "imperative recall type to avoid being the unsuccessful type" and the "successful type". The purpose of this paper is to present these three types by way of individual examples. Diode laser light decontamination proved to be very helpful in all examined patients—I feel that, based on the current results, this assessment is justified because the incorporation of diode laser decontamination into the proven treatment regimen for periodontitis resulted in a considerable reduction of the recurrence rate and a considerable improvement of the prognosis of this disease.

An evaluation of the significance of the laser treatment, which has been established as an integral part of a proven therapy regimen in our treatment philosophy, is certainly worthy of discussion. Laser critics will want to argue that a close-meshed and consistent recall, possibly supported by other adjuvant measures, would have yielded similarly positive results. This may indisputably be the case; in fact, I am sure that this assessment is true!

However, if the key to treatment success is then rather the consistency and frequency of treatment, I consider laser-assisted treatment to be one of many options in the extensive field of periodontal therapy. Laser-assisted periodontal therapy thus makes no pretence of being a unique feature, but rather an adjuvant therapy with the claim to be efficient, gentle and ultimately successful._

_contact laser

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Fig. 33


Fig. 34

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Clinical comparison of two laser wavelengths

In the treatment of periodontal disease

Author_Dr Ron Kaminer, USA

_Abstract

The use of lasers in everyday dental practice has grown steadily in the past ten years. Both Neodymium YAG (Nd:YAG) lasers and Diode lasers are routinely used in dental offices around the world for a variety of soft tissue procedures. In most clinical circumstances, a laser can offer well-defined benefits to the practitioner and patient.

Over the years lasers have been used extensively for the treatment of periodontal disease, and numerous studies have been conducted with a wide variety of techniques and laser parameters, leading to outcomes which can be difficult to interpret. In this report, two of the more common wavelengths used in dentistry to treat periodontal disease, the 1,064 nm Nd:YAG laser crystal and the 808 nm diode, will be reviewed for their clinical advantages and disadvantages.

_Introduction

Both Nd:YAG lasers and Diode lasers produce light that is highly absorbed by pigment and hemoglobin, making them ideal for use with soft tissue procedures, especially when bleeding is a concern. One of the main differences between the two technologies is the way that the laser energy is pulsed. Diode lasers are continuous lasers whose energy is pulsed or shuttered by mechanical interruption of the energy stream, similar to what happens when the beam from a flashlight passes through the blades of a fan. The energy is "turned on" the whole time but shuttered by the blades of the fan, allowing for a slight relaxation of the tissue.

The Nd:YAG laser differs from the diode in that it can be micro pulsed electronically while reaching very high peak powers. The Nd:YAG laser energy has been compared to a lightning bolt in that the energy is delivered with high intensity (high peak power) and then dissipates quite rapidly. This difference in the approach to pulsing between the two laser technologies appears to be a key factor contributing to the long-term effectiveness of each treatment.

A review of the literature shows mixed support for the use of diode lasers in periodontal treatment. In 2008, Caruso and Nasti[1], found no statistical dif-

Fig. 1_Pre-op situation.
Fig. 2_After first pass with Nd:YAG.

ference between the control group and the diode laser treated group in regards to periopathogen reduction. Also in 2008, Ribiero[2] found that diode lasers in conjunction with scaling and root planing did not provide any clinical benefits in shallow-to-moderate pockets. However, in 2007 Kamma[3] found that diode laser therapy in conjunction with scaling and root planing seemed to show a reduction in clinical parameters such as bleeding on probing and pocket depth. Other various studies have shown a decrease in oral malodor and bleeding upon probing after diode therapy.

The Nd:YAG literature shows more conclusive but not complete support for definitive periodontal treatment. Kara[4] found a decrease in oral malodor following Nd:YAG laser therapy. Grassi[5] found that Nd:YAG was a therapeutic aid to scaling and root planning. Slot *et al.*[6] did a literature review of Nd:YAG laser-assisted periodontal therapy and suggested that further research was needed.

Other more recent studies using trademarked procedures such as WPT (Wavelength-optimized Periodontal Therapy)[7] further suggest that the use of a combination of Nd:YAG and Er:YAG lasers in periodontal therapy can be associated with cementum-mediated new connective tissue attachment and apparent periodontal regeneration of diseased root surfaces.

Based on over 15 years of clinical use of lasers in periodontal therapy, the author of this article has come to his own independent conclusions after performing the following treatment procedures and consistently noting the accompanying observations.

_Laser Treatment Methods

A diode-based laser treatment technique, used on more than 120 patients over a 7 year period, was performed as follows: a complete oral exam and full series of X-rays, full mouth periodontal probings, anesthesia of the entire quadrant, followed by scaling, root planing to remove all accretions on the root surface, and subsequent diode-laser irradiation of the periodontal pocket. The diode was set at 1 watt continuous power (808 nm) and the tip was initiated. After inserting the tip to the depth of the pocket for a few seconds, it was removed and all debris was wiped off. This was repeated until no other debris was present on the tip (usually two or three times). The patient was sent home with Doxycycline 100 mg, one per day for ten days and followed up with at one week, two week and thirty day intervals. The patient was instructed to follow a strict home care regimen and to return every three months for a comprehensive prophylaxis.

Fig. 3_Selective removal of calculus with the Er:YAG laser.

The technique used with the Nd:YAG laser on over 182 quandrants to date, was performed as follows: a complete oral exam (including all necessary X-rays) was followed by a complete full-mouth probing to determine the extent of disease (see sample patient photo in Fig. 1).

The next step was to anesthetize the entire quadrant, followed by adjustment of the occlusion to remove high spots. A Fotona AT Fidelis laser system that includes two wavelength sources in one unit: the Nd:YAG (1,064 nm) and the Er:YAG (2,940 nm) lasers, was used in all treatments. The Nd:YAG parameters were set as follows: 3.75 W at 20 Hz VSP. The fiber was inserted deep enough to remove inner epithelium to separate the tissue from the tooth and create access to the entire root surface (Fig. 2).

When performing WPT treatments, the Fotona AT Fidelis 2,940 nm Er:YAG laser was then used to selectively remove calculus (Fig 3). A piezo scaler of choice was finally applied to thoroughly debride the root surface of any hard tissue accretions. Following the debridement, the Nd:YAG laser was used again at a setting of 3.75 W and 20 Hz, in the longest pulse. The fiber was inserted to the depth of the pocket and removed slowly, creating a clot to seal the periodontal pocket (Fig. 4).

This so called "fibrin clot" facilitates healing and allows the patient to go home with no concern of bleeding (as long as it is not disturbed). Patients were placed on antibiotics and told not to brush the treated quadrants for 7 days (typically two quadrants are done at one visit).

_Results

Diode laser treatment, in conjunction with scaling and root planing, led to decreased bleeding, de-

Fig. 4_After second pass with Nd:YAG laser.
Fig. 5_Post-op.

creased malodor, and from a patient's perception, a better feeling in their mouth when compared with conventional periodontal treatments. With the Nd:YAG treatment, patients likewise healed uneventfully with little-to-no post-operative discomfort. Patients were followed up weekly for four weeks and all reported feeling much better post operatively.

The diode laser treatment provided very good short term results, but the disease relapsed in almost every case within 12 months, regardless of oral hygiene control.

The Nd:YAG laser treatment administered by the author produced more stable and longer-term control of the patients' periodontal disease. Reduction in bleeding, oral malodor, and mobility of teeth was carefully noted, and the results have proven to be long-term for all patients that followed the home care and recare instructions (Fig. 4).

_Discussion

Questions have arisen as to why the Nd:YAG laser may be better suited for the treatment of periodontal disease than the diode laser. Both kill bacteria and reduce inflammation, but a study by Harris may hold the answer. Harris[7] found that the difference in the therapeutic index between the Nd:YAG and diode indicates that the pulsed Nd:YAG has 16 times greater selectivity for the destruction of pigmented oral pathogens than the diode laser. Moreover, it destroyed these pathogens while leaving the surrounding tissue intact. This concept of "getting rid of the bad guys while leaving the good guys" makes the Nd:YAG laser a far superior tool for long-term stabilized treatment of periodontal disease.

From the perspective of this author, the concept of laser use in periodontal therapy makes perfect sense. After considerable analysis of the two most common laser wavelengths used for treating periodontal disease, the author has come to the following conclusions.

_Conclusion

The diode laser can be used to contain disease in mild to early-moderate stages of periodontal disease. Based on its ability to kill bacteria, the use of the diode laser in a 5 mm bleeding pocket would be acceptable as long as expected results are short-term, analogous to using common chemo-therapeutics in dentistry. The Nd:YAG, on the other hand, can be used for all cases, including moderate to severe stages of the disease when the goal is complete long-term treatment; with proper patient follow up, long-term resolution of the disease can be expected.

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The treatment of prominent frenulum with diode laser 940 nm

Author_Dr Merita Bardhoshi, Albania

_**Labial frenectomy** is a common surgical procedure in the field of oral surgery. Labial frenectomy is a procedure usually for orthodontic and prosdonthontic reasons. Diode laser are portable, compact, efficient, with good bactericid and coagulation properties. Diode laser have a wavelength between 810 and 980 nm. They can be used in the continuous as well as pulsed mode with a contact or non contact handpiece.

The aim of this study was present the efficacity of diode laser 940 nm for treatment of prominent labial and lingual frenulum and to demostrate healing characteristics after laser surgery.

_Materials and methods

Ten patients with prominent labial and lingual frenulum are included in this report (Figs. 1 & 2). All patients are treated with diode laser 940 nm in the Dental University School in Tirana, Albania. The technique of frenectomy was used under local anesthesia (lidocaine 2 % 1cc). Informed consent was obtenaid from all patients.

Laser settings were: fiber optic 300 micrometer, cw, 4 W. The laser fiber was applied vertically and laterally to the frenulum initially causing disruption of the mucosa continuity This easily allowed performing a deeper cut of the frenulum in a horizontal dimension. The design of the frenectomy was rhomboid and the whole procedures were performed in about four to five minutes. No sutures were required in any cases. In addition the ice was applicated to avoid the increase of tissue temperature and control necrosis in the tissue. All clinical were examinated in one week, three weeks and three months after surgery. Postoperative complications such pain, bleeding, swelling, scar formation as well as would healing characteristics were evaluated.

_Results

No bleeding was observed either during treatment or during the healing period (Figs. 3, 4 & 5). One week after surgery a superficial layer of bibrine was observed in all clinical cases. No postoperative pain and swelling were not recorded. Three weeks after surgery oral mucosa was completely healthy. No scar tissue formation in any case was observed. In long term follow-up the oral mucosa in all clinical cases looked normal in colour and consistence (Figs. 6 & 7).


Fig. 1


Fig. 2


Fig. 3


Fig. 4

Fig. 1_Prominent frenulum of tongue.
Fig. 2_Prominent labial frenulum.
Fig. 3_Moment of treatment (bleedless).
Fig. 4_Moment of treatment (bleedless).


Fig. 5


Fig. 6


Fig. 7

Fig. 5_Immediately after the treatment.
Fig. 6_Healing after three months (follow-up).
Fig.7_Healing after three months (follow-up).

_Discussion

Frenectomy is a common procedure in the field of oral surgery.The advantages of laser surgery includes higher precision, less pain, bleeding, swelling and scarring. The procedure is quick, safe, easy to perform in an outpatient set and no sutures are required. All patients were satisfied with the treatment and the results obtained. Diode laser is of beneficial effects like small, compact, portable to move easily from operatory to operatory.

_Conclusion

The technique of frenectomy is easy, fast and safe to be performed with diode laser 940 nm. It could be done in outpatient clinic with local anesthesia, with good degree of acceptance by the patients and perfect results._

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Photo-acoustic endodontics using PIPS

Author_G. Olivi[1], R. Crippa[1], E. DiVito[2],G. Iaria[1], V. Kaitsas[1] & Prof S. Benedicenti[1]

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_The goal of endodontic treatment is to obtain an effective cleaning and decontamination of the smear layer, including bacteria and all its products, in the root canal system. Clinically, traditional endodontic techniques use mechanical instruments as well as ultrasound and chemical irrigation in an attempt to shape, clean and completely decontaminate the endodontic system. The effectiveness of debriding, cleaning and decontaminating of all the intra-radicular space is, however, limited given the anatomical complexity and the inability of common irrigants to penetrate into the lateral canals and the apical ramifications. The complexity of the root canal system is well known. Numerous lateral canals of various dimensions and with multiple morphologies branch off from the principal canals. A recent study found the presence of these anatomical structures in 75 % of the teeth analyzed as well as the presence of residual infected pulp, after completion of chemo-mechanical preparation, both in the lateral canals and in the apical structures of vital and necrotic teeth associated with periradicular inflammation.[1]

Lasers were initially introduced in endodontics as an attempt to help improve the decontamination of the endodontic system.[2–7] Laser-assisted canal decontamination performed with the near-infrared laser, such as an Nd:YAG or a diode laser, requires the canals to be prepared in the traditional way, and the radiation is performed at the end of the traditional endodontic preparation as a final passage to decontaminate the endodontic system before obturation. An optical fiber of 200–300 micron diameter is placed 1 mm from the apex and retracted with a helical movement moving coronally (for 5–10 seconds according to the different procedures). Gutknecht *et al.* (1996) showed that the Nd:YAG (1,064 nm) laser demonstrated a superior bacterial reduction of 85 % at 1 mm depth[2], while the diode laser (810 nm) achieved only 63 % at 1 mm depth or less.[6] Schoop *et al.* (2004) demonstrated through an experimental model how lasers spread their energy and penetrate into the dentinal wall, showing them to be physically more efficient than traditional chemical irrigant systems in decontaminating the dentinal walls.[7] This marked difference in penetration is due to the low and varying affinity of these wavelengths for hard tissue.

In recent years, the use of laser technology in endodontics has undergone another important evolution. In addition to the now well-researched use of infrared lasers for thermally destroying bacterial cells deep within the dentinal walls, lasers are now also beginning to be used very effectively for debriding, cleaning and decontaminating the root canal system.[8–18] This area represents a new trend of research in laser-assisted endodontics. One of the techniques, known as Photon Initiated Photo-acoustic Streaming (PIPS), presupposes the use of an Erbium laser (Fidelis AT and LightWalker AT, Fotona d.d.) and its interaction with irrigant solutions (EDTA or distilled water).[18] The technique uses a differ-

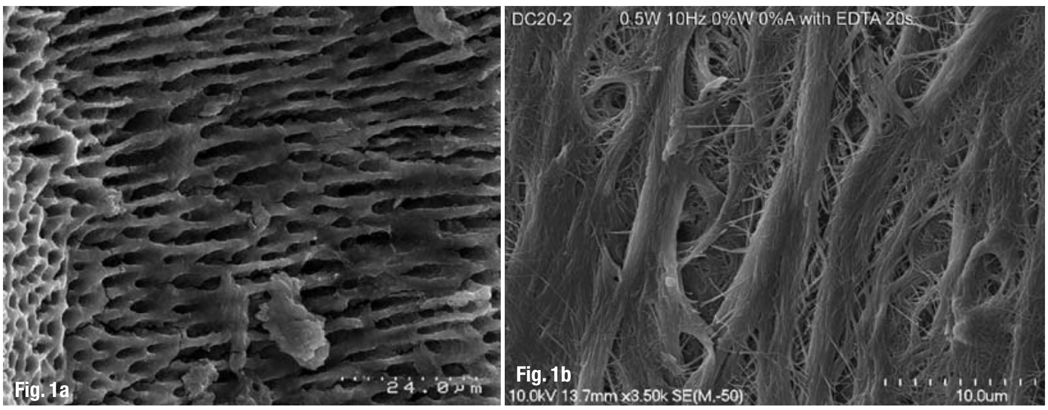
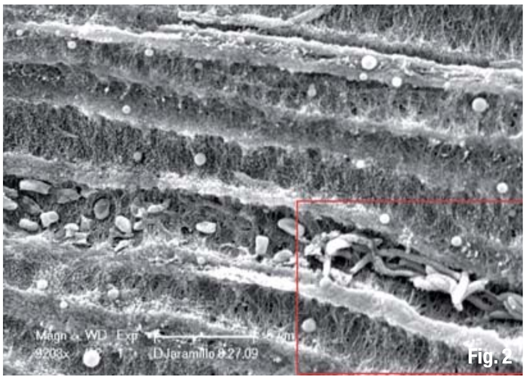


Fig. 1a & b_SEM images of radiated dentin with radial firing tip, at 50 mJ, 10 Hz for 20 and 40 seconds in a canal irrigated with EDTA. The images show a noticeable cleaning of debris and smear layer from the dentin.*



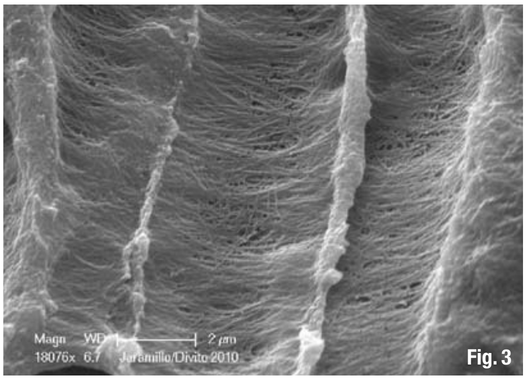


Fig. 2_SEM image of radicular dentin covered with bacterial biofilm of e.faecalis, before laser radiation.*

Fig. 3_SEM image of radicular dentin covered with bacterial biofilm of e.faecalis, after radiation with Er:YAG laser at 25 mJ,15 Hz, using a PIPS tip with irrigation (EDTA). The procedure results in the destruction and detachment of the bacterial biofilm and its complete vaporization from the principal root canal and from lateral tubules.*

ent mechanism from the preceding laser-assisted irrigation (LAI) methods[10], and is based on the latest special endodontic "radial firing and stripped" fibers tips and laser impulses of a reduced pulse energy and frequency.

Using lower laser energies in the presence of chemical irrigants, the PIPS technique minimizes undesirable thermal effects on the dentinal walls. It exploits the photo-acoustic and photomechanical phenomena which result from the use of subablative energy of 20 mJ at 15 Hz with impulses of only 50 microseconds. With an average power of only 0.3 W, each impulse interacts with the water molecules with a peak power of 400 W, creating expansion and successive "shock waves" leading to the formation of a powerful streaming of fluids inside the canal, without generating the undesirable thermal effects seen with other methodologies. A study with thermocouples applied to the radicular apical third revealed only 1.2 degrees C of thermal rise after 20 seconds and 1.5 degrees C after 40 seconds of continuous radiation.[18] Another considerable advantage is derived from the insertion of the tip in the coronal pulp chamber only, eliminating the problematic insertion of the tip into the canal or at 1 mm from the apex required by the other techniques (LAI and traditional). Tips of a new design consisting of 12 mm in length, of 300–400 microns in diameter, with "radial and stripped" terminals are used. The final 3 mm are without coating to allow a greater lateral emission of energy compared to the frontal tip. This mode of energy emission makes better use of the laser energy when, at subablative levels, delivery with very high peak power for each single pulse of 50 microseconds (400 W) produces powerful "shock waves" in the irrigants leading to a demonstrable and significant mechanical effect on the dentinal wall (Figs. 1a & b).

The studies show the removal of the smear layer to be superior in comparison to the control groups with only EDTA or distilled water. The samples treated with laser and EDTA for 20 and 40 seconds show a complete removal of the smear layer with open dentinal tubules (score 1 according to Hulsmann) and the absence of undesirable thermal phenomena, which is characteristic in dentinal walls treated with traditional laser techniques.

With high magnification, the collagen structure is maintained intact suggesting the hypothesis of a minimally invasive endodontic treatment. The research group of Medical Dental Advanced Technologies Group (MDATG, Scottsdale, Arizona), in affiliation with the Arizona School of Dentistry and Oral Health (Mesa, Arizona), with the University of the Pacific Arthur A. Dugoni School of Dentistry San Francisco, California), with the University of Genoa, and with the University of Loma Linda, School of Dentistry, California, is currently investigating the effects of this technique for root canal decontamination and the removal of bacterial biofilm in the radicular canal. The results, which are soon to be published, are very promising (Figs. 2–3).

In conclusion, current instrumentation techniques using rotary instruments and chemical irrigations still fall short of successfully removing the smear layer from inside the root canal system. The use of the Erbium laser at subablative energy using a radial and stripped tip, in combination with EDTA irrigation, results in significantly more debridement and smear layer removal. From the energy levels used at sub-ablative operating parameters, the SEM investigation of the dentin walls and apical structures revealed no thermal effect or damage. The PIPS photo-acoustic endodontic treatment thus demonstrates a great potential for an improved alternative method for debriding and cleansing the root canal system in a minimally invasive mode.[18]_

Editorial note: A list of references is available from the publisher.

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Paediatric laser-assisted dentistry

A clinical approach

Authors_Claudia Caprioglio, Giovanni Olivi, Maria Daniela Genovese, Italia

Fig. 1_Female patient, 6.2 years old. Due to 3.6 eruption an hyperplastic tissue has formed.

Fig. 2 a & b_Immediately after Erbium excision:laser-assisted gingivoplasty procedure (a). Clinical outcome (b).

Fig. 3 a–c_Female patient, 9.2 years old. An orthodontic band was placed on 1.6: hyperplastic tissue (a). A minor laser-assisted treatment of oral soft tissue was performed to insert the palatal barr and elastic ligation.

_Abstract

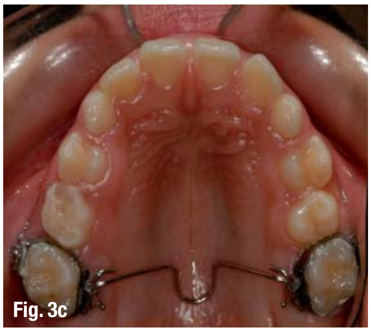
The approach to paediatric dental patient demands close cooperation between dentist-parents and the child himself. Laser-assisted therapy is a modern and effective strategy. Laser technology has a wide application in dental care and treatment, oral traumatology and minor surgical procedures, and it's suitable for the treatment both of primary and permanent teeth. The authors' aim is to stimulate more extensive scientific research in this area and to offer a clinical overview, showing also some clinical procedures.

_Introduction

One of the main roles of the paediatric dentist is to provide effective education on prevention in order to reduce the incidence of dental and oral disease throughout childhood and adolescence and into adulthood.

In this context, it is essential never to lose sight of a key aim: tissue preservation. Preferably, this is achieved by preventing disease from occurring in the first place, and by arresting its progress when it does occur. But tissue preservation also means removing diseased tissue and restoring defects with as little tissue loss as possible.

Today, we are assisted in this endeavour by techniques allowing early diagnosis (digital radiology with low radiation emission, diagnostic lasers and the dental operative microscope) and minimally invasive therapy (ozone therapy, air abrasion, rotary



instruments for micropreparation and lasers). Laser-supported dental diagnosis and treatment, which allows us to meet the important aim of "filling without drilling", is an excellent approach from the tissue preservation point of view and, as reported by Martens[1] and reiterated by Gutknecht[2] "children are the first in line to receive dental laser treatment".

In this paper we look at the use of the Erbium family of lasers in soft- and hard-tissue ablation, and also at how other lasers (diode, Nd:YAG, CO_2) can help to make a trip to the dentist a minimally invasive and stress-free experience[3, 4], which, for children, is particularly important.

The laser is a new instrument in paediatric dentistry that sometimes complements and sometimes replaces traditional techniques. Lasers, which are available in a variety of types with different wavelengths (Table I), have a number of possible applications and can be used to treat both soft and hard oral tissue (Table II).

Without going into the physics of laser therapy in detail, it is necessary to appreciate that different wavelengths interact differently with different chromophores (haemoglobin, water, hydroxyapatite) contained in the target tissue (mucous membranes, gingiva, dental tissue) and therefore that the therapeutic effect is determined by the optical affinity and coefficient of absorption of the target tissue for the given wavelength.

_Soft-tissue applications of lasers in paediatric dentistry

Oral surgery

Lasers offer a series of important advantages in the treatment of oral soft tissues: they are simple and rapid to use, they reduce the need for local anaesthesia, they allow excellent control of bleeding during incision, and they can also eliminate the need for sutures. Furthermore, the post-operative recovery is often asymptomatic thanks to the decontaminating, antalgic and biostimulant effects of the laser radiation. In short the procedure, which produces excellent clinical results, is less invasive and less traumatic than the traditional approach. This is a particularly important consideration in children, who will more readily accept this treatment. Furthermore, laser treatments, compared with conventional procedures, are associated with a greatly reduced need for analgesics and anti-inflammatory medications.

Lasers are used in soft-tissue management to remove or treat lesions of the oral mucosa. All wavelengths of light with an affinity for haemoglobin and water (chromophores contained in the gingiva and mucosa) can be used for these applications: the Argon, KTP, diode, Nd:YAG and CO_2 lasers are useful for soft-tissue cutting, vaporisation and decontamination, achieving very good coagulation and haemostasis; they are also ideal for vascular lesions.[5, 6]

The Erbium lasers, Er,Cr:YSGG and Er:YAG, are also suitable for these applications, due to the good absorption of their light wavelengths by the water contained in the gingiva and oral mucosa, however, they are less effective at controlling bleeding. The performance of the Erbium lasers can be enhanced by the use of an air-water spray, delivered through the handpiece of the laser. This ensures a clean incision and helps to avoid excessive increases in the temperature of the soft tissue during vaporisation; furthermore, the absence of peripheral necrotic tissue allows accurate biopsies (Figs. 1 & 2).[7,8]

Periodontics and orthodontics

The decontaminating effect of different lasers in pockets of periodontal disease has been widely demonstrated in adults, but data on laser-assisted therapy of periodontitis in young patients are lacking. Conversely, in the context of orthodontic treatments, there emerge many clinical situations in which soft-tissue intervention is required before, during and after treatment. These are procedures (Table II) that can be accomplished simply, safely and effectively using different laser wavelengths, depending on the laser-tissue interaction required (Fig. 3).[9,10]

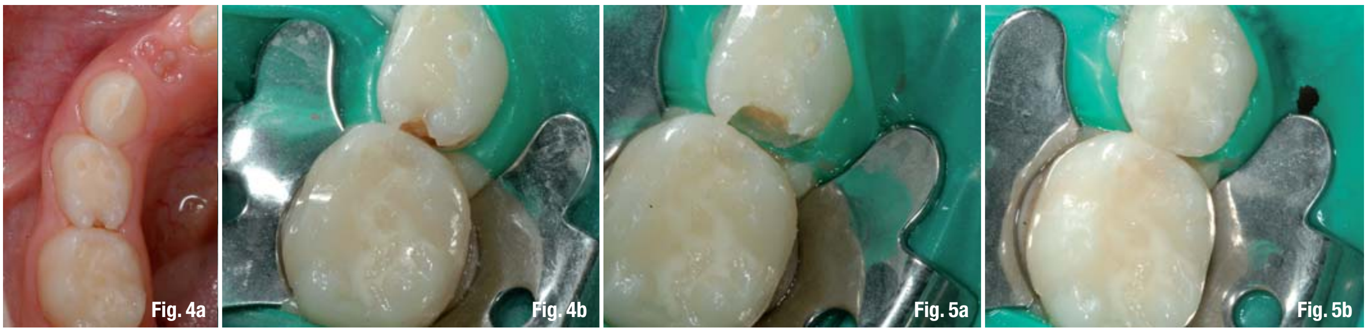


Fig. 4 a & b_Male Patient, 7.4 years old. Interproximal caries of 7.5 (a). Before isolation with rubber dam an Er:YAG laser preparation with minimum intervention is performed and analgesia is obtained by lasing (b).

Fig. 5 a & b_Enamel and dentin are etched, rinsed and dried (a). Final outcome (b).

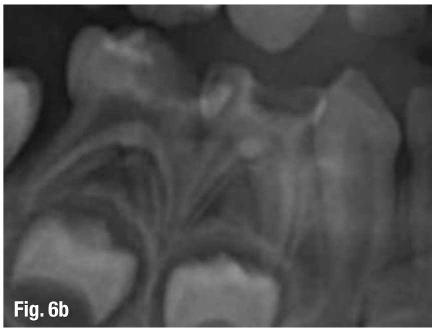
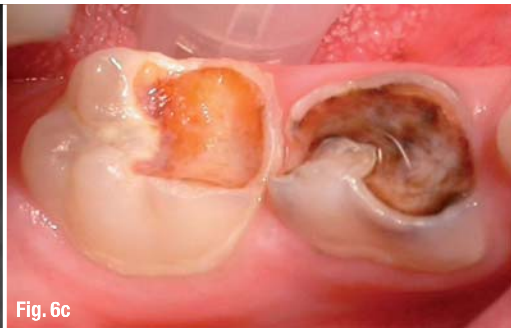




Fig. 6 a-c_Female patient, 5.2 years old. Deep caries on molar teeth. Panoramic view (a). X-ray control (b) and occlusal vision (c).

Frenectomies are among the most common and widely documented laser applications in orthodontics. Laser frenectomies, performed using diode, Nd:YAG, Er:YAG, Er,Cr:YSGG and CO_2 lasers, have been reported to be associated with less post-operative pain and discomfort and fewer functional complications (problems with speaking and chewing) compared to traditional techniques; these advantages improve the patient's perception of the therapy[9, 10], which, as mentioned, is an important consideration in children.

Lasers can be used to perform labial upper and lower frenectomies: the technique is extremely simple and effective even for lingual or labial frenectomies in newborns, in cases of severe ankyloglossia or tight maxillary frenum that create breastfeeding difficulties. Gingivectomy, gingivoplasty and operculectomy can be performed easily and without anaesthesia using all laser wavelengths, and brackets can be glued immediately.[11,12] Low-level laser therapy (LLLT) has been successfully used to accelerate tooth movement in orthodontics, stimulating the modulation of the initial inflammatory response, with the advantage of anticipating the resolution of normal conditions at earlier periods; other other studies have reported a local effect of the CO_2 laser, which was found to reduce pain associated with orthodontic force application, without interfering with the tooth movement.[13,14]

_Hard-tissue applications of lasers in paediatric dentistry

Caries prevention

The first in vitro studies exploring the potential of laser radiation to prevent dental caries (by increasing the acid resistance and microhardness of the enamel tooth surface) were conducted at the end of the 1980s.

To date, several studies on this application have been performed, giving similar results, but clinical evidence is extremely limited. Studies in this area fall into two main categories: those using Argon lasers at 488–514 nm and those using CO_2 lasers at 9,300, 9,600 and 10,600 nm. However, the capacity of the Erbium 2,780 and 2,940 nm lasers to modify the physical-chemical characteristics of the enamel surface has also been investigated. The parameters assessed by these studies were cross-sectional microhardness and enamel solubility.

Argon laser irradiation combined with acidulated phosphate fluoride treatment (APF) was found to reduce lesion depth by more than 50 % compared with control lesions, and by 26 %–32 % compared with lased-only lesions. It was also reported that the use of a zinc fluoride and Argon laser combination significantly reduced white spotting and etching. This treatment appeared to stabilise the hydroxyapatite crystal and repair its structural defects.[15]

In 2003, Hicks *et al.* argued that Argon laser irradiation combined with APF may confer a protective barrier against cariogenic attacks in primary teeth, suggesting that the surface coatings associated with this treatment contain fluoride-rich calcium and phosphate mineral phases that could act as reservoirs for fluoride, calcium, and phosphate and thus provide teeth with a certain degree of protection. It was also confirmed that enamel surface microhardness was found to be greater in teeth exposed to low Argon laser irradiation only, or to Argon laser irradiation combined with APF, than in untreated teeth (controls).[16]

Another line of research dates back to 1998 when Featherstone *et al.*[17,18] reported inhibition of caries progression, obtained using 9,300nm and 9,600 nm lasers (fluences from 1 to 3 J/cm^2). The level of inhibition obtained, compared with that obtained through daily fluoride toothpaste treatments, was in the order of 70 %. Furthermore, the subsurface temperature elevation was minimal (< 1 °C at 2 mm depth), supporting the findings of another study that reported no thermal damage to the pulp (57). In 2008, it was confirmed that the CO_2 laser is efficient in reducing subsurface enamel demineralisation and that its association with a high frequent fluoride therapy may enhance this protective effect.[19]

Fig. 7 a–c_7.5 is isolated with rubber dam: cavity opening (a). Endodontic treatment is performed (b) by using an Er:YAG laser (300 µm tip at 70 to 75 mJ, 20 Hz and 1.4 to 1.5 W). Parameters are reduced in the middle third and the cavity is filled with ZOE and a thin layer of a glass ionomer cement is placed (c).

Recent research has indicated that the Erbium laser wavelengths, too, may have the potential to increase acid resistance: subablative Erbium energies can decrease enamel solubility, thereby increasing caries resistance, without greatly altering the structure of the enamel. However, these results failed to reach statistical significance (alpha = 0.05).[20]

Clinical Implications

Subablative CO_2 laser irradiation of young, healthy teeth could be an effective method of caries prevention; long-term clinical studies are needed to validate this hypothesis. There is also a need for further studies evaluating the capacity of Erbium laser treatment to increase the acid resistance of permanent teeth.

Caries detection

Of the various laser applications in paediatric dentistry, the one most investigated is their use as a means of detecting caries: the non-ablative laser emits fluorescence visible in the red spectrum at 655 nm; this has made it a useful complement to conventional methods for detecting occlusal caries. Lussi *et al.*, in 2003, affirmed that laser fluorescence (LF) could a useful additional tool in the detection of occlusal caries in deciduous teeth, also suggesting that, thanks to its good reproducibility, the laser could be used to monitor the carious process over time.[21, 22]

Several studies have compared different caries detection methods – visual inspection alone, visual inspection with magnification, bite-wing X-ray and LF. The reliability and the diagnostic validity (sum of sensitivity and specificity) of LF have been found to be very high, the technique even outperforming bite-wing radiography as a means of proximal caries detection in primary teeth. Other studies, too, have found that LF methods for detecting occlusal caries are more efficient in deciduous than in permanent teeth, even though LF proved unable, in primary teeth, either to detect in vitro remineralisation of natural incipient caries lesions, or to quantify ongoing mineral loss due to carious processes. According to the results of a 2008 study by Braga *et al.*, the LF device performs better at the dentin threshold than at the enamel threshold; the authors therefore concluded that this method is unsuitable for detecting initial enamel caries lesions, instead confirming its efficiency, which they had already demonstrated in previous studies, as a means of predicting the extent of caries lesions.[23, 24]

Finally, studies conducted to establish the possible impact of the operator on LF treatment have concluded that the operator factor does not determine the reliability, predictability and reproducibility of outcomes obtained using this approach.

Clinical implications

In daily dental practice, the LF system emerges as a reliable complementary tool for the visual exploration of occlusal surfaces, both in primary molars and permanent first molars. In addition, thanks to the availability of new tips, the system can now be used to detect proximal lesions.

Sealing of pits and fissures

Several *in vitro* studies have evaluated the possible role of lasers in the preparation, prior to sealant application, of pits and fissures on the occlusal surfaces of young teeth.

Most of these studies compared invasive techniques and laser irradiation, with or without acid etching, finding no significant difference between the two types of enamel preparation when etching was performed.

In one study, preparing and treating the enamel surface exclusively with the Er:YAG laser resulted in the highest degree of leakage[25], while in another, there emerged no difference in microleakage between lasing and acid etching, suggesting that the lasing technique may be efficacious.[26] However, pre-treatment with the Er,Cr:YSGG laser was not found to influence the resistance to microleakage of bonded fissure sealant in primary teeth. Other studies have investigated the energy level appropriate for this application: they found that mechanical preparation prior to fissure sealing did not enhance


Fig. 8a

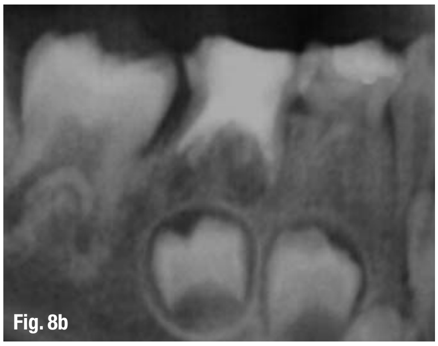


Fig. 8b

Fig. 8 a & b_Final outcome: colour and morphology are restored by the anatomical layering technique. Post-treatment X-ray control (b).

the final performance of the sealant, and that laser irradiation at 600 mJ and bur drilling eliminated the greatest amount of hard tissue.

Clinical implications

Laser irradiation does not appear to eliminate the need for acid etching of enamel prior to the application of a pit and fissure sealant. It may be considered a useful adjunct in the sealant application procedure, thanks to its cleansing and disinfecting effects. Attention must be paid to the level of energy applied in order to avoid overpreparing the pit and fissure surfaces.

Cavity preparation and caries removal

The idea that a dental drill can be replaced by a laser instrument, which is less traumatic for the patient, led to the introduction of this device into the field of pediatric dentistry. Indeed, the laser, unlike the traditional dental drill, works on hard tissue without coming into contact with the tooth; furthermore, it does not generate vibration and noise and it is less painful.

Various studies and clinical reports have demonstrated the additional safety conferred by the laser, used as an alternative to rotary instruments in paediatric restorative dentistry, even in the treatment of very young children. Thus opens up the way for minimal interventions targeting only carious tissue and overall better acceptance compared to traditional techniques.[9,10,32,33,34]

Fig. 9 a & b _Male patient, 8.9 years old. Uncomplicated crown-fracture of 2.1, which was previously protected with a $Ca(OH)_2$ paste by a colleague (a). X-ray control (b).


Fig. 9a


Fig. 9b

In this context, different laser wavelengths were studied for cavity preparation: the CO_2 laser was investigated first and found to induce thermal damage of the irradiated dental tissues; other clinical and experimental investigations indicated the possibility of treating early childhood caries of the enamel with the Nd:YAG laser, but micromorphological analysis of the irradiated primary teeth revealed the presence of collateral damage to the dental tissues.

Today, just two wavelengths, the Er,Cr:YSGG at 2,780 nm and Er:YAG at 2,940 nm, are used successfully for treating dental hard tissues. The earliest studies on the use of the Erbium laser for cavity preparation and caries removal date back to 1989, when Hibst and Keller were the first to evaluate the capacity of the Er:YAG laser to cut human hard dental tissue.[3,4] The first decade of research saw various authors studying different parameters and variables of Erbium laser application in caries removal and cavity preparation, evaluating its morphological effects on hard and pulp tissue, as well as the effects of energy density, of pulse repetition rate, and of air-water spray use.[27,28]

Moritz *et al.*, in 1998, found that the results of laser etching of the enamel were the same as those obtained with orthophosphoric acid etching.[29] Finally, Olivi *et al.* confirmed the efficacy of the Erbium laser in cavity preparation and removal of carious tissue.[30,31]

_Laser and resin composite adhesion

Different studies investigating composite adhesion to lased surfaces have given contrasting results, and this is still a controversial issue.

Many authors have reported that adhesion to laser-ablated or laser-etched dentin and enamel of permanent teeth is inferior to adhesion to dentin and enamel submitted to conventional rotary preparation and acid etching. These studies stressed how important it is to pay close attention to the energy output, in order to avoid substructural damage. They also called for standard laser energy outputs for different tooth substrates and stressed that acid etching should be mandatory even after laser conditioning of dentin and enamel.[35,36]

Studies on primary teeth reported that Er:YAG laser irradiation of dentin, at 60 mJ/2 Hz, 80 mJ/2 Hz and 100 mJ/2 Hz, prior to the adhesive protocol, adversely affected bond strength.[37]

Conversely, other authors reported that primary dentin treated with the Er,Cr:YSGG laser at lower en-

Fig. 10 a–c_A minimally invasive treatment is performed with an Erbium laser (a). Application of enamel-dentin system and building up the incisal edge (b). Final outcome after finishing and polishing (c).

ergy output 0.5 Watt (50 mJ) did not require etching; however, as the energy level increases, it is beneficial to add etching as part of the conditioning protocol in order to guarantee adequate bonding.[17]

Studies on shear bond strength to the enamel of primary teeth reported superior results in Er:YAG laser-treated patients (using 60 and 80 mJ) compared with a control group, while Er:YAG laser-treated patients receiving using 100 mJ recorded similar results to those of a control group undergoing mechanical preparation and acid etching.[38, 39] Other studies investigated microleakage at laser-prepared cavities, again producing differing results: some authors, using the dye penetration method, found less microleakage of GIC and composite materials at laser-prepared than at mechanical bur-prepared cavities.

Comparative studies of different methods of cavity preparation (drill, air abrasion and laser) found that cavities prepared using the Er:YAG laser at 300 mJ/4 Hz and 400 mJ/4 Hz showed the highest degree of infiltration, while better composite resin marginal adaptation was obtained when Er:YAG laser preparation was followed by a total acid etching procedure (Figs. 4 & 5).[40]

Clinical implications

Laser cavity preparation is closely related to a series of variables. Fluence, power density and pulse length, but also laser beam angle, focus mode, and amount of air-water spray are all factors that can cause substructural damage. A final conditioning step at low power, both on dentin and enamel, is advisable. Acid etching on lased dentin and enamel produces uniform results, eliminating the thin layer of substructural damage, exposing the collagen fibres, and creating a substrate for the formation of the hybrid layer; acid etching changes Silverstone class 2 and 3 enamel into class 1 enamel, allowing better composite adaptation.

Endodontics

The use of lasers with different wavelengths is well documented in adult endodontics, but literature on their use in paediatric endodontics is lacking. In endodontics, lasers are indicated for:
_pulp capping
_pulpotomy
_root canal disinfection.

A search of the literature indexed in PubMed found few studies that investigate the use of lasers in maintaining pulp tissue vitality.

In this field, low-level laser energy (from 0.5 to 1.0 W) is usually used, delivered in defocused mode, preferably with low repetition rate or/and in super-pulsed mode. In 1997, Santucci, using an Nd:YAG laser for coagulation and glassionomeric cement as pulp capping agent, reported a 90 % success rate after six months.[41] The following year, similarly high success rates were obtained by Moritz *et al.*: 89 % and 93 % after 1 and 2 years, respectively, compared to 68 % and 66 % in the calcium hydroxide control group.[42,43] The CO_2 laser has a purely thermal effect on tissue, 90–95 % of the energy delivered to the tissue being absorbed by a fine tissue layer (100 microns) and transformed into heat. The wavelengths of Erbium lasers, too, are almost completely absorbed by the water in a superficial tissue layer and transformed into heat: however, these lasers do not have such a marked coagulating effect (Figs. 6–8) .

Olivi *et al.*, in 2006, showed the Er,Cr:YSGG laser with adjustable air-water spray to be, by itself, an excellent mini-invasive instrument for caries removal and pulp coagulation, which does not overprepare or overheat the residual dental tissue and is associated with 80 % tooth survival at 4 years.[44] The same author, in 2007, compared the efficacy of two laser systems, the Er,Cr:YSGG laser and the Er:YAG laser, with that of a conventional calcium hydroxide procedure, observing success rates of 80 % in the Er,Cr group, 75 % in the Er:YAG group, and 63 % in the control group at two years.[45]

Pulpotomy is a very common technique in primary teeth. Although pulpotomy with formocresol (1 : 5 dilution) is used successfully, in view of the carcinogenic and mutagenic potential of its formaldehyde component, there is now a tendency to seek alternative techniques. Lasers have been proposed for this application and, in 2002, Pescheck *et al.* favourably compared CO_2 laser treatment to formocresol for pulpotomy in primary teeth, reporting a survival rate ranging from 91 % to 98 %.[46] The superpulsed mode recorded a markedly higher success rate than the continuous wave mode.

Elliot *et al.*, in 1999, also found a significant inverse correlation between the laser energy applied to the pulp and the degree of inflammation at 28 days; these authors reported a 99.4 % clinical success rate at four years compared to 88.2 % in the formocresol control group.[47] Instead, Guelmann *et al.*, in 2002, reported a correlation between healing and age and apex size of the primary teeth.[48] The Nd:YAG laser has also been used for pulpotomy on human primary teeth, but a recent study reported a clinical success rate of 85.71 % and a radiographic success rate of 71.42 % at 12 months, compared to the clinical and radiographic success rate of 90.47 % recorded in the formocresol group.[49] While clinical reports in paediatric endodontics are lacking, it is known that permanent teeth can be treated with the Nd:YAG and diode lasers, which have a high bactericidal effect in root and lateral canals.

Only one study on laser use in primary teeth is indexed in PubMed. It compared the effects of different procedures (Er,Cr:YSGG laser, manual and rotary instrumentation techniques) on root canal wall cleaning and shaping in primary teeth. Treatment with the Er,Cr:YSGG laser provided cleanliness similar to that obtained using the rotary instrumentation technique and superior to that obtained with manual instrumentation; the laser technique required less time for completion of the cleaning and shaping procedures compared with both the other techniques.[50]

Clinical implications

In pulp capping procedures, attention must be paid to the level of energy applied. Low energy delivered in defocused mode and pulsed or superpulsed mode guarantees good superficial coagulation and good decontamination, and maintenance of the vitality of the residual pulp. Due to the characteristic anatomy of the apex and the penetration depth of near infrared lasers, particular care must be taken when introducing laser energy into primary root canals for root canal cleaning and disinfecting purposes.

_Laser applications in dental traumatology

Dental traumas in children, sometimes complex and occasionally genuine emergencies, are frequent events in which laser-assisted therapy offers new treatment possibilities.[31, 51, 52] There is very little on this topic in the international literature and there are no well-coded guidelines for the use of lasers in this field, although the advantages offered by laser techniques, already described by others, make them useful options in the treatment of hard and soft dental tissue and exposed pulp.

Hard-tissue traumatic injuries

A crown fracture involves the enamel and dentin and, if complicated, exposes the pulp. As underlined in the section on hard-tissue applications, only lasers belonging to the Erbium family can guarantee good results in tooth excavation, reducing post-operative discomfort and sensitivity as well as ensuring a minimally invasive approach. These lasers can be used for the entire procedure: tooth margin preparation and finishing, coagulation of the exposed pulp, pulpotomy or pulpectomy (if needed)[42, 43], and soft-tissue procedures (Figs. 9–10). A crown fracture exposes a large number of dentinal tubules: Erbium lasers, when used with only a little or no water spray, have the capacity to fuse and seal the dentinal tubules (to depths of up to 4 m), thereby reducing the tissue's permeability to fluids and reducing dentinal hypersensitivity.[53] The other laser wavelengths (diode, Nd:YAG, CO_2) also exert this beneficial therapeutic action.[54]

Soft-tissue traumatic injuries

Indirect traumas are lesions to the supporting structures, in particular the alveolar bone, gums, ligaments, fraenum and lips. Lasers are currently an available option for the manipulation of dental soft tissue and, as reported in the literature cited above, they provide good coagulation (with an extremely clean working area), effective decontamination, photobiostimulation and antalgic effects. For these reasons, they are indicated for the treatment of traumatic soft-tissue injuries, eliminating the need for sutures, allowing good and rapid healing by second intention and reducing patient discomfort to a minimum.

In the authors' own experience, the use of laser systems improves the following procedures:

- _decontamination of the alveolus following a traumatic avulsion
- _treatment of periodontal defects following dental luxations or subluxations
- _microgingival surgery for the treatment of traumatic dental injuries
- _gingivectomy and gingivoplasty
- _surgical cutting (e.g. to remove tooth fragments).

CLINICAL IMPLICATIONS: all the advantages of laser applications (on hard and soft tissue and on exposed pulp tissue) make laser technology useful in this field.[56, 57, 58, 59, 60]

_Low-Level Laser Applications

Biostimulation and pain control (LLLT)

Low-level laser therapy (LLLT), or soft laser therapy, may provide a patient with a non-traumatic introduction to dentistry. There is a large body of literature on this topic, even though opinion on methods and doses still varies widely. Even though helium-neon lasers (632.8 nm) were the first lasers used for LLLT, they have now been replaced by semiconductor diode lasers (830 nm or 635 nm). These lasers exert a marked antalgic and biostimulating effect and speed up tissue repair processes. In short, they influence a large number of cell systems (fibroblasts, macrophages, lymphocytes, epithelial cells, endothelium), and can also have a series of benefits on the inflammatory mechanism, reducing the exudative phase and stimulating the healing process.

These are important clinical advantages, especially in youngsters with impaired defences (patients with insulin-dependent diabetes, a history of endocarditis, cardiac dysfunction or malformations, or who have undergone cardiac surgery or have prosthetic valves, oncological patients undergoing chemotherapy or radiation). In LLLT the power delivered is around 10/50 mW with an irradiation energy ranging from several millijoules to 1 or 2 Joules. After 1–3 days of biostimulation, it is already possible to observe a considerable reduction of swelling and an acceleration of the epithelisation and collagen deposition phase. LLLT has a number of applications in dentistry, both at soft-tissue level (biostimulation of lesions, aphthous lesions, stomatitis, herpetic lesions, mucosity, pulpotomy) and at hard-tissue level (acceleration of orthodontic movement); it also has important neural effects (analgesia, neural regeneration, reduction of temporo-mandibular pain, post-surgical pain, orthodontic pain).[61,62,63]

_Conclusions

The diverse parameters of use and different clinical and experimental results reported in the international literature tend to disorient the non-expert wishing to explore applications of laser technology in paediatric dentistry. The studies on soft-tissue applications are for the most part in line with each other, following similar protocols and recording reproducible results: this is due to the fact that the lasers involved (diode, Nd:YAG, CO_2) use a similar technology.

Instead, the studies on hard-tissue applications use the Erbium family of lasers, of which various types are available, differing not only in their wavelengths (2,780 and 2,940 nm), but also in their overall construction. The studies performed to date cannot be compared for various reasons: power density and fluence are only one aspect of the energy delivered to the target tissue. Above all, these lasers have different delivery systems: optical fibres (hollow fibres) and articulated arms transmit energy in substantially different ways and, as a result, the energy reaching the tissue can be very different from that selected on the display. Air/water spray flow and pressure, pulse length, and beam profile, are other parameters that affect the results of the laser-tissue interaction.

The success of minimally invasive laser therapy, in which it is crucial to apply the correct energy (the minimal effective level), is conditioned in part, by the operator's familiarity with laser technology. The operator must thus learn to act on the tissues with precision. Before using a contact-free instrument effectively, it is necessary to acquire the correct technique through a period of training with a more or less extended learning curve. Professionals also need to understand the physical characteristics of the different laser wavelengths and their interaction with biological tissues in order to ensure that they are used safely and that young patients reap the benefits of this technology.

Finally, a correct psychological approach to the patient also contributes considerably to the success of laser therapy, which is often seen by patients and their families as almost magical._

Editorial note: A list of references is available from the publisher.

Soft-Tissue lasers
KTP 532
Argon
Diode 810, 940, 980
Nd:YAG 1.064
CO_2 10.600
Hard- and Soft-Tissue lasers
Er,Cr:YSGG 2.780
Er:YAG 2.940
Low level lasers
Helium-Neon 635
Diode 810

Table I

carious detection
cavity preparation (enamel-dentin) and carious removal
hard and soft tissue traumatic
injuries
surgery
endodontics
orthodontics
biostimulation and pain relief

Table II

Table I_Classification of lasers.
Table II_Laser dentistry procedures.

_contact laser

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A concept of laser assisted treatment of periimplantitis

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_Periimplantitis is a disease with growing incidence which when untreated, leads to the loss of the implant. The ethological factors of periimplant infections are similar to periodontitis. What about the treatment? Classical treatment procedures in closed periimplant pockets have shown little success (Renvert, 2008). In open flap procedures the treatment of periimplantitis shows more promising data (Lindhe 2008). Although we gain better access to the implant surface in open procedures, we encounter the same limitations as in open periodontal therapy. Nevertheless, decontamination of the implant surface is much more complicated than decontamination a root surface. The sophisticated implant surface which is so promising at the moment of insertion will turn into a death trap in case of pocket formation. The instruments used in periodontal treatment are much too big to get rid of the bacteria on the implant surface. The classic treatment procedures show very strict limitations and their instruments are not useful for adequate decontamination of the implant surface.

What about the concept of the classical periodontal treatment? This concept integrates the cleaning of the root surface by means of mechanical instruments, the plaque control by the patient and the supportive periodontal therapy on a long term basis. Several studies have shown that this concept works very well in periodontal disease. This concept could theoretically work in the treatment of periimplantitis since the diseases share similar etiological factors; however, we have to use different and smaller instruments for decontamination. The instrument size should be equal to the size of the bacteria, since the goal is to decontaminate the implant surface and to create a biological acceptable surface.

_The concept of laser supported treatment of Periimplantitis

The lasers used in dentistry (Diode, CO_2 and Erbium lasers)have wave lengths which are similar in the size of human cells and that of bacteria. Using their characteristic abilities of absorption, lasers are able to destroy cells. Lasers used in surgery leave behind a sterile wound surface. These lasers are also able to kill bacteria, viruses and fungi. The tissues involved in the periimplant infection contain water, pigments and hydroxylapatite. In order to achieve adequate surface decontamination and good treatment outcome, the laser wave length should match the absorption potential of water, pigments and hydroxylapatite. Understanding the characteristics of absorption, we know that CO_2 and the Erbium lasers absorb highly in water, the diode laser in pigments and the Erbium in addition in hydroxylapatite. The three laser systems correspond to the necessity for new smaller instruments in order to decontaminate the implant surface.

The goals of the treatment of periimplantitis are:

- _Elimination of the periimplant inflammation
- _Stabilization of the bony attachment (levels of osseointegration).

In order to achieve these goals; the implant surface should be free of any foreign cells and toxins. Consequently, the tissue inflammation resolves and the host cells may contact and adhere to the surface again. Therefore what we really need is a decontamination and detoxification of the implant surface.

Classical cleaning methods require the use of curettes, ultrasonic devices or prophy jets however, we already have seen that these methods have their limitations (Renvert, Lindhe 2008). Studies using Diode, CO_2 or Erbium lasers have shown their efficacy in vitro as well as *in vivo*. Decontamination of implant and tooth surfaces have been shown by Coffelt (1997), Kato (1998) and Hauser (2010). Romanos (2006) and Deppe (2001) reported successful clinical treatment of periimplantitis after CO_2 laser decontamination. Implant surfaces with calculus deposits can also be treated with Erbium laser exhibiting better absorption in hydroxylapatite and water (Schwarz 2003, 2006, Sculean 2005).

Literature shows that the use of an adequate laser wave length may solve our problem of creating a surface which is accepted by the host cells. In addition the wave length of the Diode laser has an important biostimulative effects which supports the host actions on the long way to regeneration.

Based upon the classical systematic treatment plan, the laser actions support the decontamination, detoxification and biostimulation.

The classical concept of the periodontal treatment procedures is performed in four established phases:
_Hygiene phase (Initial phase)
_Evaluation
_Surgical phase
_Supportive phase (Maintenance phase).

With the advantage of absorption characteristics of lasers, using the appropriate laser and the correct dosage we know now that it is possible to treat infection. The cases which are presented in this paper were treated following this concept using the lasers in the four different treatment phases (Graph 1).

As periimplantitis often occurs with untreated periodontal disease, a full mouth periodontal treatment is essential before (inserting implants) or attempting to successfully treat periimplant infections.

During the *Hygiene phase* (nonsurgical phase) the patient is instructed in adequate plaque control around the teeth and the implants. Plaque, supra and subgingival calculus are removed from the teeth with sharp curettes according to periodontal treatment protocols. The implant surfaces should be debrided under local anesthesia with carbon curettes and the inflamed periimplant tissue is curetted with sharp curettes. Finally, the pockets around the teeth and implants are rinsed with a sterile saline solution.

The first laser treatment is performed with a diode laser (810 nm, 2.5 W, 50 Hz, 3 x 30 seconds). The laser decontamination procedure occurs by systematically moving the laser tip along the surface. The laser tip should be checked from time to time for coagulation in order to prevent hotspots in the gingival tissue. This procedure is performed 3 x 30 seconds in which the laser is alternately activated 2–3 seconds followed by 2–3 seconds of standby. Heat development should be avoided. Because of the high absorption of the diode laser in pigments, the effect is destruction of pigmented cells in close proximity and biostimulation of host cells in the surrounding tissue. The flexibility of the fiber allows for good access to the pockets. As opposed to diode laser, CO_2 or Erbium lasers are not useful in closed pockets, especially on implant surfaces with threads. The Diode decontamination is repeated twice weekly.

If there is no significant improvement after the third treatment (at week 2) a surgical intervention is planned (surgical phase). If clinical improvement can be noted, the patient is called back in 6–8 weeks for evaluation. The goal of the initial phase is the reduction of as much tissue inflammation as possible. The benefit of laser assisted debridement compared to a classical approach is the decontamination and the biostimulation.

An *evaluation* gives one the opportunity to record clinical parameters and oral hygiene status after initial treatment and to compare the periodontal situation with baseline. The patient can go into the supporting or maintenance phase when signs of improvement and reduction of inflammation can be noted. In case of persisting bleeding and pus formation a surgical laser assisted procedure should be planned.

Even if many periimplant lesions require surgical interventions it is important to start the treatment with the initial or hygiene phase in order to condition the tissues and reduce the inflammation around implants and teeth. As we know from peri-

Graph 1_Protocol of the laser assisted periimplantitis treatment.

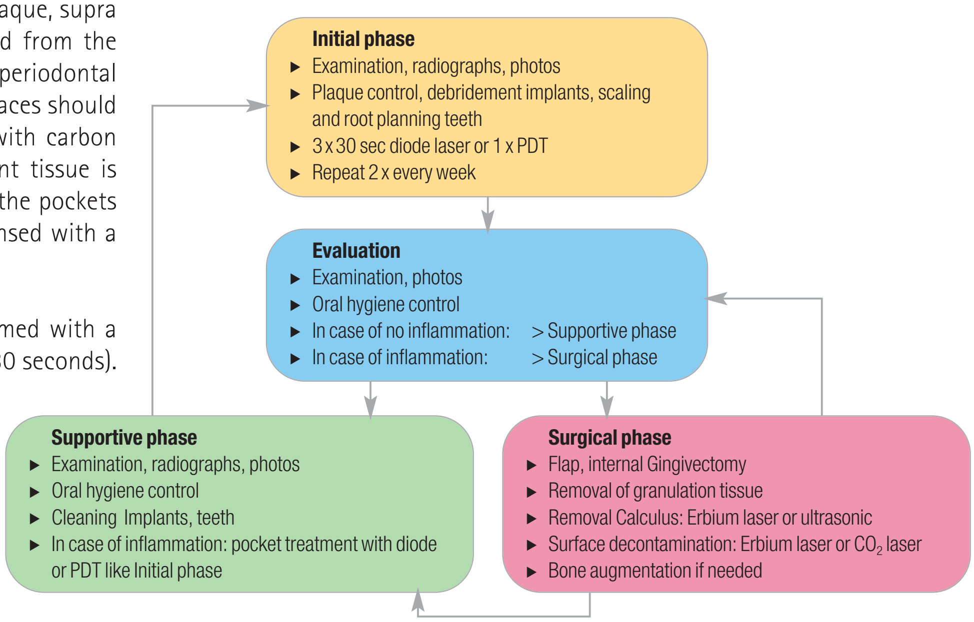


Fig. 1


Fig. 2


Fig. 3


Fig. 4

odontal treatment, it is possible to eliminate periodontal inflammation during the initial phase as long as we are able to remove plaque and calculus from the tooth surfaces. Accordingly, mucositis and moderate periimplantitis infection can be treated with laser assistance successfully using nonsurgical methods. Some cases treated non-surgically will be shown in the casuistic of this article.

The goal of the *supportive phase* is to gain full access to the implant surface for debridement, with the intent to remove calculus and to perform laser decontamination. At the same time, alveolar bone defects can be augmented when necessary. Surgical intervention is indicated in cases where the conditions around the implant failed to improve after initial phase, but plaque control is adequate, and there is a need to keep the contaminated implant.

It is helpful to remove the supra reconstruction of the implant in order to gain good access and keep as much soft tissue as possible to cover the area after surgery. The first incision is an internal gingivectomy, directed to the bony ridge, which separates the periimplant tissue from the mucosal flap. The flap is then raised to the level of the bony ridge gaining access to the entire implant surface. The granulation tissue around the implant is carefully removed and the implant surface is inspected for calculus deposits. The bone defectis then exposed.

If calculus deposits are found, the implant surface is then carefully cleaned using an ultrasonic device at low settings. The 2 cases presented in this article were treated using the above procedure. Alternatively calculus removal and decontamination can be achieved with an Erbium laser. After checking the implant surfaces for residual deposits decontamination with the CO_2 laser is performed. The tip of the laser is systematically guided over the surface without contact. The settings are 2.5 W continuous wave (cw), (Deppe 2001), 10 sec. The area is rinsed with sterile saline solution and laser treatment is continued if needed. Avoid heating the implant. Bone augmentation is performed when necessary.

The goal of the *supportive phase* or recall is to maintain the treatment results long term. Regular examination of the soft tissues, plaque control, radiographs and minor local treatmentsare performed based upon the recall interval. If there is recurrence of minor inflammation around an implant the treatment with diode laser or antibacterial PDT is repeated. Graph 1 shows the protocol of the laser assisted periimplantitis treatment.

Table I_Periimplantitis cases, bleeding on probing (BoP), pus, probing depth (PD), baseline and 2-4 years. T: Time (years) after treatment. AB: Antibiotics. diode laser and CO_2 laser were used as shown in Table 1.

Case	BoP/Pus	PD mm	Diode	CO_2	AB	BoP/Pus	PD mm	T years
1. I 24	+	10	+	-	+	-	4	2
2. I 45	+	9	+	-	-	-	3	2
3. I 24, 25, 26	+	10–12	+	-	-	-	max. 6	2
4. I 32,42	+	10	+	+	-	-	3	2
5. I 11	+	11	+	+	+	-	3	4

Table I

_Casuistic

The following five clinical cases of periimplantitis were treated by the author following the presented treatment concept. In the initial phase the diode laser WhiteStar, 2.5 W (Orcos Medical AG, Switzerland) was used for decontamination and biostimulation. In both cases, which subsequently required open flap procedures (surgical phase), decontamination was performed with the CO_2 laser SpectraDenta with 2.5 W cw (Orcos Medical AG, Switzerland). Calculus removal in case 4 was performed with an ultrasonic device. The treatment in the supportive phase was performed with antibacterial photodynamic therapy (PDT) or the diode laser as needed. The results are shown in Table 1.

Case 1 *(Figs. 1 & 2)*
Periimplantitis Implant 24: Treatment in 3 sessions, each with 3 x 30 sec using a diode laser, Flagyl 3 x 500 mg x 7, Evaluation, Recall. The radiographs show the situation at baseline and two years after therapy. No flap procedure was performed.

Case 2 *(Figs. 3 & 4)*
Periimplantitis Implant 45 and severe chronic Periodontitis: Treatment in 3 sessions each 3 x 30 sec using a diode laser, scaling root planning of the teeth, Evaluation, Recall. No Antibiotics were administered. The radiographs show the situation at baseline and two years after therapy. No flap procedure was performed.

Case 3 *(Figs. 5 & 6)*
Periimplantitis Implant 24, 25, 26 and severe chronic Periodontitis: Treatment in 3 sessions each 3 x 30 sec using a diode laser, scaling root planning of all teeth, Evaluation, Recall. No Antibiotics were administered. The radiographs show the situation at baseline and two years after therapy. No flap procedure was performed.

Case 4 *(Figs. 7–9)*
Periimplantitis Implants 32, 42: Treatment in 3 sessions each 3 x 30 sec using a diode laser; at evaluation no success, therefore a surgical flap was raised, ultrasonic were used for calculus removal, decontamination with CO_2 laser. No Antibiotics were administered. The clinical situation at baseline, intraoperative and two years post treatment.

Case 5 *(Figs. 10–12)*
Periimplantitis Implant 11: Treatment in 3 sessions each 3 x 30 sec using a diode laser, a surgical flap was raised, decontamination was performed with a CO_2 laser, as well as bone augmentation with BioOss and BioGide. Antibiotics were administered. The illustrations show the radiographic situation at baseline, intra operative and four years after therapy.

_Discussion

The five cases presented were all treated following the laser assisted treatment protocol which was described above. The diode laser was used for the decontamination and biostimulation in the pockets (Initial phase) and the CO_2 laser was used in the surgical phase where the implant surfaces was nicely accessible. Much effort was put on oral hygiene instruction and plaque control around teeth and implants. All cases were treated successfully and showed stable conditions over two years. The lesions before treatment were advanced however, at least 50 % of the bone was still present around the implants. All patients were healthy and non-smokers. Antibiotics were administered in two cases; one of them because a simultaneous bone grafting procedure was performed. The periimplant infection had probablyarisen from an untreated periodontitis or neglected maintenance care.

Cases 1–3 were treated primarily in the initial phase. The clinical conditions showed immediate improvement within the first two weeks after Diode laser application. The BoP was reduced, pus exudation ceased and the probing depths were reduced after two months. Thus no surgical phase was needed and patients went directly to the maintenance phase. The radiographs showed bone regeneration almost to the original level after two years. Accordingly, shallow probing depths were maintained and the bone attachment was stable. Since the wave length of the used diode laser (810 nm) has biostimulative properties, there is always an additional aspect of the energy which stimulates the proliferation of bone and soft tissue around the implant. Thus the diode laser is able to work on both sides of the lesion—on one side biofilm management and on the other side host management. In this manner, this wave length is beneficial to the tis-

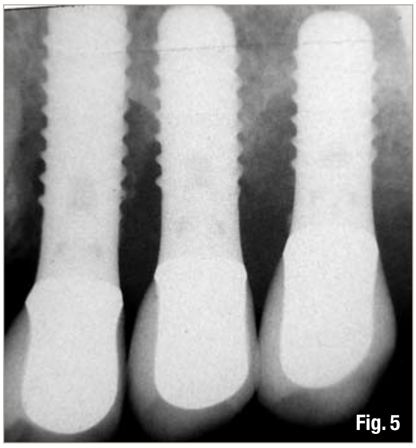
Fig. 5

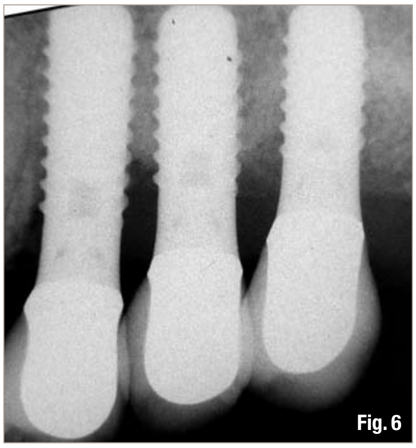
Fig. 6


Fig. 7

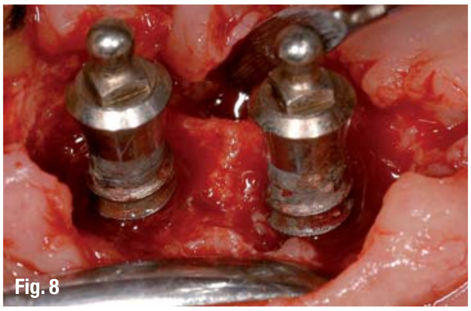
Fig. 8


Fig. 9

sue in order to bring the balance between tissue resorption and apposition to the right side. Studies have shown (Lindhe 2008) that periimplant lesions can only be treated by flap surgery. This may be true in the treatment protocol without laser. However, cases 1–3 show that nonsurgical treatments with the diode laser around implants are beneficial in that it actually kills bacteria below the host's critical mass and in turn stimulates cell proliferation. This may be a reasonable explanation for the nice bone regeneration seen in cases 1 to 3. However, keep in mind, this regeneration could only take place because the soft tissue was not opened and because the decalcified bony matrix around the implant was not removed. The applied laser energy regulated the balance in the tissue. The use of a Diode laser in the decontamination modus (no cutting) makes it possible to have additional beneficial effects than the classical treatment. Thus, it is always recommended to start the laser assisted treatment with the initial phase.

Treatment with the diode laser is not sufficient in all periimplantitis cases. In these cases there may be calculus or other deposits on the implant surface which cannot be removed performing closed therapy. If the lesion is advanced or the bony lesions should be augmented for esthetical reasons, then surgery is indicated. But even then it is of up most importance to complete first initial phase.

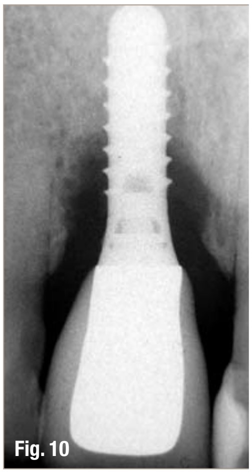
Fig. 10


Fig. 11

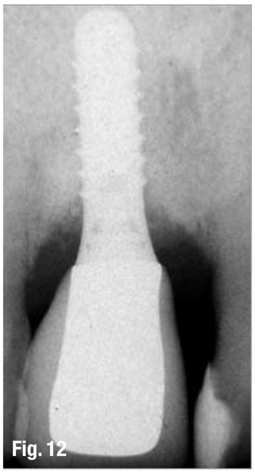
Fig. 12

Cases 4 and 5 were treated with additional flap surgery. Case 4 showed no clinical improvement after the initial phase and was further treated surgically. The flap opening revealed large calculus deposits which were then removed with ultrasonic followed by decontamination with a CO_2 laser. This treatment made it possible to beam the energy systematically in a non-contact modus to the implant surface. Case 5 needed bone augmentation for esthetical reasons. There was no calculus found on the implant surface and the decontamination was performed with a CO_2 laser. A recent *in vitro* study (Hauser 2010) showed that a SLA implant surface can be decontaminated with a CO_2 Laser with the settings of (2.5 W, cw) as used in this protocol. In the cases that required flap surgery the periimplant tissue received biostimulation from a low level laser (MED-700, 810 nm, 330 mW, Orcos medical AG, Switzerland) immediately after flap closure and one week after surgery.

It can be assumed that not only the bacterial load was reduced but also toxins were denaturized on the implant surface by the laser because all cases showed loss of the inflammation and proliferation of the tissue around the implant. This means that bacteria and toxin are well controlled through laser energy application. Moreover, the use of the laser rendered the implant surface biologically acceptable for host cells again. Consequentially proliferation of bone and soft tissue facilitated closure of the lesion. With this development, an important step in the treatment of periimplantitis is made.

As we know from the classical periodontal treatment the lesions should be treated as early as possible. This is even more important in regards to periimplant lesions because they tend to progress faster. The decontamination whichis a limitation in the classical treatment on tooth and implant surfaces seems to be possible with the appropriate use of laser energy, and this can be successfully performed without opening a flap. This aspect makes it worthwhile to continue to pursue the idea of closed treatment of periimplant lesions. However, more(RCT) studies are needed to evaluate this protocol.

_Summary

Epidemiologic Studies show an increase in Periimplantitis. Without treatment implants are lost. As we know from the periodontal treatment protocol the surface of the implant must be decontaminated. What is difficult to perform on tooth surface is almost impossible on implant surface without the use of lasers. The mechanical methods for decontamination fail and clinical studies show that implant surfaces can be decontaminated with laser energy. This paper presents a treatment protocol which integrates laser energy for decontamination and biostimulation in the periodontal treatment concept. This concept puts more emphasis on the closed Initial phase where the diode laser is used for decontamination and biostimulation in contrast to studies which profess that periimplantitis always needs surgical interventions. Decontamination and biostimulation would be not possible using conventional methods.

The treatment begins with the initial phase including plaque control, debridement and decontamination of the implant surface, biostimulation with the diode laser (WhiteStar, Orcos Medical AG, Switzerland) and scaling and root planning as needed. Three cases with advanced periimplant lesions are presented with successful initial treatment. At time of evaluation, no pus, minor bleeding and pocket reduction was observed. After two years even bone regeneration was obvious. A surgical flap procedure was performed in order to gain access to the implant surface in cases where inflammation was still present at evaluation. The CO_2 laser (SpectraDenta, Orcos Medical AG, Switzerland) was used to decontaminate the implant surface. All treated cases showed no inflammation and stabilization of the bone attachment over two to four years. Even bone regeneration in non-surgical procedures was observed. The goal of the treatment which is to create a biological acceptable implant surface seems to be fulfilled with the use of appropriate laser energy.

Editorial note: A list of references is available from the publisher.

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Esthetic rehabilitation of anterior hypoplastic tooth using Er:YAG laser

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_**Enamel hypoplasia (EH)** is a defect in tooth enamel that results in less quantity of enamel than normal. The defect can be a small pit or can be widespread that the entire tooth is misshaped with affected mechanical properties.[4] EH can occur on single or multiple teeth.[6] It can appear white, yellow or brownish in color with a rough or pitted surface.[6, 8] In some cases, the quality of the enamel is affected as well as the quantity.[8] Environmental and genetic factors that interfere with tooth formation are thought to be responsible for EH. This includes trauma to the teeth, infections during pregnancy or infancy, poor pre-natal and post-natal nutrition, hypoxia, exposure to toxic chemicals and a variety of hereditary disorders.[6]

Treatment of teeth with enamel hypoplasia must be determined on an individual basis. The enamel hypoplasia causes esthetic problems on anterior teeth resulting to psychological defects in young patients. Treatment for anterior teeth includes the following options:

1st: For sensitive teeth with no wear, applying of desensitizing agent (such as potassium nitrate) is needed.

2nd: If there are esthetic concerns, direct or indirect composite restorations, porcelain veneers or porcelain crowns may be bonded to the affected tooth after chemical etching.[2, 3, 10]

Acid etching is widely used in clinical dentistry to facilitate the mechanical retention of resin-based materials to teeth, in particular enamel surfaces.[2, 3] For chemical etching the 37 % phosphoric acid solution was the most effective, having produced the most consistent pattern of the enamel.[11] Enamel etching has a direct influence on the retention of the composite materials in adhesive dentistry. For etching it is possible to use phosphoric acid or other alternative methods such as air polishing, crystal growth, microretention with pressuring pumice and laser etching.[1, 5] Enamel etch by the acid can be complicated by the removal of surface, variability of penetration depth, and strong washing and drying affecting the bond strength.[7]

_Etching of hypoplastic enamel

The successful bonding of resins to teeth may be very dependent on the response of the enamel to acid etching.[9] Due to abnormal enamel the standard etching time and/or concentration of acid may not be appropriate for abnormal enamel.[9] Studies have shown that the hypomineralized enamel did not exhibit the typical etching pattern seen in control enamel.[7, 9] Upon etching, there may be a uniform removal of hypomineralized enamel, rather than the differential etching patterns seen in the unaffected control enamel.[7, 9] This etching of a less


Fig. 1


Fig. 2a


Fig. 2b

Fig. 1_Clinical appearance of the affected 22 tooth.

Figs. 2 a & b_Laser preparation and etching with Er:YAG laser LiteTouch (Syneron, Israel) by "Hard tissue mode" (400 mJ/20 Hz; 8.00 W). View of air dried laser treated surface with "frosted" appearance.

Fig. 2 c & d_Adhesive agent application and final restoration view.

organized enamel structure may result in a pattern that is not the classic etched pattern, which may have a detrimental effect on bonding between the restorative/adhesive materials and the affected enamel.[7] For that reason the dentist would like to find an alternative procedure for preparing the hypoplastic enamel. One of the effective methods may be to etch the hypoplastic enamel with Er:YAG lasers.

LiteTouch Er:YAG laser (Syneron, Israel) incorporates special software, which allows for the broadest range of energy and frequency settings. The unique LiteTouch optical system incorporated in the ergonomic handpiece prevents loss of energy and along with the precision control over pulse duration, pulse energy and repetition rate optimize, allows for a wide range of hard tissues procedures. Another characteristic of this laser is the wavelength (2,940 nm) which is absorbed mostly by the water and also sapphire tips, showing stability in providing focused energy of laser radiation. The mechanism of LiteTouch action is based on interaction between laser radiation and hard tissues incorporated water that results in microexplosions. It is believed that this process is the mechanism of ablating particles from dental tissues without overheating, and without smear layer formation.[12] This combination allows precise microinvasive cavity preparation with minimal heating and optimal rate of radiation absorption by the hydroxylapatite incorporated water.

The program "hard tissue mode" removes enamel, dentin and dental caries effectively and without visible carbonization or disturbance of the dental microstructure. Evaluated under SEM the dental tissues treated with LiteTouch Er:YAG laser showed rough and irregular surface without presence of smear layer.[12] Enamel shows preserved prismatic structure, but also strong retentions due to microexplosions on its surface.[12] The observed changes correspond to changes in hard dental tissues reported by other authors in previous studies on Er:YAG lasers.[1, 5] These results suggested Er:YAG lasers to be effective in treatment of hypoplastic enamel in order to avoid acid etching.

_Case Report

16-years-old female patient was referred to the Clinic of Operative Dentistry and Endodontic, Faculty of Dental Medicine, Medical University, Plovdiv for examination. The patient had left lateral maxillary incisor with severely impaired esthetics and expressed lowered self-confidence. The Maxillary lateral incisors were asymmetric and discolored (Fig. 1).

The patient's history revealed trauma between the ages of 3 to 4. Therefore, the etiology of the existing pathology was associated with traumatic injury during enamel formation i.e. Turner's dysplasia. The patient was informed about the etiology of her complaint and treatment options were evaluated. The patient preferred a minimally invasive and esthetic treatment modality.

The treating team decided to restore the affected anterior tooth with the direct laminate technique using an adhesive bonding system and laser preparation and etching prior to restoration. Hypoplastic enamel and darkened dentin that may negatively affect the final esthetic appearance of the rehabilitation were removed, and suitable composite resin color was determined using the shade guides.

Preparation and etching was performed with LiteTouch Er:YAG laser (Syneron, Israel) for 10 seconds without anesthesia by "Hard tissue mode" (400 mJ/20 Hz; 8 W) (Figs. 2 a & b). The tooth was dried with air and primer (3M Scotchbond Multi-Purpose Primer; 3M ESPE, St. Paul, USA) was applied on the surfaces and spread-dried with an air spray for 20 seconds. Bonding agent (3M Scotchbond Multi-Purpose Adhesive; 3M ESPE, St. Paul, USA) was applied and polymerized with a light source for 10 seconds and increments of hybrid composite resin (Filtek Supreme; Body and Enamel, 3M ESPE, St. Paul, USA) were placed and light-polymerized for 40 seconds (Figs. 2 c & d). Finishing and polishing was accomplished with ultrafine diamond burs and composite rubber polishing burs. The final result corresponded to patient's esthetic expectations and no pain sensations during laser procedure was reported.

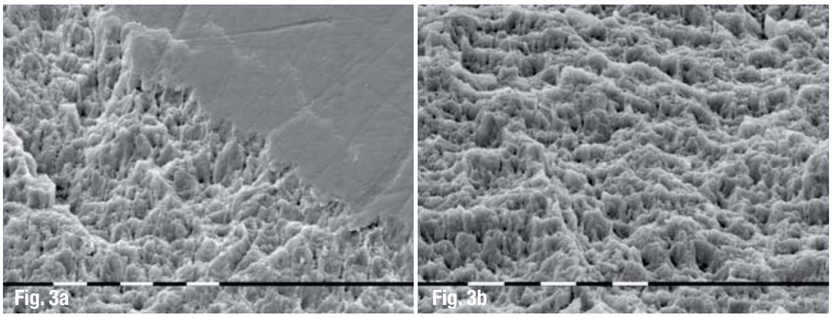

Fig. 3 a & b _The surface changes seen in the Er:YAG laser-etched enamel are non-uniform, but they result in a rough and porous surface (Magnification x 3,000). (Author's SEM photos archives).

_Discussion

The enamel hypoplasia causes esthetic problems on anterior teeth resulting to psychologic affect in young patients.[10] This makes the problem urgent from psycho-social point of view. A great number of treatment modalities are known for the treatment of anterior teeth affected by the enamel hypoplasia.[2, 3, 10] Tooth bleaching and microabrasion are non-invasive steps in achieving acceptable results in the removal of enamel stains and minor surface defects. When there is loss of tooth structure associated with defects, the use of composite resins produces excellent esthetic results and stable clinical longevity.

The traditional method for restoring hypoplastic areas is to prepare cavity and insert a restoration. Unfortunately, these techniques require cavity preparation with rotary instruments and additional acid etching procedures before placement. In this case report, the efficacy of a shortened method to restore hypoplastic tooth by using laser preparation and laser etching was presented.

This method would be particularly beneficial for patients with different enamel defects. Advantages of laser preparation and etching is the simplicity of use and short treatment time required to obtain retentive surfaces, without acid etching. This is important, because etching pattern of defective enamel is vague and has no resemblance to that of normal enamel.[7, 9] This could be due to difference in structure and composition of defective enamel. Seow W.K. and, Amaratunge[9] suggested that variation of etching patterns could be due to differences in orientation of crystallites relative to the direction of attack together with differences in chemical composition between central and peripheral parts of enamel prisms. This explanation may highlight the variation in enamel structure that can occur not only between normal and defective enamel but also from tooth to tooth, or site to site, on a single tooth surface.[11] Also, variation of etching patterns for defective enamel could be a result of different etiology of the enamel defects in different teeth which is unknown.[9] This variations may resulted in problems in bond strength.[7]

Variation of bond strengths between normal and defective enamel could be due to difference in etching patterns.[7] In some cases, it could be due to bonding to exposed dentin rather than bonding to full enamel layer. The coefficient of variation of bond strength reported data are very high—47 % and 59 %.[7] The high coefficient of variation suggests that the clinical classification of normal enamel does not predict in any specific manner that the composite will adhere better than when the enamel is classed as defective.

Different studies summarize the results of the interaction of Er:YAG laser radiation with the hard dental tissues.[1, 5, 12] It has been demonstrated that the higher energy of Er:YAG laser radiation might etch very well the enamel.[1, 12] With proper cooling, the treated areas are clean without damage of the adjacent hard substances and without debris.[12] The Er:YAG laser produces minimal thermal damage to the pulp and surrounding tissues when used with water spray. Local anesthesia can be eliminated in most cases, which provides a more comfortable procedure for the patient. Surfaces prepared with Er:YAG laser LiteTouch are characterized by a rough and irregular topography without presence of smear layer (Figs. 3 a & b). Laser ablation procedures change enamel and the surfaces appeared strong retentive and suitable for adhesive restorations.

_Conclusion

Composite laminate technique should be considered the primary treatment option for enamel hypoplasia cases in an urgent attempt to improve the life quality of this group of patients. The Er:YAG laser preparation and etching at same time is easy to apply and allow to avoid any risks connected with acid etching. The time of preparation is acceptable and admitting that the laser preparation is painless, from the point of view of the patient it is beneficial. The initial results of this case-report have confirmed laser preparation to be a good alternative of acid etching for the esthetic rehabilitation of anterior teeth affected by enamel hypoplasia._

Editorial note: A list of references is available from the publisher.

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Laser-assisted teeth bleaching

Author_Dr Dimitris Strakas, Greece

_It is more than evident that in our every day practice, patients are asking for a whiter and brighter smile. Advertisements, movies, television shows and all kinds of media services, are centralized on the totally white teeth which seem to project ones health, well-being and beauty. As a profession we have learned that we have to deal not only with pain itself but also with the esthetics of our patients. For that reason many materials and techniques have evolved giving us the opportunity to implement it in our offices. Composite veneers, porcelain laminates all-porcelain crowns and teeth bleaching are some of them. Today the dental clinicians have to be capable and willing to offer esthetic interventions to their patients in order to be considered modern and up-to-date.

If we want to give a definition of teeth bleaching we could say that it is the process that a dentist alters the color of the patient's teeth so as to appear whiter. This is made possible with the use of different oxidizing bleaching agents and different techniques in order to eliminate teeth discoloration. The main oxidizing agents that are used today are hydrogen peroxide in concentrations of 30–35 % and carbamide peroxide in concentrations of 10–22 %.

The decomposition of those agents ends up to the production of perhydroxyl free radical (-2) with high bleaching capability. It is known that by heating hydroxyl or carbamide peroxide its decomposition rate is accelerated. By increasing the bleaching agent's temperature by 10 °C, the speed of the decomposition is doubled. At this point more hydroperoxyl free radicals are released and then the free radicals penetrate the porosities in the rod-like crystal structure of enamel and oxidize the interprismatic stain deposits. Many different light sources both coherent and incoherent have been used for tooth bleaching (arc/plasma lamps, halogen lamps, LED's, lasers).

The advantages of the use of laser in teeth bleaching can be concentrated on the speed of the procedure, the comfort of the patient and the minimal to none after treatment discomfort (pain kicks) that are often encountered in light activated teeth bleaching with incoherent light sources (e.g. plasma lamps). In a pulsed mode operated laser these advantages are more apparent due to the fact that packs of energy are offered to the bleaching agent in a very short time period, thus giving enough time for heat dissipation to the tissue.

_Clinical procedure

It is essential that the steps of the procedure are followed carefully in order to achieve the best possible result and maintain it as long as possible. In the following case report a young woman aged 32 came to our office for laser-assisted teeth bleaching.

After obtaining the medical and dental anamnesis of the patient we are making clinical and radiographic examination in order to find and address any therapeutical (caries, endodontic treatments, periodontal) problems. The patient must be informed that composites and ceramic crowns (if present) will not be


Fig. 1


Fig. 2

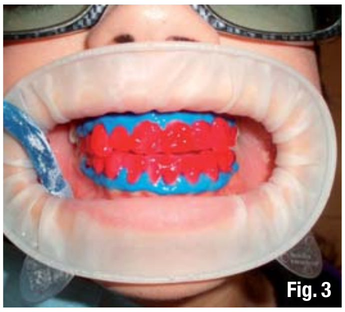
Fig. 3


Fig. 4


Fig. 5

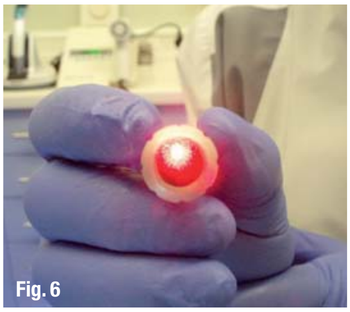
Fig. 6


Fig. 7

bleached and that after bleaching might need replacement. Also patients should know in advance that the result of the procedure is not permanent. It is dependant to the age of the patient and the use of tobacco and extrinsic staining by deposition of tannins found in coffee, red wine, tea and cola beverages. The average duration expectancy is 3–4 years for non-smokers. Discussing and consulting the patient on the desired bleaching results will help you to determine the best treatment plan for each individual situation.

The first session will be a prophylaxis session. Teeth must be carefully cleaned from plaque, calculus and extrinsic staining (Fig. 1). On the following session the laser-assisted bleaching can begin.

At first we have to evaluate the initial color of the teeth. In our case patient's initial color was evaluated as A3 in the VITA Classical Shade Guide (Fig. 2). Safety goggles must be worn by the patient all personnel in the laser working area in advance. We apply a lip protection cream and then we isolate the working area with a cheek and lip retractor. After drying teeth and gums with gentle air stream we apply the gingival barrier carefully.

It is time to apply the bleaching agent in a layer of 1–2 mm on each tooth (Fig. 3). We select the appropriate power settings for our laser and we activate the bleaching agent for three intervals of 10 seconds on each tooth (Fig. 4). After the end of the procedure we leave the activated bleaching gel for 8–10 minutes. Then we use dry suction to remove it. We can repeat the same process two or three times on the same appointment until we achieve the desired results and evaluate the final color. In our patient after three repetitions of the process on the same appointment the color of the teeth moved to B1 according to VITA Classical Shade Guide (Fig. 5).

_Discussion

In our clinic we are using an Nd:YAG laser and a red colored bleaching agent provided by Fotona with a concentration of 35 % H_2O_2. The special bleaching handpiece has a spot size of 8 mm and the fiber is a 320 µm one. The power settings that are used: Power 8 W, Pulse duration 120 µm, Repetition rate 60 Hz (Fig. 6).

The advantages of the system are obvious. The wavelength of 1,064 nm has a high absorption coefficient on pigments, and it is absorbed by the colorants of the bleaching gel (usually carotene) and the added small silica particles in the nm or lower µm-scale which are also increasing the absorption of red and infrared light. Its pulsed operation offers packs of high energy on the gel. Consequently the bleaching gel is heated rapidly, increasing rapidly the decomposition rate of hydrogen peroxide to perhydroxyl free radical.

Different wavelengths can be used in laser-assisted teeth bleaching. Apart from Nd:YAG, diodes (940 nm, 980 nm) which are also in the near infrared spectrum can be used and also double-frequenced Nd:YAG lasers (532 nm). Recently there have been proofs that Er:YAG lasers can be used for laser bleaching using non-ablative power settings. The clinician has to select the appropriate bleaching gel that absorbs in the best way the laser energy applied in order not to harm the pulp by transmission of the non-absorbed energy.

_Summary

Lasers can be very useful as an activation medium of the teeth bleaching process. The whole procedure is faster, the results are excellent and the patient feels comfortable throughout the appointment. The future aspects are also encouraging and we can expect better designed handpieces for bleaching and wavelength-special bleaching agents. Taking great caution in the different steps of the procedure, selecting the right wavelength and the proper parameters, is essential for the clinician in order to achieve the best results in profit of his/hers patients (Fig. 7)._

_contact laser

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_**Laser Dentistry in Hong Kong** and China is becoming more and more popular, especially because several Chinese companies are producing and selling very cheap diode lasers. Dentists are using now these diode lasers in their clinics, but unfortunately the companies do not train them. Education using laser therapy is a must and therefore we offer in Hong Kong and China laser courses and workshops, certified by AALZ and RWTH Aachen University.

During the year 2010, we have even organized two Laser Safety Officer Certification Courses, one in Hong Kong and the other one in Macau. Although there are no official regulations or guidelines on the usage of lasers of different energy levels in dentistry in China and Hong Kong, more than 20 participants joined the programs, aiming at acquiring the highest standards of knowledge and principles on the safe use of lasers provided by AALZ.

In 2011 AALZ HK and China will organize LSO courses on a regular basis. Also, different training courses in the use of lasers in dentistry will be provided in several parts of China and Hong Kong._

_information laser

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The expert defines laser dentistry 2011

An interview with Prof Dr Norbert Gutknecht

_In the meantime another five years have elapsed since the book „Evidence Based Laser Dentistry" was published in 2006. A great deal has also happened in laser dentistry in this period. Prof Norbert Gutknecht, President of Deutsche Gesellschaft für Laserzahnheilkunde (DGL—German Society for Laser Dentistry), Executive Director of World Federation for Laser Dentistry (WFLD) and editor of the book „Proceedings of the 1st International Workshop of Evidence Based Dentistry on Lasers in Dentistry", gives answers to the most important questions on laser-assisted therapy in the various fields of treatment in the following interview.

_The criteria to select a laser are important for the newcomer. For which indications is the use of the laser particularly recommendable and which significant advantages result from this for the dentist and his/her patient?

Prof Gutknecht: There is no such thing as THE laser and THE field of application but there are different wavelengths with different fields of application. A clear advantage can be achieved for the dentist and the patient in the respective special fields of application with regard to the wavelength.

_Are the large devices superior to the compact laser systems in terms of efficiency and range of applications?

Prof Gutknecht: "Large" laser devices, i.e. in this case in particular erbium lasers or combination lasers, offer a broad field of applications. The erbium wavelength hereby provides above all the possibility to treat hard tissue. This is the classic "laser drill" the patient imagines when thinking of a laser. These indications are not covered by any other commercially available wavelength.

_Can we say: an erbium laser is an erbium laser? And what about the other wavelengths, for example diode lasers, Nd:YAG lasers, etc? Where are the relevant differences?

Prof Gutknecht: Of course, we cannot say, for example "Er:YAG is an Er:YAG". That would be like saying "a car is a car". This also applies to diode and Nd:YAG lasers, the same applies here that one motorbike is not the same as the next motorbike. The relevant differences lie in the technical configuration of the laser systems.

_Different criteria are relevant when purchasing a laser system. Which are the most important for you and what should we bear in mind when purchasing the system?

Prof Gutknecht: If you wish to choose a laser system, you have to have decided beforehand in which indication field this laser is to be used. If this question has been clarified, you should then compare along with the technical data also the quality, maintenance service and training possibilities for the respective system. As well as pre-programmed protocols, which are good for the beginner, a modern laser device should also have a variable adjustment of its laser parameters in order to give the well trained dentist the possibility to be able to adapt his/her treatment to the needs of his/her respective patients. The dentist can obtain expert advice through Deutsche Gesellschaft für Laserzahnheilkunde (DGL) or from our institute as well—Aachen Dental Laser Center (AALZ).

_Which wavelengths would you choose for starting up in laser dentistry if you have a limited budget?

Prof Gutknecht: To start off, there is the diode laser if the amount you are able to invest plays an essential role. In the meantime, these compact devices can be purchased at reasonable prices and offer a solid, if not comprehensive treatment spectrum. Therefore it is appropriate to purchase other wavelengths in the practice at a later date in order to further extend the treatment spectrum for the joint use of patient and dentist.

_In the meantime there are three wavelengths available in the field of diode lasers. In your opinion is there a wavelength here that can be applied most effectively for use in daily practice?

Prof Gutknecht: The 810 nm diode laser has the greatest all-round features and has been scientifically researched to the greatest extent.

_Are the systems working with the help of a battery safe in terms of energy performance and efficiency during the treatment?

Prof Gutknecht: We are not aware of any problems in this respect.

_How can it be guaranteed that the energy parameters adjusted on the system are also actually reached at the end of the work? Can any guarantee be given here that the performance is correct and that this can be verifiably documented?

Prof Gutknecht: Although the efficiency of the lasers are checked annually in the framework of the safety check, we recommend that the user buys his/her own power measurement device in order to be able to guarantee the optimum parameters. Some lasers have internal power measurement devices that constantly monitor the laser performance during operations; however, the power is measured here in front of the fibre resp. in front of the articulated arm. Unfortunately, no defects on these transmission systems can be detected in this way. Other lasers have their own power measurement devices included in the scope of delivery. Along with the pure measurement, however, careful handling and maintenance of the optical elements is indispensable. Deserving a special mention here are the fibre tips or coupling-out windows which should also be kept clean as far as possible during the treatment. Along with the longer lifespan of these consumables, the user also guarantees in so doing that the measured, power not only leaves the hand piece but also reaches the tissue. There is often a disregarded source of error particularly with newcomers. Such errors can be avoided if the newcomer has completed the right training before using the laser for the first time.

_Let's move on the most well-known indication field in laser therapy: endodontics. What are the advantages of laser assisted endodontics? Are there any additional advantages for the persons giving the treatment, who carry out intensive preparations, through using a laser?

Prof Gutknecht: The advantages of laser-assisted endodontics can be particularly recognised in areas where there is a highly infected root canal system, combined with periapical ostitis, periapical granula or periapical cyst. Moreover, the morphological features of an endodontic system present a problem in attempting to achieve a germ reduction in the main and lateral dentinal tubules as well as the accessory canals and ramifications. The advantages of laser-assisted treatment are based on a very effective removal of the smear layer and the organic components from the main canal when additionally using an Er:YAG resp. an Er,Cr:YSGG laser with relevant fibre attachment. A significant difference in the germ reduction can be achieved by using a Nd:YAG laser or a 810 nm diode laser. The extremely high transmission of the Nd:YAG laser through dentine and its good absorption in the pigmented bacteria (96 % of the germs) leads to a germ reduction not existent up to now in the lateral dentinal tubules up to depths of 2,000 – 3,000 µm. The germ reduction is still over 80 % with 1,000 µm in the lateral dentinal tubules. Compared to this we have a measurable germ reduction in the lateral dentinal tubules up to 100 µm in depth with a conventional mechanical-chemical treatment of the root canal system.

_Is the invoicing a problem? How is the laser treatment to be settled and can this also be used, for example, in the field of endodontics or periodontology?

Prof Gutknecht: Invoicing the laser treatment is not a problem if the patient has been informed beforehand about the additional treatment steps and he/she has given his/her consent in writing that this treatment not covered by the health insurance companies is to be paid privately. This approach is the method recommended and supported by Deutsche Gesellschaft für Laserheilkunde (DGL) in endodontics as well as in periodontology.

"The removal of the biofilm on the root surface is possible just as with adequate power settings."

_Could you give a ranking list of the wavelengths in endodontics if there are different wavelengths available?

Prof Gutknecht: Of course,
1. pulsed Nd:YAG laser
2. 810 nm diode laser
3. 940 nm diode laser
4. 980 nm diode laser

_Let's get on to the subject of periodontology and in particular closed curettage. How effective is the use of the erbium laser in connection with the new side-fire-tips in the field of periodontology?

Prof Gutknecht: In my opinion making a definitive statement on this question is still too early since there are still too few clinical studies dealing with this question. However, what is clear from the studies and case presentations already carried out is that there is a reduction in the germs in the pocket bottom and a superficial erosion of the granulation tissue from the sulcus wall. The removal of the biofilm on the root surface is possible just as with adequate power settings like the micro retentive surface resulting from this, which has a very positive effect on a re-attachment.

_Which advantages will the person performing the treatment and the patient have when using a laser within this indication field?

Prof Gutknecht: The germ reduction also leads to an improved body immune defence, which in turn leads to the repair mechanisms and the healing process associated with this being able to be initiated more quickly.

_How can any guarantee be given that all infected areas are able to be reached and the germs killed?

Prof Gutknecht: The best way to achieve this is if the treating dentist has acquired good know-how about the mode of action and handling through a sound training. These form the prerequisites of being able to perform a correspondingly successful treatment.

_How can it be guaranteed that the sensitive root cement is not damaged by the laser?

Prof Gutknecht: Likewise, the best way to achieve this is if the treating dentist has acquired good knowledge about the mode of action and handling. Basic tools with a laser-assisted periodontal treatment are: 810 nm diode laser, pulsed Nd:YAG laser, 940 and 980 nm diode laser.

If we have the possibility of combining two wavelengths, a combination of erbium lasers and 810 nm diode or Nd:YAG laser would be a great advantage.

_The topic "closed curettage with photo sensitizer" is a major subject of debate at the moment. In the meantime there are several systems on the market that are said to bring about a germ reduction in parodontology and peri-implantitis, etc. with the aid of photo sensitizers etc. How effective is the use of these systems and can these be used alone in order to be able to achieve better results than through conventional methods?

Prof Gutknecht: The PDT therapy has its origins in medicine and is used there in the various fields with different photo sensitizers and wavelengths. The systems and areas of application already used in dentistry are proven through various clinical studies, which have shown that this supporting PDT therapy has contributed towards an improvement in treatment success, particularly in periodontal therapy. Since photo sensitizers and wavelengths are not directly comparable with each other, a correspondingly sound statement can only be made after a comparable clinical study of all three systems used in dentistry has been performed.

Due to the biochemical features and investigations already carried out in other expert fields, we can assume that when using the "Emundo" process we helped to develop, an improved efficiency of the therapy is able to be achieved.

_In which indications do these methods make sense, in which should they not be used?

Prof Gutknecht: Periodontology is primarily an indication that makes sense. Other indications fields still have to be verified.

_Are these methods suitable for the initial therapy or do they only represent a supplement to the recall treatment?

Prof Gutknecht: The Emundo method, for example, is perfectly suited for the initial therapy, particularly if it is carried out by an assistant. After the dental treatment and in the recall treatments it represents a very helpful supplement to the therapy and promotes good treatment results.

_Cavity preparation is the domain of the erbium laser group. Are the erbium lasers less damaging to the substance even with high energy settings than the rotating instrument? How great is the danger of micro defects through the high energies?

Prof Gutknecht: The erbium lasers are only less damaging to the substance if the person performing the treatment has clear ideas about the type and scope of the area to be treated. When working with performances in the range of 10 and 20 W, even healthy tooth structure will be very quickly eroded when the dentist is not trained sufficiently.

_What are the advantages of a preparation by means of laser compared to a rotating instrument along with insensitivity to pain?

Prof Gutknecht: The preparation by means of laser is a biophysical and not a purely mechanical preparation. Due to the thermo mechanical ablation, hydroxylapatite crystals are loosened from the tissue surface in an athermal way. Vibrations occurring when drilling as well as micro cracks and structural weaknesses caused by this do not occur. No smear layer is created and the cavity floor, as well as the cavity walls, is completely germ-free through this laser treatment.

_Frequently the speed of a laser preparation is assumed to be more time-consuming. Can you con-

firm this? Or are there perhaps even time advantages through using a laser?

Prof Gutknecht: The speed of the laser preparation is dependent on the material to be treated (enamel, dentine, bones, composite, glass ionomer cement, etc.) and naturally also extremely dependent on the adjustment values and adjustment combinations of the various devices. Time advantages through the laser preparation can be gained in the fields where an anaesthetic has to be given in conventional treatments; in laser treatment it is not necessary to give a surface anaesthetic or to wait for the reaction time or wait for the actual anaesthetic to take effect after the injection has been given. In addition, particularly in the approach used in preserving dentistry, not having to apply the etching gel and take the time needed for rinsing is seen to be gain in time with laser preparations.

_Is it possible to remove selective caries with a laser?

Prof Gutknecht: The erbium laser is the only tool with which caries can be selectively removed due to its biophysical features.

_Is it possible to carry out a preparation for a CAD/CAM restoration completely by means of laser or does a rotating instrument have to be used for after treatment?

Prof Gutknecht: Preparations for a CAD/CAM restoration by laser can be performed even without the additional use of rotating instruments.

_Is there the possibility to prepare onlays by means of laser?

Prof Gutknecht: Onlays can also be prepared by means of erbium lasers.

_Training and further training plays a big role in all the answers you have given. Can you specify this?

Prof Gutknecht: Undergraduate dental education does not include any information on the use of lasers in dentistry. Since the laser systems are not a further development of a currently known dental instrument but are based on very different modes of action, a sound training about the set up, function, indication and application of laser systems is an absolute must.

_Can people providing the treatment work without the relevant training with a laser system made available to them as a trial? What consequences could this have in the case of this happening anyway?

Prof Gutknecht: Even laser systems made available on loan may not be operated without proof of laser safety training due to statutory regulations. The relevant laser protection precautions also have to be on hand in the treatment rooms. A breach of these regulations is punishable with high fines and a temporary closure of the dental office.

_What does Deutsche Gesellschaft für Laserzahnheilkunde say about questions of laser safety and training?

Prof Gutknecht: There is a clear statement by DGL that lasers may only be operated after completing a recognised laser safety officer course (LSO). Moreover, an urgent recommendation has been issued that lasers may only be used on patients after completing a basic training course (two to three day workshop).

"Even laser systems made available on loan may not be operated without proof of laser safety training due to statutory regulations."

_To what would you attach special importance in view of the training for laser use?

Prof Gutknecht: Due to the complexity of the laser application in the oral cavity I would agree with the recommendations of DGL to complete a training program which not only deals with the bare necessities regarding adjustments and actions but a training system in which dentists also have a relevant scientific background, and in which are given clinical demonstrations and practical exercises. In addition I personally would recommend the DGL mastership curriculum to each future laser user.

_In your opinion are practical demonstrations not sufficient?

On the basis of what I have said before it is clear that practical demonstrations are by far not sufficient.

I thank you for the interview._

Editorial note: The interview was led by Kristin Urban, Germany.

Manufacturer News

KaVo

Reliable and comfortable detector of calculus in periodontal pockets

The KaVo DIAGNOdent pen is well-known and established, as a unique instrument for the detection of caries that can quickly and reliably identify healthy and unhealthy tooth substance by means of varying fluorescence. In addition to caries detection, the DIAGNOdent system can be used with a special Perio probe for reliable and comfortable detection of periodontitis. The Perio probe detects concrements in the deepest pockets reliably and without pain despite the presence of saliva or blood and is therefore an ideal control instrument after root cleaning. A gentler, more thorough cleaning of pockets is thereby enabled with substantially enhanced healing. The DIAGNOdent pen's readings are communicated as a digital and acoustic signal. This confirms to the patient the need for treatment and increases compliance.

Clinical studies confirm that the use of the DIAGNOdent Perio probe for calculus detection and control of treatment improves the postoperative bleeding index and noticeably reduces pocket depth in comparison to the use of a conventional probe.

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Fotona

LightWalker—A Breakthrough in Dental Laser Technology

Fotona, the European manufacturer known for producing the highest performance medical lasers, introduces the highest technology dental laser system offering supreme clinical results and unmatched simplicity of use.

The development of LightWalker is based on Fotona's 45 years of experience in laser technology: Elements such as VSP Technology, Energy Feedback Control, QSP mode and Scanner-ready technology ensure LightWalker will lead the way in laser dentistry. The system features the ultimate in convenience and ergonomics. It has an easy-to–use color touchscreen, interchangeable optics for the new titanium technology handpieces, a Nd:YAG handpiece detection system and a new, patented OPTOflex arm which allows a complete range of motion. LightWalker lasers have three models to choose from. The top-of-the-line 20-Watt AT model combines dentistry's two best laser wavelengths: Er:YAG and Nd:YAG for no-compromise dentistry. With its groundbreaking scanner-ready technology you will be able to cut perfectly into the tissue, which will revolutionize future applications in implantology. The dual wavelength 8-watt model DT and single wavelength 8-watt model ST-E can be used in both hard and soft tissue options.

LightWalker will start a new era in dentistry, bringing treatments that are extremely comfortable for the patient and easy for the dentist to perform.

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Syneron Dental Lasers

Changing the Face of Laser Dentistry

Laser Dentistry is the wave of the future—its ticket to success is already here. Dental lasers have certainly become indispensable and are growing in popularity among the practitioner community, as well as the patients. Newer, more versatile dental lasers are making it possible for dentists to embrace laser dentistry technologies and develop new clinical applications.

Of particular interest is Syneron Dental Lasers' latest innovation, the LiteTouch™ with its breakthrough Laser-in-Handpiece™ technology, which is simply the industry's most innovative technology in recent years, well on its way to change the face of laser dentistry. Syneron Dental Lasers, the inventors of LiteTouch™, first introduced the ground breaking product in mid-2007.

This fast cutting, non-fibre, all tissue Er: YAG-Laser (wavelength 2,940nm) was commercially available by the end of 2007. Since then, the company has experienced significant success and a strong foothold in Europe and Asia. Increased demand and popularity of the LiteTouch™ in Japan has led to penetration in such new markets as Taiwan, Hong Kong and Australia.

In European countries, such as Germany and Switzerland, the Laser-in-Handpiece™ innovation has been given the thumbs up and widely adopted by private practitioners, key opinion leaders and dentistry schools. In 2010, LiteTouch™ sales in Germany alone reached a record high in comparison to other Er:YAG lasers. So what is it about LiteTouch™ that makes it so precious to laser dentistry? We investigated further with a few LiteTouch™ practising dental laser experts. “First of all, the LiteTouch™ is small, and because there’s no delivery system, you are not limited with the movement of the hand. You can reach wherever you want – into all areas of the oral cavities due to the 360 degrees swivel,” says, Dr Avi Reyhanian, DDS, an expert in laser dentistry who currently practices general dentistry and oral surgery in Netanya, Israel, and also lecturer at the ALD conference in USA. Dr Reyhanian’s practice has employed dental lasers since early 2002, continues, “And what’s most amazing is that this small laser has such a powerful cutting power. This laser is extremely easy to manipulate, it saves the doctor’s time and is almost free of maintenance costs.” He adds, “There are lots of procedures we can carry out with LiteTouch™ in the field of restorative dentistry, oral surgery, and at my clinic, no procedure is performed without LiteTouch™! We are talking about episectomy, crown lengthening, implantology, sinus lifts, GBR-technique, etc.” Dr Reyhanian concludes, “LiteTouch™ has really provided me with the opportunity to earn money. I have upgraded my clinic. I have upgraded my patients and I have certainly upgraded myself as a laser specialist, no doubt about it.”

Dr Mark Levin, DMD, B Med Sc, CEO and MD of Medclinic, a private medical center in Tel-Aviv, Israel, a renowned dental phobia treatment and dental treatment under anesthesia laser dentistry expert, told me a little bit about LiteTouch™, “For example, when you extract the tooth, perform the operation on the gums, prepare the teeth around this tooth, take impressions, and finish prosthetic work—all of this is carried out within a single session, and for this, LiteTouch™ is absolutely valuable.” He continues, “Without LiteTouch™ we could not offer what we are offering now. This includes implantation, where the laser drills through the soft tissue and the bone, creates an opening in which we insert the implant. That means the stabilization of the implant and the gum is immediate.” But more than that, actually, LiteTouch™ is a revolution. The advantage of this specific laser is that it is the first device to be flexible enough to be used in the same way as a drill. For the first time, dentists can use a laser and fully focus on their art and expertise. LiteTouch™ customers benefit from end-to-end support through Syneron Dental's network of distributors. The company often meets with the distributors to keep the flow of information and exchange of ideas constant.

Ira Prigat, President of Syneron Dental Lasers, believes 2011 will help dentists fulfil their dreams. Asked why, Prigat responds: “LiteTouch™ gives dentists the ability to serve their patients with better dentistry, the LiteTouch™ system is cost-effective and a step up toward a complete high tech clinic—Just as mobile phones freed our world from cables, LiteTouch™’s ‘Laser-in-the-hand piece technology’ has freed the dentistry world from optic fibers and articulated arms limitations. This metamorphosis allows free and full expression of dentists’ mastery.”

When asked about research and education, Prigat responded that laser dentistry education is still at its infancy. It may be due to the fact that laser dentistry is relatively new discipline and its distribution is mostly empowered by the business world. This trend is gradually changing, as laser dentistry’s clinical advantages are well adopted by new generation of dentists, researchers and academic institutes. Prigat says LiteTouch™ can certainly provide the paradigm shift that is so necessary to change higher education in this field. “Our goal is to establish a very close collaboration with various universities across the globe. In fact, we are already working with several universities in Asia and Europe. At the University of Geneva, Switzerland, Dr Bader conducted a study that compared between the various Er:YAG lasers and concluded that LiteTouch™ achieved extremely high advantages in terms of performance—and results of this study will soon be presented forthcoming WFLD 2011 conference in Rome.”

In Bulgaria, Syneron Dental Lasers is actively cooperating with Plovdiv and the University of Sofia, where researches on laser treatment for caries and non-caries defects. They concluded that LiteTouch™ is a healthier alternative to eliminate defects literally within seconds and completely without drilling and with hardly any pain, while fully preserving healthy tooth substance. In the Balkan region, Syneron Dental works closely with a number of leading dentists including Dr Georgi Tomov, a professor of Operative Dentistry and Endodontics and member of the Faculty of Dental Medicine at the Medical University Plovdiv. Another leader in this field working with Syneron Dental Lasers is Prof Ana Minovska, Vice Dean of Academic Affairs of School of Dentistry, Cyril and Methodius University, Skopje, Macedonia, and Director of the Dental Hygienists School.

Professor Arnabat and Professor España, Associate Professors at the Surgical Oral Implantology Master Corse at Barcelona University, Spain, have joined Syneron Dental’s luminary team to cooperate on further research and education with LiteTouch™ technology.

Many other key opinion leaders have teamed with Syneron Dental family and share their growing enthusiasm regarding LiteTouch™. Some of these experts have been key figures in the industry and have years of experience with dental lasers. They report that their experience of using LiteTouch™ had significantly reduced their typical occupational health discomfort experienced with old generation lasers; dental practitioners can say goodbye to such symptoms as common hand arthritis and shoulder pain. According to an iData Research report, 12 per cent of dentists around the world are using lasers. With LiteTouch™ on board, the next generation of dental lasers looks promising and its impact is phenomenal. As the applications for dental lasers expand, more practitioners will use LiteTouch™ technology to master the future of laser dentistry and provide patients with precision treatment that may minimize pain and recovery time.

Litetouch™ is actually fulfilling the laser technology promise. The time has come for every dentist to achieve and master the dentistry future. “You have to see it to believe it”, commented Dr Georgi Tomov, who is inviting passionate dentists to have a first-hand experience of this superb laser at the IDS 2011 show. Dr Tomov added: “I will certainly be happy to demonstrate LiteTouch™.“

At IDS 2011, Syneron Dental Lasers plans to unveil the latest features and new technologies of the next generation of LiteTouch™, as well as deliver the latest clinical findings of LiteTouch™ laser dentistry from across the globe. Meet LiteTouch™ at IDS Show, Booth N050, Hall 4.2, March 22–26, Cologne, Germany. To explore cooperation opportunities please contact dental@syneron.com.

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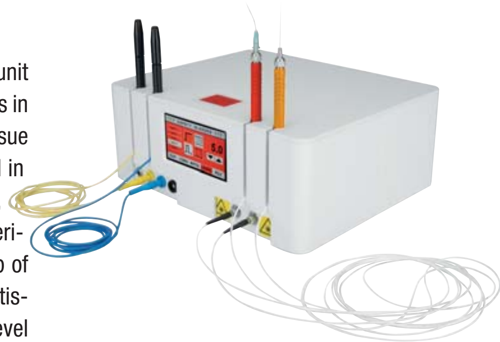
Hager & Werken

Radio frequency and laser combined

LaserHF from Hager & Werken is a combined unit which for the first time offers both technologies in one device: laser and radio frequency. While tissue can be perfectly cut, resected and coagulated in the radio frequency, the laser offers additional, fascinating applications in endodontics and periodontics as well as in implant surgery. On top of that, new therapeutic approaches, such as the tissue treatment in therapeutic terms (Low Level Laser Therapy) and antimicrobial photodynamic therapy (aPDT) can be carried out. In fact LaserHF includes two types of laser: A diode laser with 975 nm/6 W and a diode soft laser with 650 nm/100 mW for LLLT and aPDT. An easy to use touchscreen offers 15 pre-set programs in the laser unit (10 x diode laser, 5 x diode soft laser). The radio frequency-unit offers various pre-set programs. Additionally the user can save individual programs.



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Biolase

Successful showing of Waterlase iPlus

Biolase Technology announced that it completed a successful showing at the 146th Chicago Dental Society Midwinter Meeting. Federico Pignatelli, chairman and CEO, commented, "BIOLASE has returned to its highest level of orders at the Chicago Midwinter Dental Show since 2007, when the company enjoyed annual sales of $67 million."

"Over three days at the show, the Biolase booth was visited by many current and former luminaries, as well as dozens of current customers, who showed a high level of interest in the Waterlase iPlus system," Pignatelli said. "The Waterlase iPlus system features a dual wavelength by combining the handheld and ergonomic 940 nm iLase system with the 2780 nm Waterlase iPlus. The Waterlase iPlus has further advanced laser dentistry with the introduction of new, patented laser technology that allows for cutting speeds that surpass both the dental drill and any other dental laser on the market." Pignatelli added, "Due to the strong initial interest and demand since its recent launch at the Yankee Dental Congress 36 in Boston on Jan. 27, where we received the first orders, the price of the Waterlase iPlus system has been raised by $3,000 and was offered at the Chicago Midwinter dental show at its full price, contrary to the traditional discounts expected at trade shows. Biolase's plan for the current quarter is to manufacture 80 systems, and it appears that we may have a realistic chance to end the quarter with a backlog of orders. It is certainly shaping as what could be our most successful product launch of an all-tissue laser in the history of the company."

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elexxion

Brand-new lasers at IDS 2011

elexxion AG will be presenting its shooting star pico and its new delos 3.0 – a completely new interpretation of the ideal of Er:YAG/high-power diode laser combination – in Hall 4.2, Stand J41 at IDS 2011. Optimized versions of the well-proven nano and the claros and duros dental lasers will also be on display.

The elexxion pico has only been on the market since September 2010. The only mobile diode laser for professional use weighing less than 600 g (21 oz.) has been greeted with tremendous user enthusiasm. Dental professionals appreciate this unit for its therapeutic benefits and outstanding economy, with an excellent price-performance ratio. The pico was designed for mobile deployment anywhere in the dental office. Each charge of the high-performance lithium-ion batteries is sufficient for regular treatment day. Its well-conceived five-button user interface lets dentists alternate between endodontic and periodontological indications, three surgical levels and more than 25 specific soft-laser indications. The pico is also ideal for laser power bleaching. This laser unit makes an important contribution toward popularizing laser treatment in dentistry – a treatment modality long since successfully adopted by other medical specialties such as ophthalmology.

More and more dentists are discovering that a state-of-the-art Er:YAG/diode laser combination such as the elexxion delos 3.0 is perfectly suited for preparing the dental office for the challenges of the future, using innovative treatment methods to appeal to new patients. The elexxion delos 3.0 is based on the delos, praised since its introduction as the number-one reference device for the Er:YAG/diode laser combination as it combines the advantages of the two most important laser wavelengths in a single unit. With its patented Digital Pulsed Laser (DPL) technology, the elexxion claros occupies a unique position on the market as the arguably most powerful diode laser available. This highly mature and easy-to-use product offers the broadest range of indications, with special emphasis on major surgical procedures. The new model shown at IDS 2011 features a completely new software interface for even better operator usability.

delos 3.0

pico

The elexxion duros has been the focal technology of many clinical studies. At IDS 2011, a new and greatly improved version – the duros 3.0 – will be revealed to the public. It is a pure-bred Er:YAG dental laser facilitating efficient hard-tissue preparation and bone ablation tasks – without requiring external compressed-air or water connectors.

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International events

2011

IADR 89th General Session & Exhibition
San Diego, CA, USA
16–19 March 2011
www.iadr.org

34th International Dental Show
Cologne, Germany
22–26 March 2011
ids@koelnmesse.de
www.ids-cologne.de

33rd Asia Pacific Dental Congress
Manila, Philippines
3–6 May 2011
www.apdc2011.com

3rd European Congress World Federation for Laser Dentistry (WFLD)
Rome, Italy
10 & 11 June 2011
www.wfld-org.info

FDI Annual World Dental Congress
Mexico City, Mexico
14–17 September 2011
www.fdiworldental.org

Annual Congress of DGL
Düsseldorf, Germany
28–29 October 2011
www.startup-laser.de

Greater New York Dental Meeting
New York, NY, USA
25–30 November 2011
www.gnydm.org

2012

LaserOptics Berlin
Berlin, Germany
19–21 March 2012
www.laser-optics-berlin.de

IDEM International Dental Exhibition
Singapore
20–22 April 2012
www.idem-singapore.com

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WFLD World Federation for Laser Dentistry
Formerly ISLD, founded 1988

oemus

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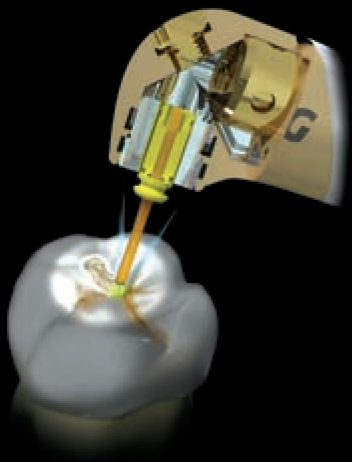

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- Step 2: Procedure

- Step 3: No Shot/No Drill

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