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Wavelength variation

Prof. Dr Norbert Gutknecht

Dear colleagues,
Dear laser society members,

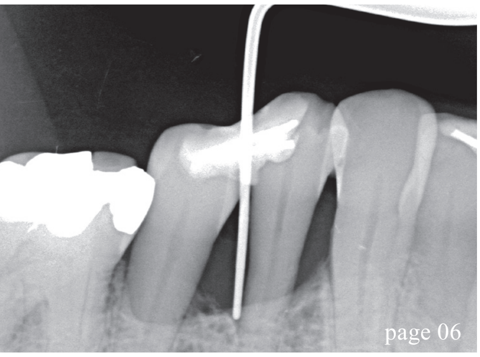
More and more companies offer laser systems with a variety of wavelengths for dental indications. This development gives rise to the hope that the insight in absorption, transmission, reflexion and dispersion in different tissues after irradiation with various wavelengths and the different effects on this tissues will increase. On the other hand we must now ask ourselves when different wavelengths should be applied alternatingly or at staggered intervals.

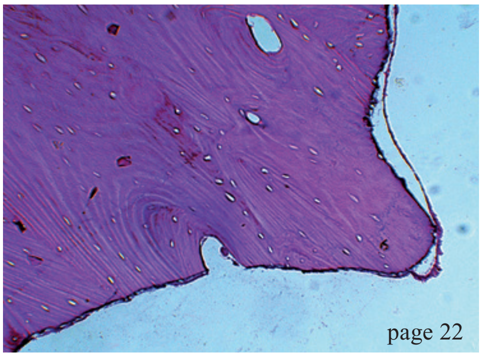
The upcoming IDS—International Dental Show certainly will present new and interesting combinations of laser wavelengths, hopefully featuring well-researched and differentiated evidence on their clinical applications. The larger the number of different laser wavelengths in the dental practice, the more will the probability of applying them more specifically in terms of individual indications increase. I am glad that this issue of laser international magazine of laser dentistry confronts its readers with an article on this topic.

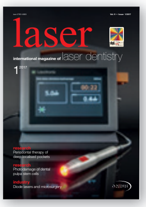
I wish all of you who are going to attend IDS much fun in examining the new dental laser generation.

Yours,

Prof. Dr Norbert Gutknecht







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Periodontal therapy of deep localised pockets larger than 9 mm

Adjunctive laser irradiation without antibiotics or open surgery

Author: Dr Gottfried Gisler, MSc, Switzerland

1. Introduction

The aim of this paper is to demonstrate that even "hopeless" teeth with very deep periodontal pockets of 10 mm and more pocket depth can be saved. Lasers as adjunctive therapy in periodontics have been described for a long time for the following reasons: Bactericidal effect of low-level laser application in photodynamic therapies[1–4] and decrease of immune-inflammatory mediators[5], stimulation of wound healing with application of low-level lasers[6–9], bactericidal effect[10–12] or better wound healing for lasers in the near infrared like diode lasers[13] or Nd:YAG lasers[14,15], calculus removing[16,17], and bactericidal effect with lasers in the middle infrared[18–20] and stimulation of bone healing with Er:YAG lasers[21].

Fig. 1: Light absorption constants μ_A of biological materials.[22]

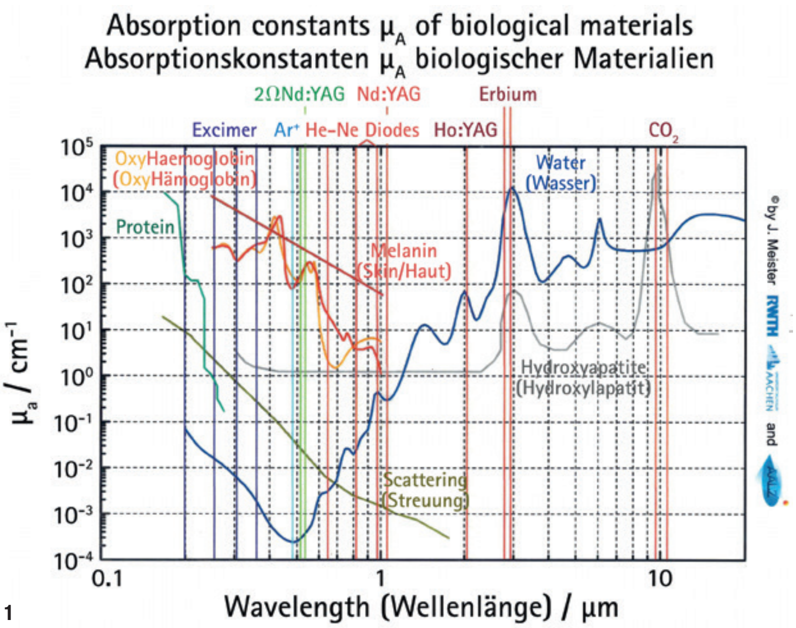


Fig. 1

To achieve the above-mentioned effects of laser irradiation, the laser energy must be absorbed in the specific chromophores or absorbers of the tissues. The graph by Meister et al.[22] in Fig. 1 gives a perfect overview about the different wavelengths and their chromophores applied in clinical situations. It can be seen that there is a high absorption in water for lasers in the mid-infrared like Er:YAG or Er,Cr:YSGG. A lower absorption was found for hydroxyapatite. The absorption constant of 10^2/cm in hydroxyapatite can lead to misunderstandings of ablation in hydroxyapatite containing tissues like bone or dental hard tissues. If ablation in these tissues would occur by absorption in the secondary absorber for these wavelengths in the mid-infrared, the hydroxyapatite crystals would be strongly heated above the melting point and the generated heat would be transferred by conduction directly in the irradiated hard tissue.

Ablation of dental hard tissues and bone occurs by absorption in water for the wavelengths in the middle infrared. As can be seen in Fig. 1, the absorption curve shows a very high absorption in water at about 10^4/cm. If water covers the irradiated surface during ablation, dental hard tissue and bone removal is achieved by explosive (water-mediated) ablation, socalled thermo-mechanical ablation.[23] In this process, light is absorbed by water molecules, rapidly heating a small volume. The vaporisation of water

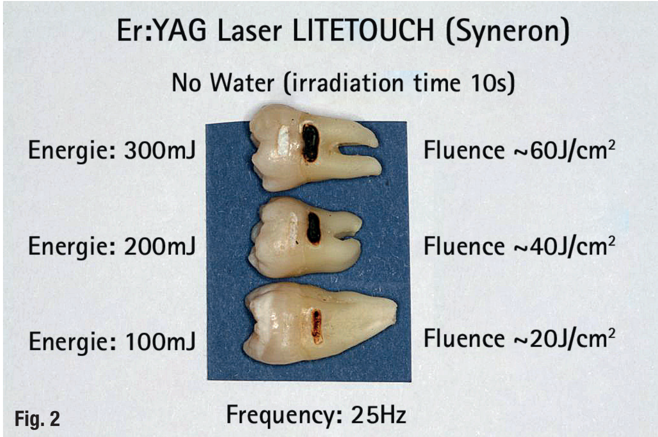


Fig. 2

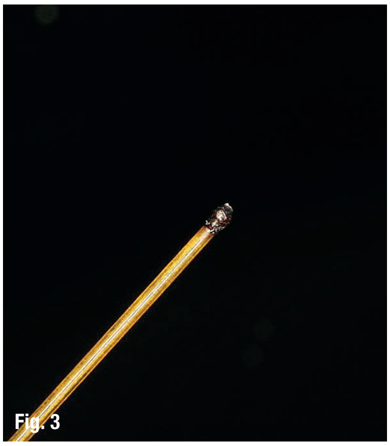


Fig. 3

Fig. 2: Irradiation effect by absorption of the Er:YAG laser energy in hydroxyapatite in dentine. After 10 s of irradiation with no water at 25 Hz, dentine will be carbonised even with an applied fluence of only 20 J/cm². A tooth irradiated for 10 s with a fluence of ~ 60 J/cm² becomes very hot, quite warm at ~ 40 J/cm² and still warm at ~ 20 J/cm². In enamel there is less ablation but a strong heating.

Fig. 3: A "hot spot" at the fibre end of the diode laser is black burned tissue. Energies emitted with such a fibre end would bring the contrary desired therapeutic effect.

creates a strong subsurface pressure and leads to an explosive removal of the surrounding mineral.[24,25] The removal of hard tissue is done by micro-explosions far below the melting point of these tissues. If water does not cover the irradiated surface of bone or teeth, e.g. when the dentist's assistant sucks off the water spray during cavity preparation, the tissue water of the hard substances would be consumed by absorption very fast and the absorption takes place in the secondary absorber, the hydroxyapatite, which leads immediately to a strong overheating.[26] The clinical effect is carbonisation of the irradiated tissue (Fig. 2).

The chromophores that an Er:YAG or Er,Cr:YSGG laser in a periodontal pocket can identify are water or hydroxyapatite (Fig. 1). The laser user executing a closed curettage by such a laser has to avoid any absorption in hydroxyapatite. Therefore, the tissue water in the pocket must be sufficient to provide an absorption of the energy solely in water.

Calculus removal in a closed subgingival situation working with an Er:YAG laser must obey the same biophysical background. The water content of calculus[27] is similar to fresh dentin. Therefore the ablation threshold for both materials must be close together. If big masses of subgingival calculus should be removed only by an Er:YAG or Er,Cr:YSGG laser, working efficiently demands high energy densities. The risk to remove healthy subgingival dentin by a wrong angulation of the laser tip towards dentin or a too high energy (180 mJ) then is very high.[28] In safety guidelines for laser removal of dental calculus[29] the Japanese society for laser dentistry recommends that the laser tip should be parallel[30,31] to the root surface and the applied laser energy be about 40 mJ.

Er:YAG and Er,Cr:YSGG lasers are suitable tools for working in the subgingival periodontal area because of its biophysical background. Ablation of soft and hard subgingival deposits without any pathological thermal side effects is possible, bactericidal effects[18–20] with energy densities far below 10 J/cm² are given, bone healing is stimulated[21], and no discomfort for the patients after treatment is to be expected. The most important thing for closed working in very deep pockets of 10 mm and more with these wavelengths is to avoid any absorption of the laser energy in hydroxyapatite. There are many authors[32–35] working in a closed subgingival setting with Er:YAG lasers and power settings of 160 mJ, 10 Hz and energy densities of 20 J/cm² and more. But it is obvious that the higher the applied energies and the deeper the periodontal pockets are, the greater is the risk of causing damage in the hydroxyapatite-containing tissues like alveolar bone or root dentine because of absorption of the laser energy in the secondary absorber. To minimise this risk, we present seven cases working with the Er:YAG laser with energy densities close above the ablation threshold of bone and dentin.[36]

2. Material and Methods

Seven clinical cases, four of women and three of men aged between 48 and 74 years are presented. Eight periodontal pockets larger than 9 mm were treated with pocket depths between 10 and 12 mm. The tooth mobility degree (TM) of six teeth was 4. Not only was the horizontal mobility measured, but also the vertical mobility. One tooth 33 in case 4 had been already fixed by a crown to the neighbouring tooth and tooth 16 in case 5 had enough stability despite the 11 mm deep pocket.

All patients had to pass a strict therapy protocol including:
- patient instruction for an adequate oral hygiene,
- evaluation and elimination of the pockets' cause,
- splinting the teeth except TM < 3
- conventional pocket therapy with scaling and root planing (SRP)
- laser irradiation

Laser irradiation includes three wavelengths of $\lambda = 670$ nm, $\lambda = 810$ nm, and $\lambda = 2{,}940$ nm.

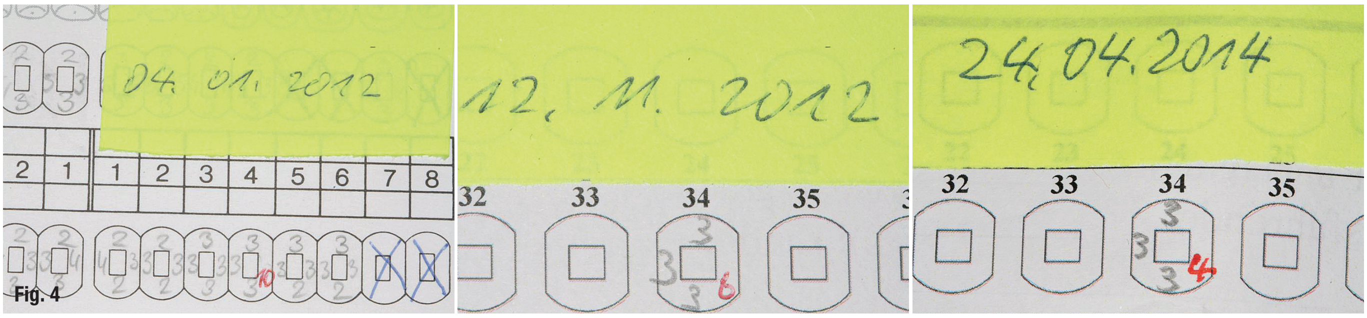


Fig. 4

Fig. 4: Development of the clinical pocket depth. From the left: 4 January 2012, 12 November 2012 and 24 April 2014.

2.1 The conventional treatment protocol

The patient had to pass an oral hygiene phase prior to pocket treatment, followed by a first pocket treatment session, including:

- Splinting the tooth with wire and traditional or acrylic and glass fibre reinforced composites (everStick®).
- Elimination of the pockets cause or causes, e.g.
  - endo/perio laesions → begin endodontic treatment,
  - occlusal traumata → eliminate pre-contacts or hyperbalances etc.,
  - food impaction (FI) → close the gap with reconstructive methods,
  - foreign bodies → remove them,
  - no attached gingiva → if periodontal treatment is successful → free gingival graft (FGG),
  - special pathogen bacteria like Aa → decontamination by laser light.
- SRP under local anaesthesia.

In up to three or four following sessions, the conventional treatment always consists of only ultrasonic cleaning of the treated pockets to remove any plaque formation without anaesthesia and finishing of the conservative therapies (endodontic treatment, fillings, occlusion, FGG, etc.).

The therapy of deep pockets greater than 9 mm demands at least three, oftentimes four laser applications in time intervals between four to ten days. During the whole treatment period, when common prophylactic actions in the treated area are impossible or contra productive, the patients have to rinse their mouth with 0.2 % Chlorhexidine (CHX) solution. The healing of the periodontally treated area with correctly applied laser therapy is almost painless for the patient, fast and without any uncomfortable side effects.

To understand why the local application of laser energy is able to replace antibiotics and to substitute augmentation procedures in many cases, it is indispensable to know the biophysical background of the therapeutic effects of the different laser wavelengths. Antibiotics must be applied only when the general health state demands antibiosis and augmentation procedures are needed in aesthetically very sensitive areas.

2.2 The laser treatment protocol

2.2.1 The first laser treatment session follows directly after the conventional SRP under anaesthesia. The curettage is not done by conventional instruments, but by laser irradiation of an Er:YAG laser for two reasons:

- The laser in the middle infrared region stimulates bone growth factors.[21]
- The soft tissue is removed by the laser in a sterile way because of its ablation mechanism and disinfects the remaining soft and hard tissues.[18]

If we do a closed curettage of a very deep pocket of 10 mm and more pocket depth with an Er:YAG laser, it is impossible that during such irradiation the water spray gets inside of the deep pocket. The water spray has only a cooling effect from outside. Therefore, the tissue water in the pocket must be sufficient to provide an absorption of the energy solely in water. This can be safely achieved by special settings and a special technique of application. Our setting for closed pocket curettage with the Er:YAG Laser (LiteTouch, Syneron) are:

- fluence < 10 J/cm^2
- energy on the device display: 50 mJ

Fig. 5: Radiological situation of bone regeneration. From the left: 4 January 2012, 12 November 2012 and 24 April 2014.

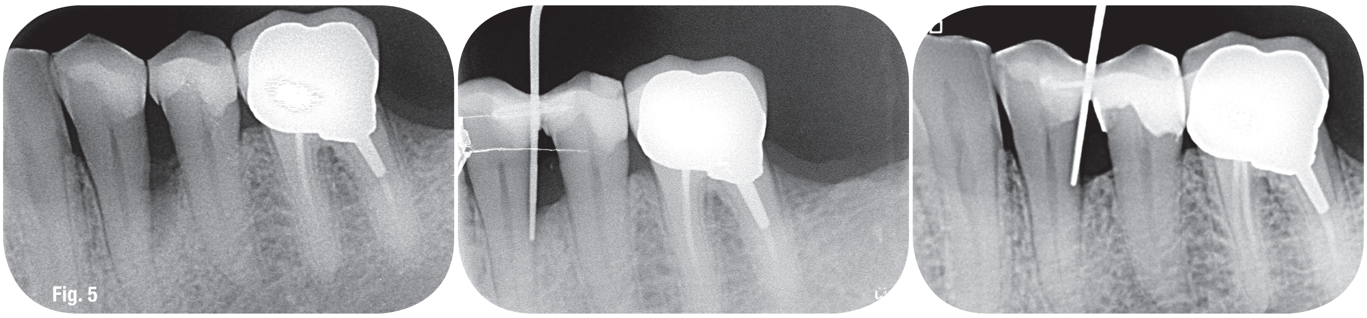


Fig. 5

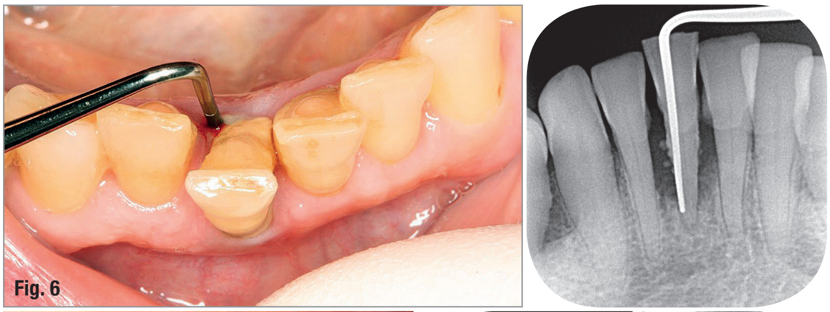


Fig. 6

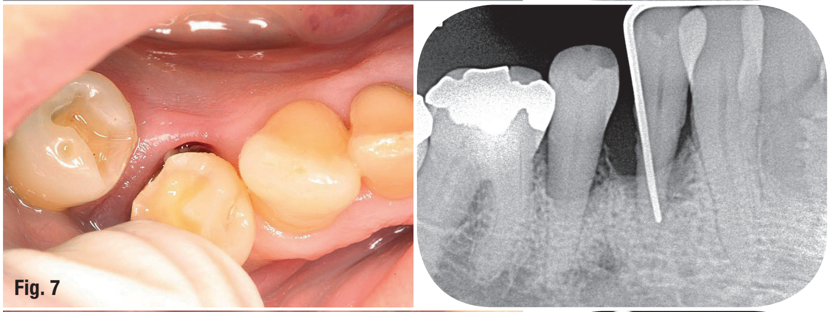


Fig. 7

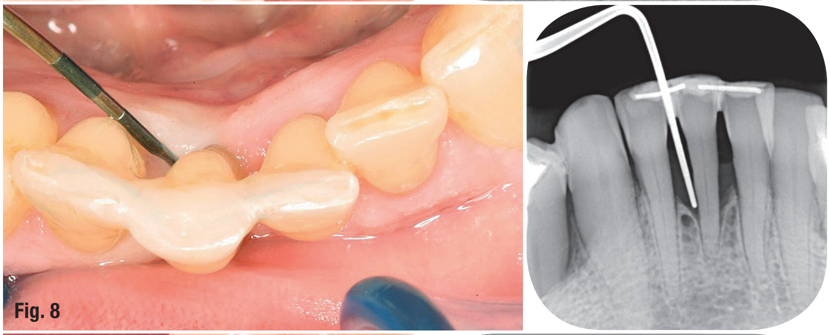


Fig. 8

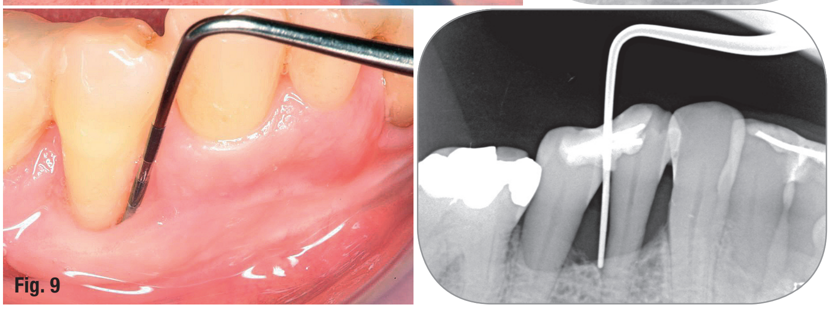


Fig. 9

Fig. 6: Tooth 41, initial clinical situation (left) and radiological situation (right).
Fig. 7: Tooth 44, initial clinical situation (left) and radiological situation (right).
Fig. 8: Tooth 41, final clinical situation (left) and radiological situation (right), 15 months later.
Fig. 9: Tooth 44, final clinical situation (left) and radiological situation (right), 15 months later.

- frequency: 15–20 Hz
- saphir tip: chisel (15 mm long)
- water spray ~ 35–40 ml/min

This setting with a fluence of about 6 J/cm^2 allows the operator to work with minimal risk for the patient to overheat the irradiated tissues or even carbonisation of dentine or bone in the subgingival area. The only thing to be considered is safely reaching the ablation threshold of the irradiated tissues like alveolar bone and root dentine at about a fluence of 2–4 J/cm^2 respectively.[36]

Application technique

1. Irradiation of the subgingival root surface: The laser beam must be parallel[29,30] to the root surface and the movement is from crown to pocket bottom. The pocket should be slightly enlarged by this movement and little rests of calculus can be removed. The irradiation time is only a few seconds.
2. Curettage: The inflamed soft tissue in the periodontal crater must be removed completely. The direction of the laser beam inside of the pocket is slightly directed towards the soft tissue and the movement of the chisel is from the margin of the gum to the pocket bottom. This irradiation lasts several minutes for each deep pocket. The curettage is finished when the chisel "reads" the osseous pocket bottom and can feel its anatomy. The pocket crater must be free of soft tissue.
3. Irradiation and stimulation of the bony pocket crater by removing some micrometers of the superficial surface: It's a fresh-up of the alveolar pocket bottom. This irradiation lasts about one minute for each deep pocket.

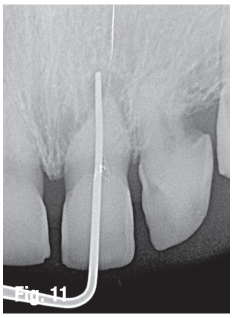
The expected effects in a closed periodontal treatment with lasers in the middle infrared in the first session are:

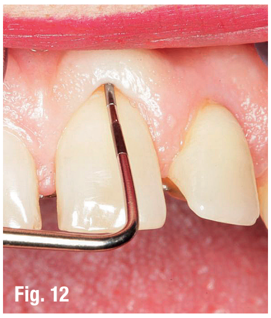
- Removal of little rests of concrements on the subgingival root dentin.[29]
- Complete de-epithelization of the inner pocket up to the margin of the gum.
- Removing of the inflamed pocket soft tissue.
- Decontamination of the whole pocket including root surface, osseous and soft tissue parts with energy densities far below 10 J/cm^2.[2,19,20]
- Stimulation of the osseous pocket crater for bone regeneration.[21]

The whole irradiation time of a deep pocket is between five to eight minutes. To avoid any carbonisation in hard tissues (Fig. 2), such closed curettage by lasers with wavelengths in the mid-infrared need time. It is therefore totally different from an open cur with high laser settings, where the water spray prevents absorption of the energy in hydroxyapatite.

There is an easy home experiment to demonstrate the effect of laser irradiation on dental hard tissues without water. One takes a freshly extracted wisdom tooth between one's fingers and irradiates dentine at these wavelengths without water with laser settings as illustrated in Fig. 2. If the fluence is about 60 J/cm^2, then after some pulses of irradiation the tissue water of dentine is totally consumed and absorption in hydroxyapatite starts immediately. After some seconds one is no more able to hold the irradiated wisdom tooth between one's fingers. It becomes too hot! The clinical effect is carbonisation of the dentine. In enamel there is less ablation but high heat generation (Fig. 2).

Directly after Er:YAG irradiation of the pocket, transmucosal photodynamic therapy (tPDT) with a soft laser (Med-701, LASOTRONIC®) is applied. The tPDT is done with a buffered 1 % methylene blue





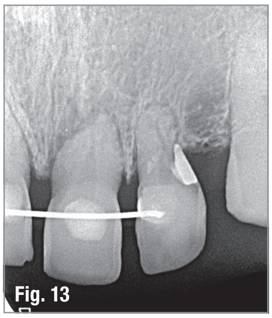
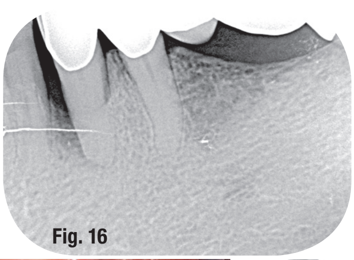


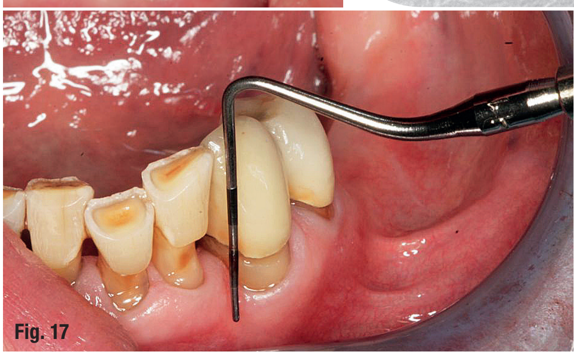
Fig. 10: An 11-mm pocket on the buccal side 21.
Fig. 11: X-ray shows the deep pocket on 21 and a heavy subgingival resorption distally from 22.
Fig. 12: Restitutio ad integrum, clinically.
Fig. 13: Radiological health, CO_2 positive.
Fig. 14: Three years later, a healthy periodontal situation at 21.

solution as a photosensitiser and a softlaser of 670 nm wavelength having a maximal output power of 300 milliwatt (mW) in continous wave (cw) mode. The Er:YAG-irradiated pocket needs to be completely coloured with the methylene blue solution. After one minute, the pocket is washed out with a 3 % H_2O_2 solution and then irradiated during one minute with the softlaser at 670 nm and a maximum output power of about 250 to 300 mW from the buccal and oral sides. After the Er:YAG irradiation the pocket is always bleeding because of the intervention by itself and the very low duty cycle[37] of the Er:YAG pulse. The blood must be washed out with water or an isotonic saline solution, otherwise the laser energy will be absorbed in the blood and cannot enter deep enough into the pocket tissue. Figure 1 shows that the laser has an absorption coefficient of about 10^1/cm for venous blood at 670 nm. The penetration depth of the laser energy is per definitionem the reciprocal value of the absorption coefficient and in our example ~ 10^{-1} cm or ~ 1 mm. In this layer, about 2/3 of the emitted laser energy is already absorbed (Beer-Lambert absorption law). For the same reason, methylene blue colouration of the outside of the gum must be avoided. The patient must not feel any warmth. The expected therapeutic effect is decontamination of the pocket due to formation of oxygen radicals by absorption of the energy in the coloured cell walls of the bacteria[1–4] and stimulation of wound healing.[6–9]

2.2.2 The second treatment session for the patient is normally one week after the first treatment and is done without anaesthesia. The conventional pocket treatment is only an ultrasonic cleaning of the pocket followed by the second laser treatment:

First, a diode hardlaser with a wavelength of 810 nm (White Star) is applied directly after the conventional pocket treatment. The output power is 1 Watt in cw mode, and the application time lasts three times 30 seconds for each pocket side. The laser fibre has a diametre of 0.4 mm. The energy is emitted at the fibre end with a divergence angle of about 12°. The fibre is placed at the pocket bottom. In his other hand, the operator holds e.g. a 5 ml syringe with physiological NaCl solution. Before starting the laser, blood in the pocket is washed out with the rinsing solution. To avoid any formation of "hotspots" (Fig. 3) at the end of the laser fibre, the pocket is rinsed simultaneously with the isotonic saline solution during the application of the laser energy. A "hot spot" is black burned soft tissue at the fibre end. The emitted energy will be absorbed there with an absorption coefficient of about 10^2/cm (Fig. 1). For this reason, the fibre end



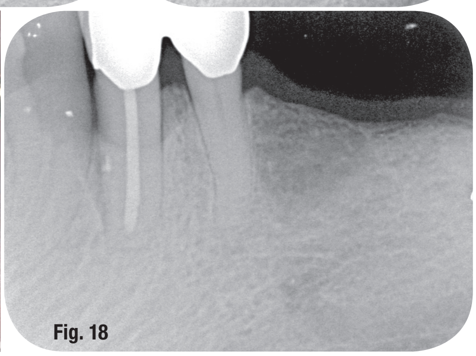
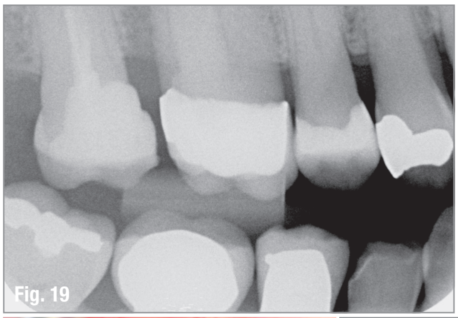
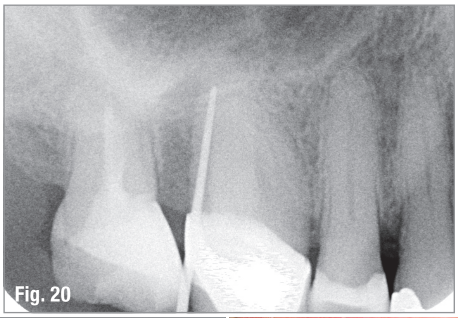
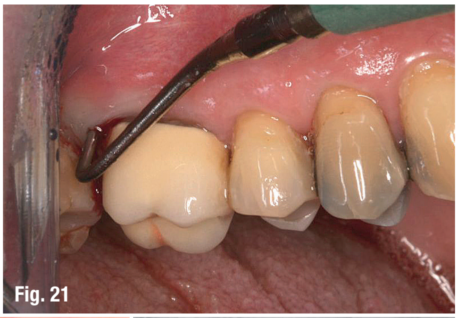
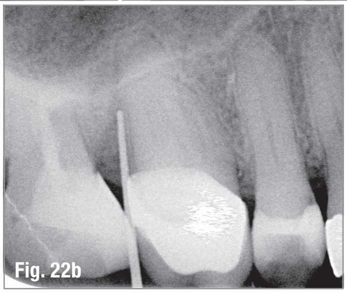


Fig. 15: A 12-mm active pocket mesially from tooth 33.
Fig. 16: X-ray, teeth 33, 34 and 37.
Fig. 17: Ten months later: A small recession of the gum.
Fig. 18: Ten months later: regeneration of the periodontal bone.









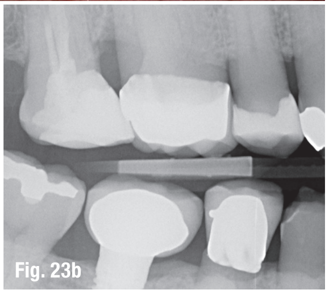


Fig. 19: Cause of the 11 mm deep pocket distally from 16: Fl.
Fig. 20: Pocket's cause restored.
Fig. 21: An 11 mm deep pocket, active.
Fig. 22a: Eight months later: 6 mm inactive pocket.
Fig. 22b: The corresponding X-ray with bone regeneration.
Fig. 23a: Two years later: healthy clinical situation.
Fig. 23b: Corresponding bite wing.

becomes very hot and damages the surrounding tissue by overheating.

The laser fibre is guided from the pocket bottom to the papilla or the margin of the gum in uniform movements and several times during 30 s. This is repeated three times for each pocket. The optical property of non- or less-pigmented tissue allow a deep penetration of the laser light (Fig. 1). The expected therapeutic effects will be decontamination of pigmented bacteria[10,11] and stimulation of bone regeneration and wound healing[12,13] without any generation of heat. Directly after the diode laser treatment the pocket undergoes tPDT.

2.2.3 The third treatment session for the patient is normally one week after the second session and is identical to the second session with:
- ultrasonic cleaning of the pocket
- diode laser irradiation
- tPDT

If necessary, it can be added one week later a fourth session identical to session two and three.

3. Case presentation

Case 1

Patient MU, a 69-year-old man complained on food impaction at tooth 34. The clinical situation showed an occlusal gap between 34 und 35 due to a fractured composite filling. The X-ray showed a 10 mm deep pocket crater distolingually from 34. The treatment of this pocket under local anaesthesia followed the general periodontal treatment protocol described in point 2.1 with two new composite fillings and 34 and 35 splinted together. The laser protocol was added. This first treatment session was followed by four other laser sessions, a combination of a diode laser at 810 nm and tPDT as described under section 2.2.2. In Figures 4 and 5, the clinical and radiological development of the pocket on 34 is shown: Complete regeneration of the alveolar bone. The clinical state is stable until today (2017).

Case 2

Patient SA, a 74-year-old woman, came to see us because of a loose bridge in the upper jaw. Incidental findings: 10 mm pocket distolingually from 41, TM 4 and 10 mm pocket circularly 44, TM 4. Pocket's causes 41: calculus, food impaction, occlusal pre-contacts, and 44: occlusal dysfunction, food impaction, calculus, no attached gingiva on the buccal side. Tooth 41 (Fig. 6) and 44 (Fig. 7) were extremely mobile and could be easily brought into their original situation. They were fixed with wire and composite to the other lower incisors and to 45, respectively. In the same session, calculus removal, correction of the occlusal dysfunction and adding the laser protocol were performed. Tooth 44 got an FGG from 45 to 41 three months later. Figures 8 & 9 show the final clinical and radiological situation of 41 and 44 15 months after beginning the pocket treatment.

Case 3

Patient ED, a 48-year-old woman came into our practice due to fear of losing two upper-front teeth because of their high mobility, teeth 21 and 22, TM4. Tooth 21 on the buccal side featured a periodontal pocket of 11 mm. Pockets' cause: occlusal dysfunction. All upper front teeth were CO_2 positive. Figure 10 shows the clinical periodontal situation and Figure 11 the radiological situation of 21 and 22. Tooth 21 was splinted on the palatal side with a wire and composite to the neighbouring teeth 11 and 22, similar to an orthodontic retainer. Under anaesthesia, SRP and laser



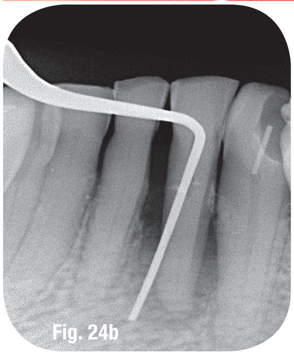
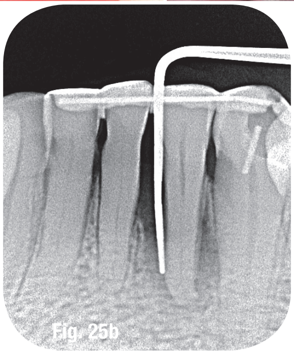
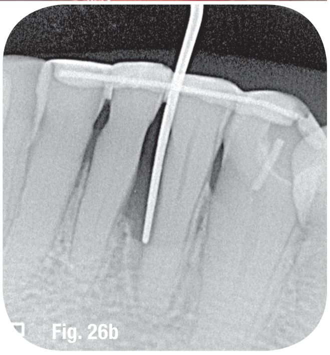






Fig. 24a: A 12 mm deep pocket mb to ml 32.
Fig. 24b: Initial X-ray.
Fig. 25a: Three months later: 7 mm pocket depth.
Fig. 25b: Beginning bone regeneration.
Fig. 26a: Eleven months later, 5 mm pocket depth.
Fig. 26b: Final bone regeneration.
Fig. 27: Two years later, healthy clinical situation.

protocol were applied. Here, it was very important to not go deeper than about 8 mm to prevent a devitalisation of 21 by SRP or laser irradiation. Figures 12 & 13 depict the situation six months later. The periodontal situation was normal and both teeth 21 and 22 had normal CO_2 vitality. Figure 14 shows a clinically healthy periodontal situation three years later, lessened symptoms and both teeth 21/22 CO_2 positive.

Case 4

Patient TA, a 70-year-old man came for a general consultation into our practice, with no pain. Canine 33 had an active, 12 mm deep periodontal pocket, shown in Figure 15 and the X-ray of 33 in Figure 16. The tooth was CO_2 negative, the pocket's cause: Endo/Perio. In the same session, we started endodontic treatment for 33, the bridge was separated distally from 34, and we removed 37, did SRP for 33, and applied laser treatment protocol. Ten months later Figure 17 shows a little recession of the gum, a healthy periodontium, and in Figure 18 a very nice bone regeneration corresponding to the pocket's anatomy. Five years later, no change in the periodontal situation of 33 was seen.

Case 5

Patient BA, 71-year-old man was referred for periodontal treatment of tooth 16, with a 11 mm deep active pocket distobuccally and distopalatally. Pocket's cause: food impaction as seen in Figure 19 between 16 and 17. Tooth 16 was CO_2 vital and crowned. In a first session, we restored tooth 17 with a new composite filling to close the gap. Figures 20 & 21 show the periodontal situation. In a second session, SRP was done and laser protocol was followed with four sessions.

Eight months later, Figure 22a shows a healthy periodontal situation with a small recession of the gum and in Figure 22b the corresponding X-ray and visible regeneration of the bone can be seen. Two years later, we found a clinical, inactive 6 mm pocket (Fig. 23a), and in Figure 23b a radiologically acceptable situation. Because of a heavy calculus formation we recommended that the patient visit the dental hygienist three times a year.

Case 6

Patient BL, a 69-year-old woman was referred for laser treatment of the 12 mm deep pocket at the mesiobuccal to mesiolingual side of tooth 32, with no pain, TM 4 and CO_2 vitality. Pocket's cause: occlusal dysfunction. Fig. 24a shows the initial clinical periodontal situation and Fig. 24b the initial X-ray of 32.

After following the conventional treatment protocol described in section 2.1, splinting 32 to 33, 41, 31, occlusal reseating and applying laser protocol in three sessions. Figure 25a shows the clinical state with 7 mm pocket depth and Figure 25b the beginning bone regeneration. After eleven months, 5 mm pocket depth remained as depicted in Figures 26a & b (final bone regeneration). Figure 27 shows the healthy clinical situation two years later.

Case 7

Patient BS, a 55-year-old-woman, was referred by her diabetologist for a general periodontal consultation. The only heavy periodontal problem was an active pocket of 12 mm mesially from tooth 24 and 11 mm distally and mesiopalatally from 23 due to food impaction and occlusal dysfunction, with TM 4 for tooth 24 and TM 3 for tooth 23. The pathogenic bacteria found in the analysis were *Porphyromonas gingivalis* and *Tannerella forsythia*. Figure 28a shows the initial clinical and Figure 28b the initial radiological situation before laser treatment. On the X-ray, no calculus can be seen in the interdental area 23/24 and neither mesially from 23. The therapy of choice was therefore to splint the teeth together, to eliminate the occlusal dysfunction and to eliminate the pathogenic bacteria. After SRP followed laser protocol in four sessions.

Eight years later, the whole regenerated bone mesial of 23 was stable and the bone had regenerated interdentally at 23/24 according to the pockets' anatomy. Clinically, both teeth in Figure 29a present normal periodontal clinical values and Figure 29b shows osseous regeneration ad integrum mesially from 23 and the maximally possible bone regeneration interdentally at 23/24.

The reduction of the pocket depth to an inflammation-free, painless and long-term satisfactory periodontal situation has always been described as a combination of gingival shrinking and bone regeneration. Bone regeneration was in all patients dependant of the pockets' anatomy and is rather well predictable, whereas the predictability of the extent of gingival recession after such a treatment is less safe.

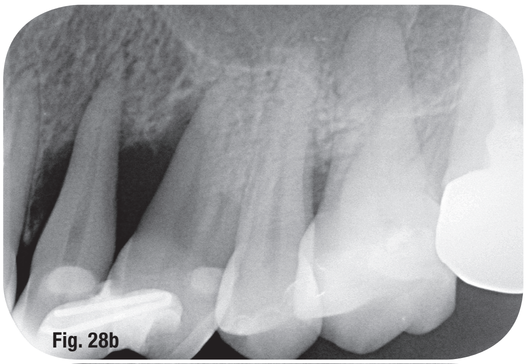
4. Discussion

When we started with lasers in our practice nine years ago, we had only the wavelength of 670 nm and methylene blue at our disposal. We then treated a young lady of 37 years with a 12 mm deep pocket distally at 23 (Fig. 30). We remember that we told her this would be a very long and expensive treatment with augmentation procedures. She was really shocked about the future costs. Then we informed her that another therapy exists but no guarantee for success would be given. She agreed to commence this treatment. The pocket was caused by *Actinobacillus actinomycetemcomitans* (Fig. 31).

After SRP and curettage under local anaesthesia we added four sessions only with tPDT as described under section 2.2.2. No antibiotics or augmentation procedures were applied. Five months later, Figure 32 shows that all pathologic bacterial flora was eliminated only by the correct application of tPDT. Nine years later, the patient is very happy and completely satisfied with the stable result.

In September 2009, the author, 62 years old at the time, was immatriculated at RWTH university of Aachen for the master course of lasers in dentistry. He finished two years later.

The literature for lasers in dentistry in periodontal treatments is still contradictory. There are many authors that cannot find better therapeutic results compared to conventional closed periodontal treatments alone or with adjunctive lasers. Neither a PDT with toluidine blue and a laser wavelength of 632 nm[38] could improve the clinical parameters of bleeding and probing, probing pocket depth and clinical attachment level nor did a diode adjunctive laser[39] therapy improve the above mentioned clinical parameters and the measured gingival cervicular fluid inflammatory mediator interleukin-1β (IL-1β). Even the



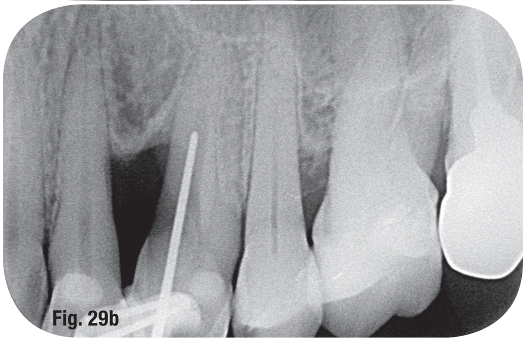


Fig. 28a: Clinical initial situation of teeth 23 and 24.
Fig. 28b: Radiological initial situation after splinting 23/24.
Fig. 29a: Clinical situation eight years later.
Fig. 29b: Corresponding X-ray: mesial 23 restitutio ad integrum and interdental 23/24, the maximally possible bone regeneration.

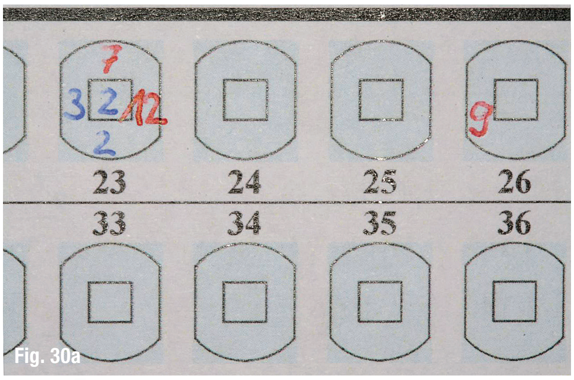


Fig. 30a

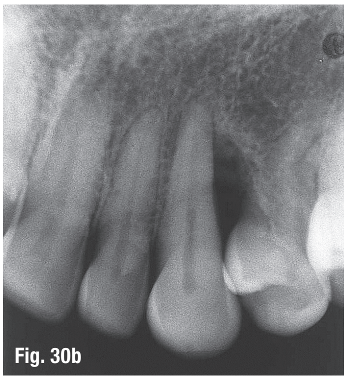


Fig. 30b

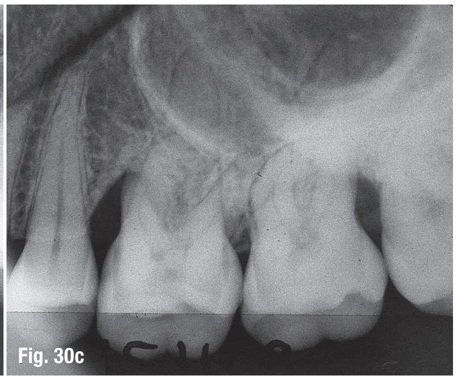
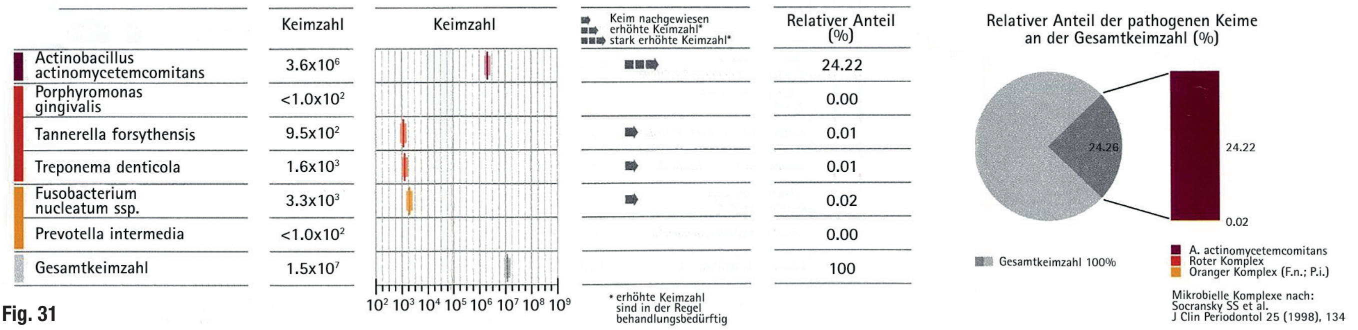
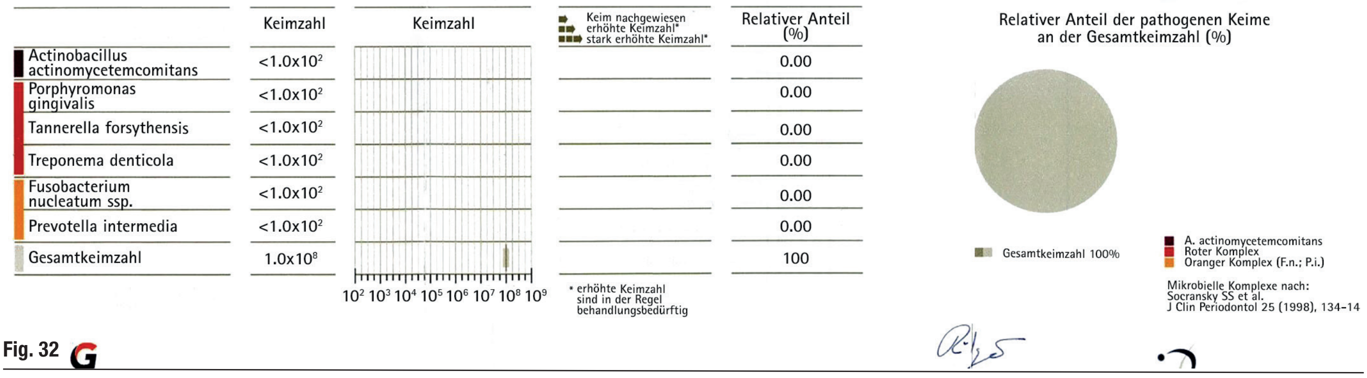


Fig. 30c



	Keimzahl	Keimzahl	Keim nachgewiesen / erhöhte Keimzahl* / stark erhöhte Keimzahl*	Relativer Anteil (%)
Actinobacillus actinomycetemcomitans	3.6x10⁶		■■➡	24.22
Porphyromonas gingivalis	<1.0x10²			0.00
Tannerella forsythensis	9.5x10²		➡	0.01
Treponema denticola	1.6x10³		➡	0.01
Fusobacterium nucleatum ssp.	3.3x10³		➡	0.02
Prevotella intermedia	<1.0x10²			0.00
Gesamtkeimzahl	1.5x10⁷			100

Fig. 31



	Keimzahl	Keimzahl	Keim nachgewiesen / erhöhte Keimzahl* / stark erhöhte Keimzahl*	Relativer Anteil (%)
Actinobacillus actinomycetemcomitans	<1.0x10²			0.00
Porphyromonas gingivalis	<1.0x10²			0.00
Tannerella forsythensis	<1.0x10²			0.00
Treponema denticola	<1.0x10²			0.00
Fusobacterium nucleatum ssp.	<1.0x10²			0.00
Prevotella intermedia	<1.0x10²			0.00
Gesamtkeimzahl	1.0x10⁸			100

Fig. 32

Fig. 30a: The pocket depth on 23 d and 26 mp. **Fig. 30b:** X-ray of 23. **Fig. 30c:** X-ray of 26, all images from 18 March 2008. **Fig. 31:** The bacterial situation in the pockets, 28 April 2008. The main responsible bacteria for the pockets is Aa. **Fig. 32:** All pathologic bacteria eliminated by tPDT. Analysing date of bacteria pocket probe: 8 October 2008.

Er:YAG laser could not improve the conventional periodontal treatments.[40]

As we know that the field of laser adjunctive therapy in periodontics or other fields is very young in dentistry and is not integrated in the general education of dentists, we must assume that many laser applications perhaps do not respect the biophysical background of the different laser wavelengths. Too much venous blood in the pocket absorbs the laser energy for lasers with wavelength from excimer laser to the diode laser of 940 nm. Hotspots at the fibre end overheat the irradiated tissues very fast and too much energy or energy densities with lasers in the middle infrared can harm subgingival tooth surface or alveolar bone. And we clinicians know that for physical reasons a parallel access to the subgingival area during a closed periodontal treatment with our laser handpieces is very, very difficult. For this reason the author thinks that settings of 160 mJ, 10 Hz in subgingival, closed working can be dangerous ablating too much health dentine too fast. However, we were able to demonstrate with the presented cases that very good clinical results can be reached safely with settings close above the ablation threshold of the hard tissue. And in the author's opinion, it is a pity that the industry has not yet produced slightly angulated sapphires for the handpieces. This would allow easier and safer access to the subgingival root surface. A parallel laser beam to the root dentine of the Er:YAG or Er,Cr:YSGG laser would minimise the risk for our patients. Whatever the sellers of laser devices do promise during a sales pitch, in this context the laser user may always be reminded of the fundamental principle in medical ethics "primum non nocere".

It is absolutely necessary to sensitise laser practitioners to respect the properties of the different laser wavelengths on the one hand and on the other hand to correctly assess the optical properties of the irradiated tissue. In our cases, we observed no uncomfortable side effects after treatment and the wound healing was much faster than when done only with SRP and curettage with conventional instruments like


Fig. 33a

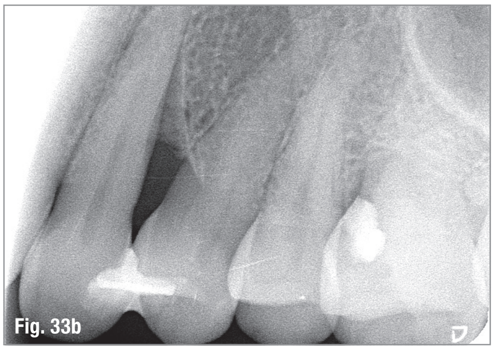


Fig. 33b

Fig. 33a: Clinical situation nine years after the beginning of the conventional closed periodontal treatment with adjunctive laser therapy.
Fig. 33b: Radiological situation.

scalers and curettes. The regeneration of the alveolar bone progressed according to the pockets anatomy.

5. Conclusion

The successful clinical treatment of very deep periodontal localised pockets of 10 mm and more without antibiotics or augmentation procedures can be achieved by consequently following the conventional periodontal therapy principles and by performing adjunct laser irradiation.

Laser irradiation is a local decontamination of the treated areas by formation of oxygen radicals (PDT) or absorption of the laser energy in the chromophores of the bacteria-like pigments (diode lasers in near infrared) and water (erbium group in mid-infrared). In addition, the three presented wavelengths have inhibitory effects of the inflammation process of the soft tissues after treatment and stimulate wound healing and osseous regeneration. The patients do not experience any uncomfortable side effects from the correct laser application and the wound healing is fast and almost painless. To minimise the risk for iatrogenically generated tissue damages by laser application, for example overheating or carbonisation of the irradiated tissues, the applied power settings are laser much lower then generally described in the literature for diode (810 nm) and the Er:YAG (2,940 nm). To achieve the best clinical results, it is indispensable to know the biophysical background of the applied laser wavelengths and to assess correctly the optical properties of the irradiated tissues._

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Kurz & bündig

Die Eliminierung von pathogenen Keimen in der parodontalen tiefen Tasche ohne Antibiotika als ein wesentliches Behandlungsziel wird mittels Lasereinsatz von verschiedenen Wellenlängen sicher und zweckmäßig erreicht, sei es durch Bildung von Sauerstoffradikalen in photodynamischen Therapien[1–4] oder durch Absorption der Laserenergie in den Pigmenten (naher Infrarotbereich)[10–12] oder im Wasser (mittlerer Infrarotbereich)[18–20] der Bakterien. Die zusätzliche entzündungshemmende und biostimulative Wirkung von Laserlicht[5–9,13–15] verkürzt die Abheilungszeit und macht den Eingriff für den Patienten erträglicher und schmerzärmer. Die geschlossene Parodontalbehandlung von sogenannten „hoffnungslosen" Zähnen mit Taschentiefen von 10 mm und mehr erlebt dank adjunktiver Lasertherapie erstaunliche, ja verblüffende, mit viel Knochenregeneration stabile Langzeitresultate, was in den beschriebenen Fällen gezeigt werden konnte. Voraussetzung für solche Resultate ist der korrekte Einsatz der Laserenergie und das Einhalten allgemeingültiger Therapiegrundsätze konventioneller Zahnmedizin und hier speziell der parodontalprophylaktischen Maßnahmen. Um iatrogenen Gewebeschäden durch Laserbestrahlung möglichst vorzubeugen, wurden hier sowohl für den Diodenlaser wie auch für den Er:YAG-Laser viel tiefere Laserleistungen eingesetzt als häufig in der Literatur beschrieben.[32–35] Grundsätzlich gilt es beim Einsatz von Lasern im mittleren Infrarotbereich eine Absorption der Energie im Hydroxylapatit zu vermeiden, bei Lasern im nahen Infrarotbereich die Bildung eines „Hotspots" am Faserende zu verhindern und bei der transmukosalen photodynamischen Therapie mit Methylenblau im sichtbaren Rotbereich das durch die Behandlung im Operationsgebiet ausgetretene Blut simultan während der Irradiation auszuwaschen. Wer Laserlicht als Therapie einsetzt, muss die biophysikalischen Grundlagen und Wechselwirkungen der einzelnen Wellenlängen mit dem Gewebe kennen und die optischen Eigenschaften des bestrahlten Gewebes richtig einschätzen – man denke an Zahnstein, Dentin und Erbium-Laser!

Literature

Photodamage of dental pulpa stem cells during 700 fs laser exposure

Authors: Prof. Dr Karsten König & Dr Anton Kasenbacher, Germany

Material and methods

Cells

Human stem cells from the dental pulp of adults (given by S. Gronthos, NIH, Bethesda, USA) were cultivated in α-modified Eagle's Medium (MEM) by Gibco BRL Life Technologies (Paisley, Scotland) while adding 20% FCS, 2 mM L-glutamine, 100 µM L-ascorbate-2-phosphate, 100 u Penicillin and 100 µg/ml Streptomycin at 5% CO_2 and 37°C in 25 ml and 75 ml cell culture flasks (Greiner, Frickenhausen, Germany).[1] The cells were treated for experiments and cultivation with 0.25% trypsin, 5 mM glucose, 0.05% EDTA in PBS for 5 minutes at 37 °C. After having been thus detached from the base of the culture flasks, the cells were incubated in cell chambers (MiniCeM, JenLab GmbH, Jena, Germany) for laser microscopy.

Comparative studies were conducted on Chinese hamster ovary (CHO) cells, which are available in many international laboratories as reference cells. The CHO cells were incubated in Dulbeccos HAM-F12 Medium (Gibco BRL) with 10% FCS, L-glutamine and an antibiotic mix of Penicillin, Streptomycin and Amphotericin B at 5% CO_2 and 37 °C. Trypsinisation corresponded to that of the stem cells.

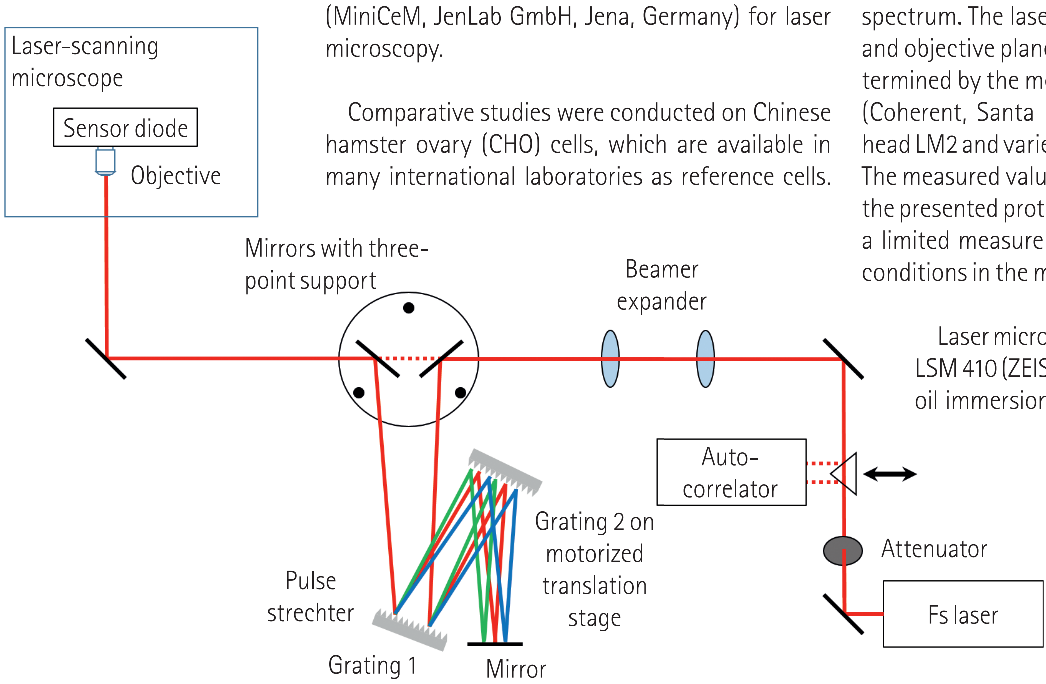
Individual cells were marked by special diamond engravings in the exterior glass window. In case of the detection of cellular damage, these engravings were easily located by applying the phase-contrast technique.

Laser microscopy

An 80 MHz Ti:Sa Laser, Mai Tai (Spectra-Physics, Mountain View, USA) was applied for femtosecond-laser microscopy in the near infrared (NIR) spectrum. The laser power at microscope entrance and objective plane (power at the sample) were determined by the measuring instrument Fieldmaster (Coherent, Santa Clara, USA) and the measuring head LM2 and varied by grey filters when necessary. The measured values were specified as corrected in the presented protocol. This correction results from a limited measurement area and altered radiation conditions in the medium when compared to air.

Laser microscopy was realised via a modified LSM 410 (ZEISS, Jena, Germany) with a 40x/1.3 oil immersion objective. The microscope scan modus 512 x 512 with a laser scan time t = 16 s was applied for cell irradiation. The cells were scanned ten times at the same focus plane. These experiments were realised at a central wavelength of 800 nm. After irradiation, the cells were

Fig. 1: Femtosecond laser system with pulse-stretching unit.



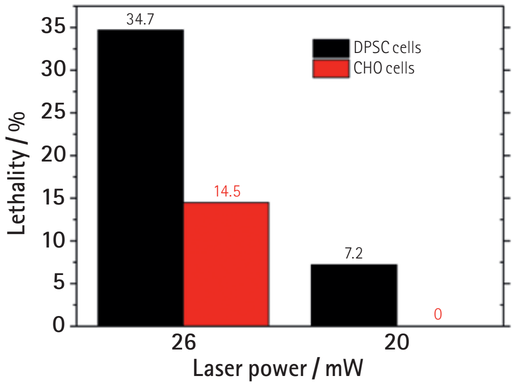


Fig. 2: Laser-induced damage rate (lethality).

transferred to an incubator in order to guarantee optimal conditions for further growth, cell division and repairing processes.

Pulse-stretching unit, generation and measurement of 700 fs pulses

In order to increase the pulse duration at the sample to 700 fs, a pulse-streching unit was implemented in the light path in front of the microscope. This unit consists of coated mirrors and two parallel arranged gold-sputtered gratings with a grating constant of 600 lines/mm. The second grating was mounted on a motorised stage with micrometre precision. The pulse width was varied in dependence on the grating distance. The laser beam received a spatial dispersion by the first grating, which was compensated at the second grating (Fig. 1).

The pulse duration was initially determined at the laser exit with the autocorrelator MINI (APE, Berlin, Germany) with 88 fs at a central emission wavelength of 750 nm, 80 fs at 800 nm and 91 fs at 850 nm, hypothesising a Gaussian function. In general, measurements at the focal plane of the objective proved difficult, as divergent beams exist. A flat, non-linear measurement diode was employed, thus facilitating the measurement at the focal plane of high-aperture objectives. The autocorrelation function (ACF), which can be fitted with either Gauss-, Lorentz or Secanthyperbolicus-based analysis programmes in order to calculate the pulse duration.

Life-/Dead-Test

In order to examine the vitality of dental pulp stem cells (DPSC), a test by Molecular Probes (Eugene, Oregon, USA) was applied. A mixture of 2 µM calcein AM and 4 µM ethidium-homodimer-D1 was added to the cell chambers and incubated for 20 min at 37 °C.

Live cells were stained by calcein (emission in the green spectrum), dead cells by ethidium-homodimer-D1 with an emission in the red spectrum (nucleus). Calcein AM is a non-fluorescent dye which easily permeates the cell membrane of live cells and is transformed by an enzymatic reaction to the strongly green fluorescent calcein which cannot pass the intact membrane. Ethidium-homodimer-D1 is a red fluorescent so-called dead-cell staining agent which can only permeate damaged cell membranes and is significantly intensified by binding to DNA. The Life-/Dead-Kit was incubated 5.5 h after irradiation. Fluorescence was achieved by two-photon excitation.

Verification of laser-induced ROS-formation

The formation of ROS was verified in situ via two-photon excitation of the membrane-permeable fluorophore dihydroflurescein (DHF) according to the method by Hockberger et al.[2] First, the cells were incubated with the marker (10 µM, Fluka, Germany) and irradiated after 15 min incubation time. Only one ROI (region of interest) was subjected to irradiation. Surrounding cells were used as control. After irradiation, a full-frame scan was realised with the low power of 4 mW in order to visualise the effect.

Results

The pulse-stretching unit was adjusted in a way that allowed for each laser wavelength a pulse duration of 700 fs ± 50 fs in the focus. Single DPSC cells were scanned 10 x and the effect compared to the non-irradiated surrounding cells was determined. In addition, comparative experiments were accomplished using CHO cells. Cells or cell clusters were selected which were widely spaced in order to inhibit any intercellular communication as far as possible. During scanning, the transmission signal was detected and displayed as a picture on the monitor. A total of 325 cells was subjected to morphological examinations as well as a life-/dead-test, 50 cells underwent ROS examination. The results were compared to earlier findings with a pulse width of 170 fs.

Morphological changes

So-called black spots resulted from specific irradiation power perameters in locations with significant granulation in the cells. The laser power was gradually increased by 2 mW in order to measure the threshold value for the appearance of the first laser-induced morphological changes (Tab. 1). Under these conditions and with optimum focus, the minimal power for the appearance of black spots was 20 mW for the DPSC cells and 22 mW for the CHO cells (Tab. 2). At a power of 26 mW, 30 % of the DPSC cells and only 15 % of the CHO cells presented these morphological changes. Cells with laser-induced black spots generally revealed morphological changes within the following five hours thus indicating a photodamage effect.

Occurance of black spots in DPSC cells

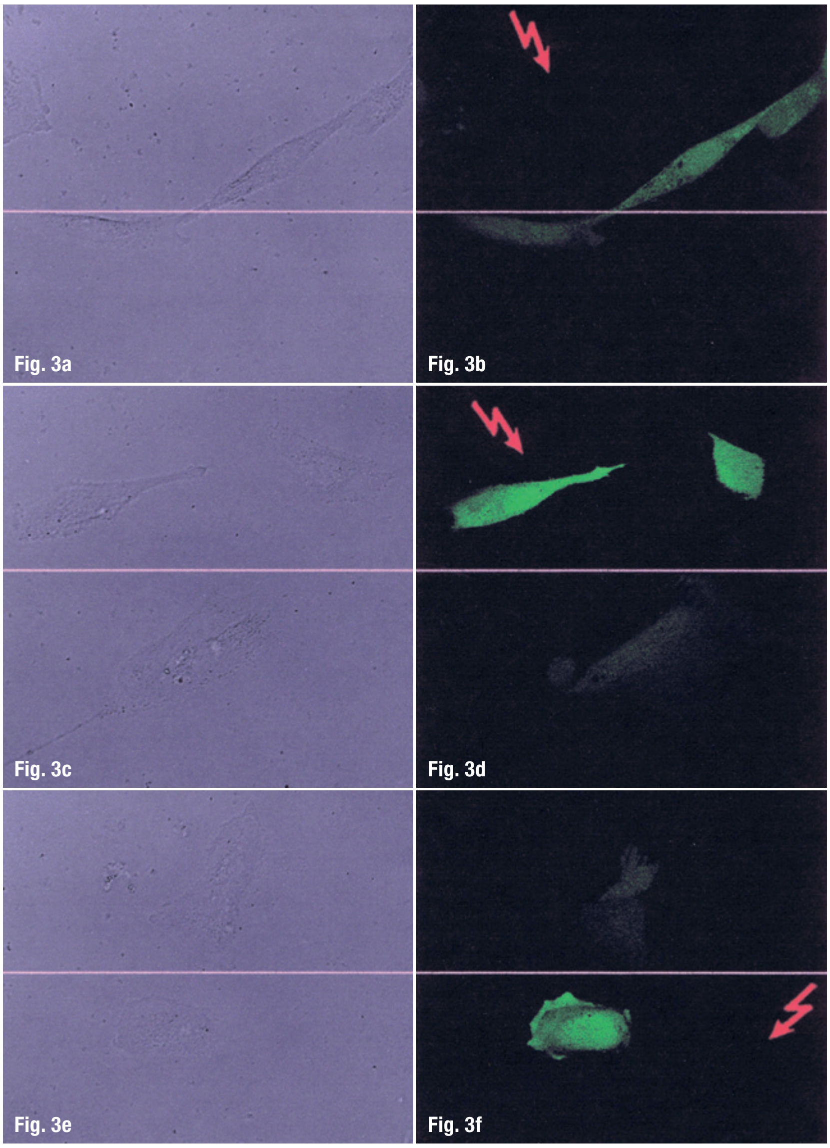
mW	Total of irradiated cells	Cells with spots
16	10	0
18	10	0
20	69	1
26	72	21

Table 1

Occurance of black spots in CHO cells

mW	Total of irradiated cells	Cells with spots
16	10	0
18	10	0
20	69	0
26	72	11

Table 2



Figs. 3a–f: Verification of the laser-induced formation of ROS.

Life-/Dead-Test

First, the DPSC cells were irradiated with different power parameters (4 mW, 12 mW, 16 mW, 20 mW and 32 mW). The irradiated cells were marked, incubated after 5.5 hours with the Life-/Dead-Kit and after 1 hour of incubation tested concerning their fluorescence behaviour. At an irradiation of 20 mW, 64 of 69 DPSC cells revealed a green cytoplasm fluoresence, while a red fluorescence was observed in 5 DPSC cells (Tab. 3). This corresponds to a damage of 7%. When the power was raised to 26 mW, already 35% were subjected to a lethal effect. However all of the CHO cells tolerated a power of 20 mW, with 15% of them dying at 36 mW (Tab. 4 and Fig. 2). The comparison with experiments of shorter pulse widths, at which already 73% of the DPSC cells were damaged at a power of 20 mW, shows that the longer pulse width of 700 fs is better tolerated by the cells.

Verification of the laser-induced formation of ROS (reactive oxygen species)

The irradiation showed that no detectable DHF signals occurred at average power lower than 35 mW. As can be seen from Figure 3 (upper part of a and b) ROS signals were detected at a higher power of 37 mW in both upper irradiated cells. Weak fluoresence signals occurred in the lower non-irradiated cell too. However, this cell was linked to the irradiated cells via membrane contacts. If the power is only insignificantly increased, its effects become more pronounced. In Figure 3c the irradiated cells show a significantly higher intensity. This effect is also confirmed by the considerable fluorescence of the irradiated cell (Fig. 3f). Thus, destructive oxygen radicals are formed during irradiation of a pulse duration of 700 fs. In comparison to the 170 fs experiments, a significantly higher average power is necessary to achieve detectable ROS formation.

Conclusions

DPSC are less sensitive to irradiation with femtosecond NIR laser at a pulse width of 700 fs under the described irradiation conditions than to shorter pulse width of 170 fs. At average power parameters of 20 mW, up to 10% of the cells were subjected to lethal effects within six hours after irradiation. At an average power of 26 mW, still two thirds of the cells survived. At the shorter pulse width all cells would be subjected to a lethal effect.

The observed lesser sensitivity at higher pulse widths and constant pulse energy corresponds to the results of earlier studies on Chinese hamster ovary

Lethality of DPSC cells

mW	Total of irradiated cells	vital	lethal	% lethal
16	10	10	0	0
18	10	10	0	0
20	69	64	5	7
26	72	47	25	35

Table 3

Lethality of CHO cells

mW	Total of irradiated cells	vital	lethal	% lethal
16	10	10	0	0
18	10	10	0	0
20	69	68	0	0
26	72	65	11	14,5

Table 4

cells (CHO) at an irradiation wavelength of 780 nm.[3] In these earlier studies, it was concluded that the damage is subject to a two-photon effect, for which a damage effect E can be expected according to the formula

$E \sim P^2/\tau$ with P: average laser power and τ: pulse width.

As in comparison an increase of the pulse width by factor F = 700 fs / 170 fs = 4 exists, it follows that a power increase by factor S = 1.7 to 2 should be necessary in order to achieve the same destructive effect.

This relation cannot be confirmed exactly basing on the presented data, but a factor S > 1.25 can be assumed, as already 7 % of the DPSC cells died at an average power of 16 mW and a pulse duration of 170 fs, but 20 mW at 700 fs were necessary to achieve the same effect.

DPSC cells react slightly more sensitive at a pulse width of 700 fs than CHO cells. At an exposure of 26 mW laser power only 15 % of the CHO cells were damaged in comparison to 35 % of the DPSC cells. The detected ROS formation indicates a photochemical damage process._

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Kurz & bündig

Die humanen Stammzellen aus der Zahnpulpa Erwachsener (erhalten von S. Gronthos, NIH, Bethesda, USA) wurden in α-modifiziertem Eagle´s Medium (MEM) bei 37 °C in 25 ml und 75 ml Zellkultur-Flaschen (Greiner, Frickenhausen, Deutschland) kultiviert. Die Zellen wurden für Versuche und Zucht mit 0,25 % Trypsin, 5 mM Glucose, 0,05 % EDTA in PBS für ca. 5 min bei 37 °C behandelt. Die so vom Boden des Kulturgefäßes abgelösten Zellen in Zellkammern (MiniCeM, JenLab GmbH, Jena, Deutschland) für die Lasermikroskopie inkubiert. Vergleichend fanden Untersuchungen an Chinesischen Hamsterovar-(CHO-)Zellen statt, die weltweit in vielen Laboren als Referenzzellen vorliegen. Einzelne Zellen konnten markiert werden, indem ein Spezialdiamant in das äußere Glasfenster Gravierungen erzeugte. Diese konnten bei Detektion von Zellschäden leicht mit dem Phasenkontrastverfahren lokalisiert werden.

Auf eine Bestrahlung mit einem Femtosekunden-NIR-Laser mit einer Pulsdauer von 700 fs reagieren die DPSC-Zellen nach vorliegenden Bestrahlungsbedingungen weniger empfindlich als bei einer kürzeren Pulsdauer im Bereich um 200 fs. Bei mittleren Leistungen von 20 mW erleiden bis zu 10 % der Zellen letale Wirkungen innerhalb von 6 Stunden nach der Bestrahlung. Bei einer mittleren Leistung von 26 mW überleben immer noch 2/3 der Zellen. Bei der kürzeren Pulsdauer wären bereits alle Zellen einer letalen Wirkung unterlegen. Die DPSC-Zellen zeigten sich bei der Pulsdauer von 700 fs etwas empfindlicher als CHO-Zellen. So wurden bei Einwirkung von 26 mW Laserleistung nur 15 % der CHO-Zellen im Vergleich zu 35 % der DPSC-Zellen geschädigt. Die detektierte ROS-Formation deutet auf einen photochemischen Schädigungsprozess hin.

Literature

Histomorphological changes in human bone

After *in vivo* Er:YAG laser and ultrasound osteotomy

Authors: Bistra Y. Blagova, Elena G. Poriazova, Petia F. Pechalova & Prof. Georgi T. Tomov, Bulgaria

Introduction

Bone surgical interventions are performed using two major techniques: an osteoplasty and osteotomy. They are carried out by a great number of tools (osteotomes) which cause certain changes in bone morphology, i.e. cell vitality and physiology.[1-14] The applicability of different osteotomes in bone surgery depends on the severity of tissues damage and the healing process afterwards.[1] Therefore, the features of bone repair have been object of a many histomorphological research trials performed on laboratory animals.[1-3] The analyses of the results published showed tissue recovery following ultrasound and laser osteotomy to be superior to the procedures performed by conventional rotary tools.[1,4,5] However, the conclusions from these researches are not automatically relevant to humans. Therefore, the aim of this study was to evaluate the histological changes in the border area following *in vivo* human bone cutting by an ultrasonic device and an Er:YAG laser during extractions of impacted mandible wisdom teeth.

Tab. 1: Histopathological changes in 60 bone specimens taken *in vivo* from human mandibles by ultrasound- and Er:YAG-laser osteotomy.

Histopathological changes in 60 bone specimens

Histomorphological changes	Woodpecker®	LiteTouch™, Light Instruments
border configuration/ margins	sharp, severely fragmented and irregular (Figs. 1 & 2)	sharp, precise configuration (Figs. 3 & 4)
debris fragments	a satellite zone of numerous debris fragments (Figs. 1 & 2)	no smear layer of debris fragments (Figs. 3 & 4)
thermal damage/ carbonisation	no significant signs, preserved bone microstructure (Figs. 1 & 2)	no significant signs, mildly expressed darker superficial area (Figs. 3 & 4)

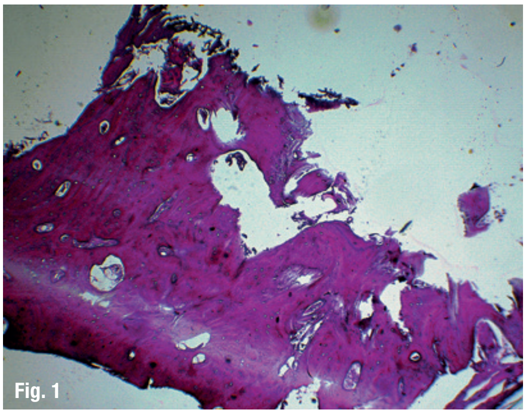
Materials and methods

Objects in this study were outpatients aged between 18 and 35 in order to minimise age-related bone changes. All patients were indicated for surgical extraction of their mandibular third molars. Presence of any co-morbidities or bone infection were considered as exclusion criteria. The research objects were sixty bone specimens divided into two groups equal in number according to the tool used for their collection: an ultrasonic surgical device (Woodpecker Ultrasurgery®, China) and an Er:YAG laser (LiteTouch, Light Instruments®, Israel). All bone samples were obtained by a trained oral surgeon. No complications occurred either intra- or postoperatively. A standard setup of both devices for bone manipulations were used as follows:

- Ultrasonic unit—Bone function—Bone quality 1—frequency utilised up to 29.5 kHz—water pump 5;
- LiteTouch™ Er:YAG laser—wavelength 2.94 µm (2,940 nm)—bone remodeling—Hard Tissue—Non-Contact mode—300 mJ—25 Hz—water spray 8.

Laser specimens were obtained using a cylinder sapphire tip of 1.3 mm in diameter and 19 mm in length (LiteTouch™, Light Instruments, Israel) in a non-contact mode at a distance of 1–2 mm from the target surface. Ultrasound-obtained bone chips were taken by a tip # US 1.

All samples were fixed in 10 % buffered formalin, decalcified and cut into slices within 3–5 µm each. The slices were stained with haematoxilin-eosin (H&E)



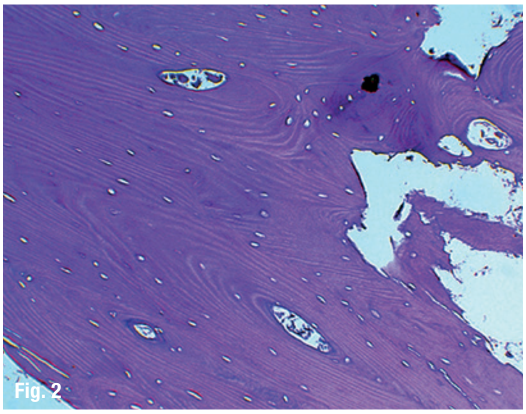


Fig. 1: Ultrasound obtained human bone specimen (H&E x100).
Fig. 2: Ultrasound obtained human bone specimen (H&E x400).

(Bio-Optica®, Italy). The microscopic observations were performed by pathologist in a blind manner under optical microscope (Olympus®, Japan) at magnifications of x100 and x400.

The histomorphological evaluation included groups of observation:
1. border configuration/margins quality;
2. presence of debris fragments;
3. thermal damage/carbonisation.

All the sixty bone fragments were investigated according to the above-mentioned histological criteria.

Results

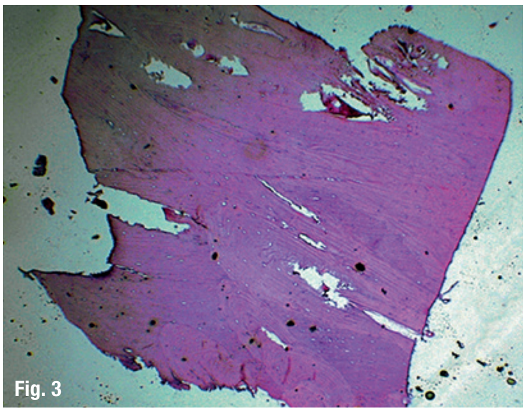
The histomorphological findings in both groups (30 specimens for each) are summarised in Table 1.

Discussion

Osteotomes, technical characteristics and principles of action determine their biological effects reported in different trials on laboratory animals. Based on extensive studies, fundamental differences between humans and animals in bone morphology and physiology were proved.[11] These publications led our team to verify on human bone in real-time procedures, the tissue changes following osteotomy performed by ultrasound- and Er:YAG-laser and to compare them to the ones reported in animals.

Ultrasound obtained specimen from human bone

Ultrasonic devices work through mechanical waves within frequencies of approximately 25–30 kHz created by the piezoelectric effect.[8] Bone cutting is performed by vibrations of lineally oscillating movements within 20–80 microns. Exactly these parameters establish the micro-precision of the ultrasound-assisted osteotomy and its effects only on mineralised tissues as well as the depth of insertion into them.[8,12] Histologically, *in vivo* ultrasound obtained specimens from human lower jaw showed sharp margins[1,6,7] corresponding to these observed by Romeo et al. in their *in vitro* study on fresh porcine mandibles (Figs. 1 & 2).[1] Meanwhile, the configuration of the cutting area on the investigated bioptata was irregular with clearly detectable layer of bone debris attached to the main fragment (Figs. 1 & 2). No signs of morphology alteration were detected during the collection of human bone chips. All examined *in vivo* ultrasound obtained specimens revealed a preserved microstructure (Figs. 1 & 2). The open vascular canals observed were likely to improve nutrition during the early healing phase of the bone repair sequence as reported by Sohn DS et al.[7] Based on the histopathological findings established in the presented study and the non-complicated postoperative period in our patients, we confirmed that ultrasound-assisted bone



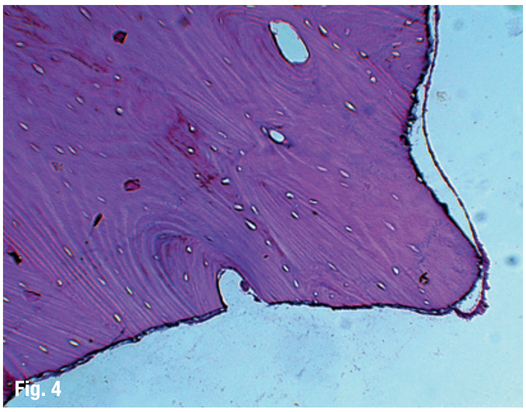


Fig. 3: Laser obtained human bone specimen (H&E x100).
Fig. 4: Laser obtained human bone specimen (H&E x400).

surgery in humans is an atraumatic and minimally invasive procedure. Same conclusions were reported by Berengo M. et al.[13]

Er:YAG laser obtained specimens from human bone

Er:YAG lasers emit infrared light with a wavelength of 2.94 µm which is absorbed predominantly by water and hydroxyapatite.[14] The Er:YAG radiation is an efficient tool in bone surgery. In contrast with ultrasound devices, osteotomy by laser is performed in a non-contact mode. The laser tip is positioned 1–2 mm away from the target surface and there is no collateral friction damage to surrounding tissues.

Under light microscopy observation, the cutting surfaces in laser obtained bone chips from our patients revealed a precise border configuration (Figs. 3 & 4) confirming previously-published statements based on animal models for clear and effective osteotomy achieved by thermo-mechanical laser ablation.[1,9,10] In all laser ablated human bone samples, a mildly expressed darker amorphous layer within microns was observed superficially near to the incision line (Figs. 3 & 4). Romeo and Panduric et al. reported analogous tissue characteristics found in laboratory research on porcine mandibles and ribs respectively.[1,10] The reason for detected bone changes in all specimens in the group could be the cumulative heat deposition within the area surrounding the lased tissue.[1,10] Compared to the ultrasound-obtained specimens, laser-obtained human bioptata in our study showed no smear layer or debris bone fragments attached to the cutting surface (Figs. 3 & 4). Those findings correlated to the results of Romeo et al. in their *in vitro* trial on fresh porcine mandibles and also could explained the benefits for bone healing after laser bone ablation proved by Kesler et al. in rats models.[1,4] Probably the increased blood elements adhaesion potential ensured by laser irradiation due to the absence of any smear layer enhancde the start of the remodeling process.[1,10] The non-complicated postoperative period in our study confirmed that all tissue changes histologically approved on the biopsied specimens were harmless with regard to the bone healing in humans.

Conclusion

The microscopic observations in the presented study showed that both the type and quality of bone transformations is attributed to the cutting mechanism per se. Tissue changes in human bone following *in vivo* laser- and ultrasound-assisted osteotomy established on the evaluated samples proved the tolerable effects of the two studied tools toward the vital human bone. The choice of adequate osteotome should be always influenced by evidence-based results. The Er:YAG laser offers advantages over ultrasound osteotomy techniques because of the non-contact intervention, with no mechanical vibration, free-of-debris cutting lines and aseptic effects. Nevertheless, with adequate training and experience, the surgeon is able to use this device for certain and selective procedures in bone surgery._

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Im Vorfeld zum Verfassen des Artikels recherchierten die Autoren ihre Analyseergebnisse zur Zellregeneration nach Ultraschall sowie Laserosteotomie im Vergleich zu rotierenden Instrumenten. Da die bisher vorliegenden Studien zu diesen Themen nicht zwingend auf menschliche Zellen anwendbar waren, zielt der hier präsentierte Bericht auf einen histologischen Vergleich der Zellveränderungen nach *In-vivo*-Einschnitten in menschlichen Knochen durch Ultraschall sowie Er:YAG-Laser während der Extraktion geschädigter mandibulärer Weisheitszähne.

Die mikroskopischen Untersuchungen zeigten, dass sowohl Art als auch Qualität der Knochenveränderungen in starker Abhängigkeit zu den angewendeten Schneidmechanismen standen. Zellveränderungen im menschlichen Knochen in *In-vivo*-Laser- sowie Ultraschallosteotomie resultierten in den untersuchten Proben tolerierbare Effektive der zwei Instrumente auf das vitale humane Knochengewebe. Die Auswahl des passenden Osteotoms sollte immer auf evidenzbasierten Ergebnissen beruhen. Aufgrund der kontaktfreien Intervation ohne mechanische Vibration, ablagerungsfreien Schnittkanten sowie seiner aseptischen Effekte besitze der Er:YAG-Laser deutliche Vorteile im Vergleich zur Ultraschalltechnologie.

Literature

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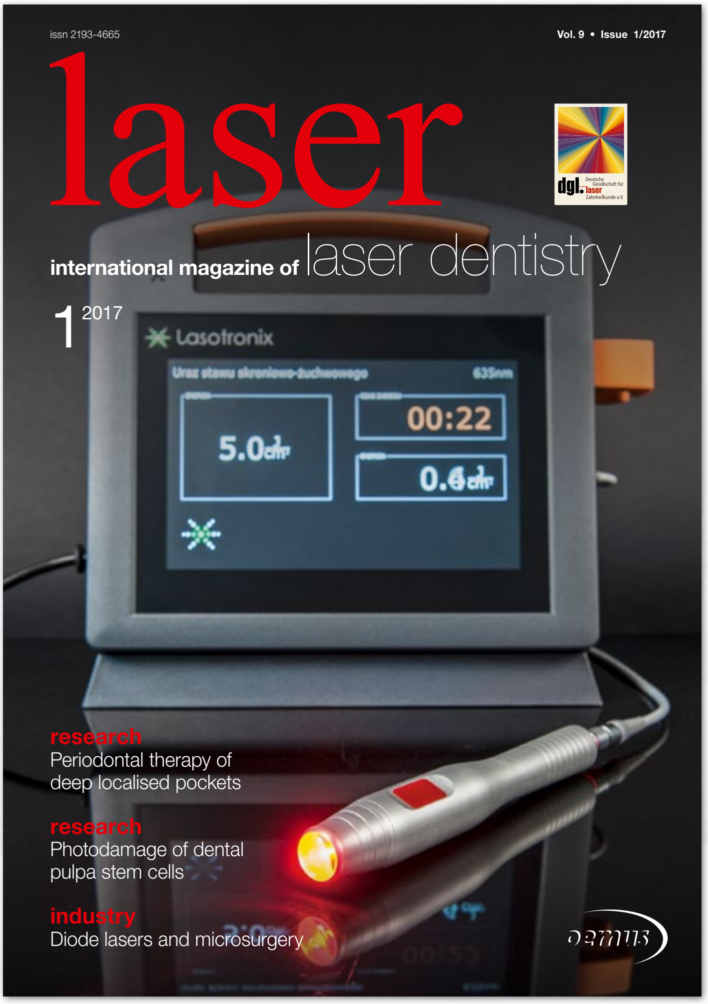

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Diode lasers and microsurgery

Author: Dr Isabelle Nguyen, France

Many families of dental lasers have become available in recent years. Throughout this article we will review a diode laser, which is unusual in that it supports three different wavelengths in the same device. A large number of studies have awakened interest in near infrared wavelengths, 970 nm for example, which enable the use of high penetration lasers for disinfecting endodontic canals and periodontic pockets. The 660 nm wavelength promotes biostimulation.

Diode lasers can be used for surgical applications in mucous tissue, though it should be noted that bleeding from the tissue has always occurred because the rays penetrate the tissue below, thus requiring caution when heating the tissue underlying the target tissue. The factors above resulted in a new wavelength of 445 nm—in the blue range—as a potential solution for dealing with mucous tissue as it is more readily absorbed by haemoglobin (Fig. 1). As it is not possible to cover the wide range of potential uses of diode lasers in a single article, we will focus here on their microsurgical applications.

Creating pontics

In the presented case, there was an old bridge with three incisors and reduced intercanine space, but the patient refused orthodontic treatment. Figure 2a shows the initial state in which two pontics were implemented with a 970 nm 3 W CW diode laser to recreate the emplacement for two central posts under local anaesthesia with air/water irrigation (Fig. 2b). There was no bleeding, which simplified the work of preparing and installing the temporary resin bridge (Fig. 2c). An examination of scar healing was performed seven days later (Fig. 2d). An impression was then made for the permanent bridge (Fig. 2e). Figure 2f shows the permanent bridge when installed.

Widening the sulcus

The diode laser is an excellent alternative to the conventional technique for widening the sulcus before creating an impression. It makes avoiding undesired secondary gingival retractions possible as its use in these cases requires less force, and since the

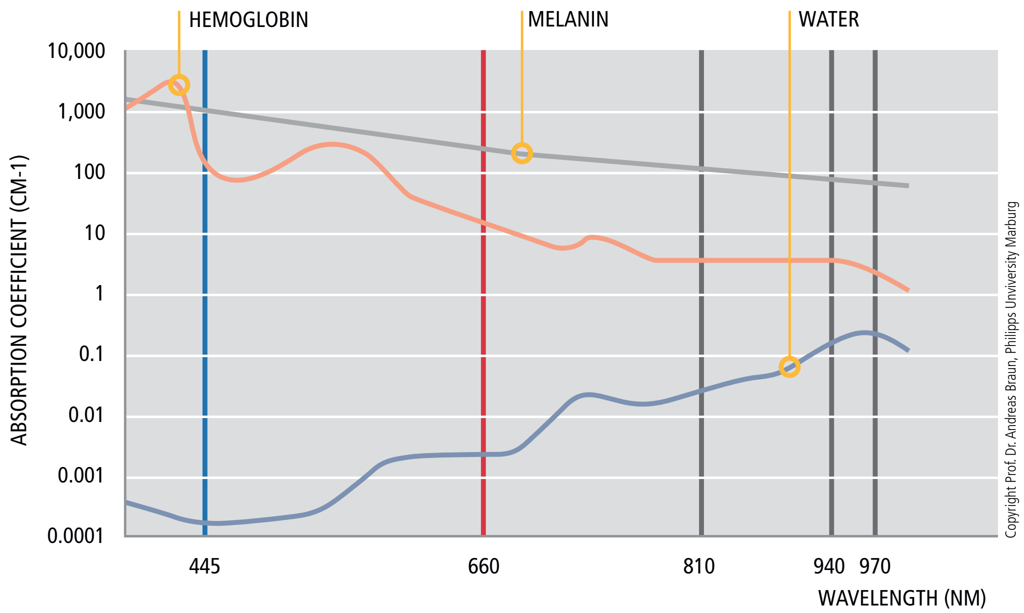


Fig. 1: Influence of different laser wavelengths on haemoglobin, melanin and water.

Fig. 2a: Initial state: two pontics were implemented with a 970 nm 3 W CW diode laser.
Fig. 2b: Recreation of the emplacement for two central posts under local anaesthesia with air/water irrigation.
Fig. 2c: Preparation and installation of the temporary resin bridge.
Fig. 2d: Examination of scar healing after seven days.
Fig. 2e: Impression-taking for the permanent bridge.
Fig. 2f: Installation of the permanent bridge.

temperature remains under 60 °C, the treatment is always in the reversible range and the tissue that is removed will be restored (Table 1). With its biostimulatory action, the diode laser promotes high-quality healing of wounds in the target tissue.

Figure 3a shows the peripheral subgingival preparation of tooth 16. Figure 3b shows the opening of the sulcus with a 970 nm, 1.2 W diode laser with air/water irrigation and without anaesthesia. The CEREC® crown can then be bonded within one hour under supragingival conditions (Fig. 3c). A follow-up examination on D+7 shows that the gingiva had returned to its original position (Fig. 3d).

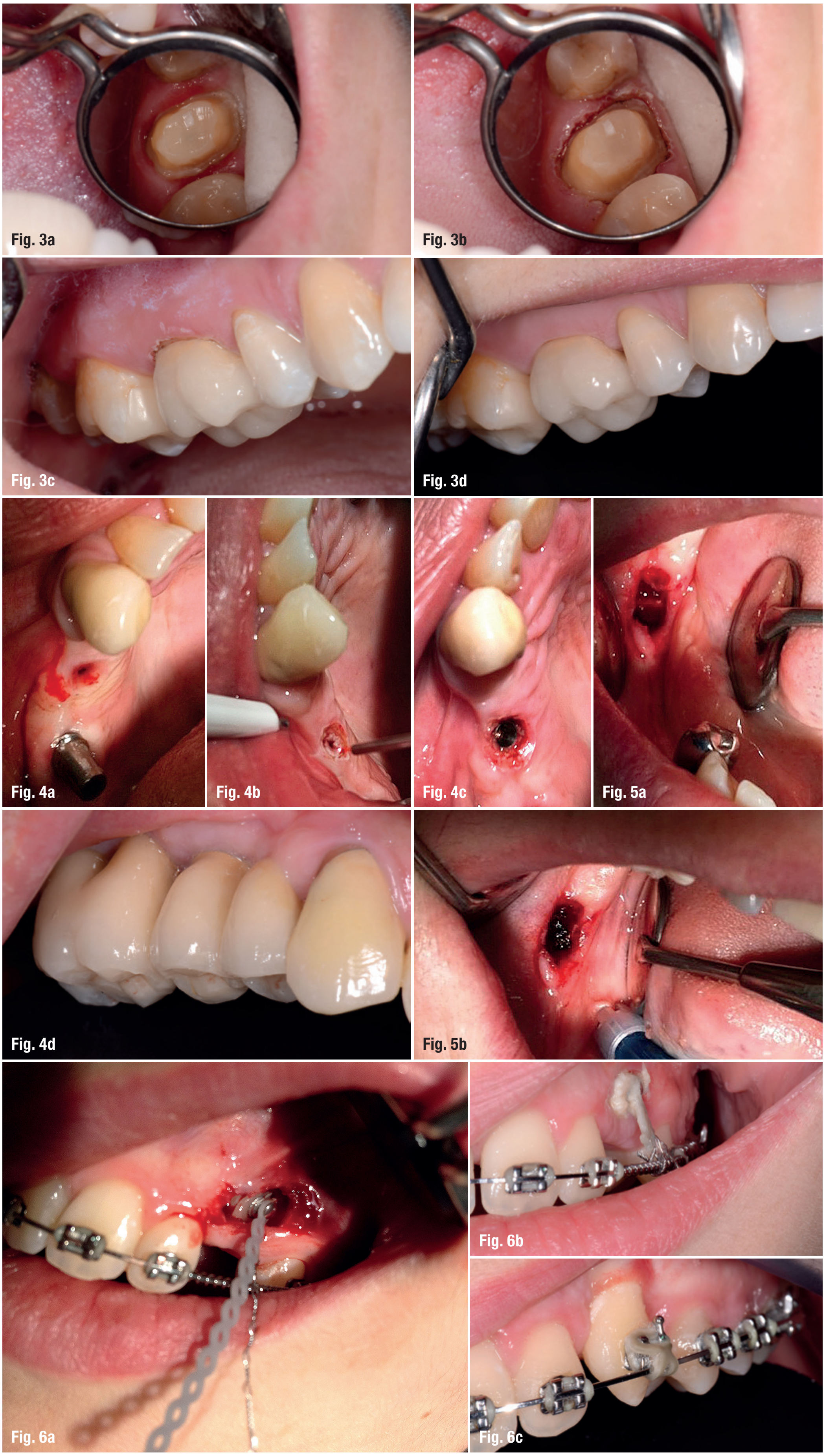
Detaching the implant and implant abutment

In implant applications, it is important to note the axis of the laser fibre to avoid aiming it directly at the implant or touching it. Working with an air/water irrigation circuit prevents the implant system from be-

Temperature °C	Thermal effect of laser energy on soft tissue
45	Vasodilation
50	Disruption of cellular activity
60	Denaturation of proteins
70	Denaturation of collagen
80	Carbonization and cellular necrosis
100	Dehydration by vaporization of water
> 100	Evaporation of tissues

Tab. 1: Overview on thermal effects of laser on soft tissue.

Fig. 3a: Peripheral subgingival preparation of tooth 16.
Fig. 3b: Opening of the sulcus at 970 nm, 1.2 W (diode laser) with air/water irrigation and without anaesthesia.
Fig. 3c: Bonding of the CEREC® crown after one hour.
Fig. 3d: Follow-up examination after seven days.
Fig. 4a: Covering of implant head 14.
Fig. 4b: Introduction of a wider, higher gingiva former.
Fig. 4c: Wound healing after two days, impression-taking.
Fig. 4d: Bridge on implants 14/16 in location.
Fig. 5a: Biostimulation at 660 nm to induce bleeding.
Fig. 5b: Haemostasis.
Fig. 6a: Surgical exposure with a 970 nm 3 W laser and bonding of the bracket at 23.
Fig. 6b: Follow-up after one day.
Fig. 6c: Follow-up after five months.



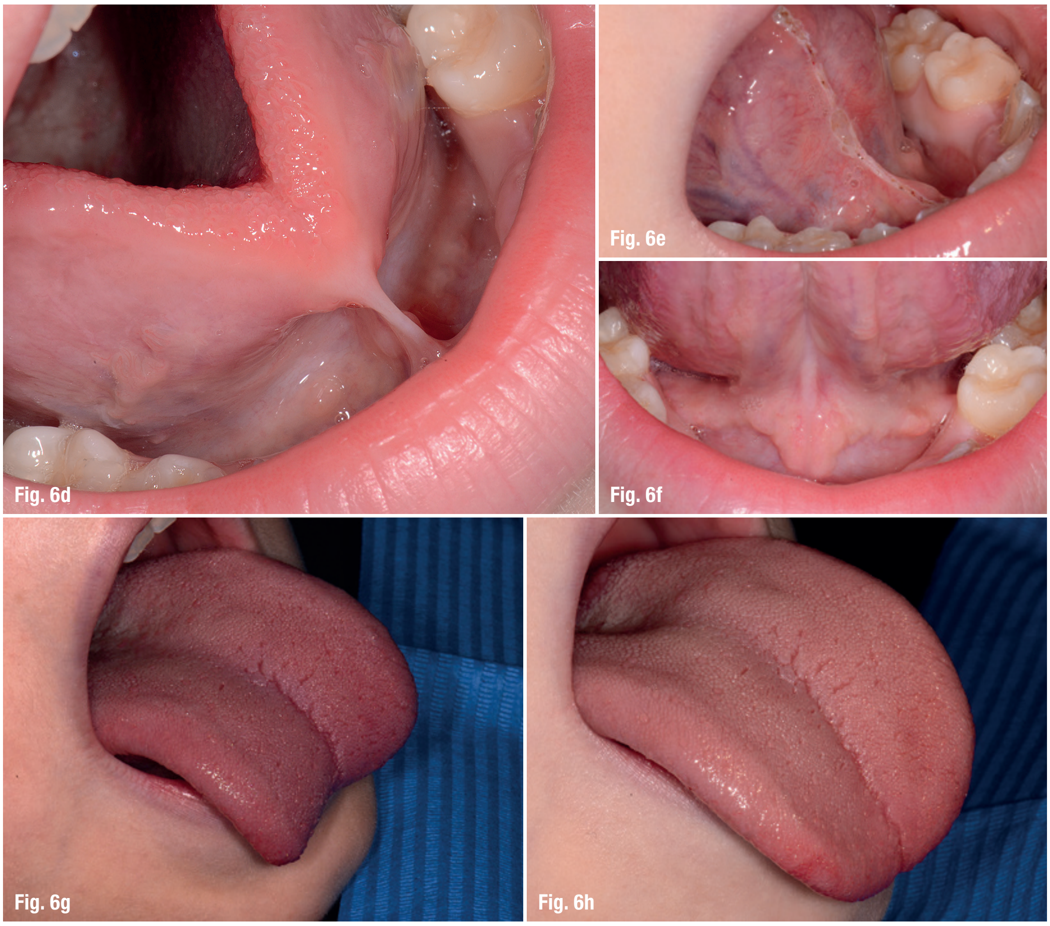


Fig. 6d: Initial frenulum.
Fig. 6e: Rapid frenectomy with 445 nm 2 W laser under local anaesthesia.
Fig. 6f: Follow-up after five days.
Fig. 6g: Lateral view of the tongue before frenectomy.
Fig. 6h: Lateral view of the tongue after frenectomy.

coming heated. Now we turn to irreversible gingivectomies (Table 1).

Of course in this clinical context, as the gingival thickness conditions are favourable, there was no need to thicken the gingiva by creating a tissue flap. The implant head 14 was covered (Fig. 4a), and it was exposed with the 970 nm 3 W CW laser before the introduction of a wider, higher gingiva former (Fig. 4b). Figure 4c shows wound healing on D+2; the impression was then made. Finally, the bridge on implants 14/16 were in location (Fig. 4d).

Haemostasis

Clinical case: extraction from alveolus 38. The interradicular alveolar wall is still visible just after the extraction, and it was decided to biostimulate at 660 nm to induce bleeding (Fig. 5a). Haemostasis with the 445 nm 2 W diode laser at a distance of 2 mm is shown in Figure 5b.

Laser and orthodontics

The general dental practitioner can also use a laser as an aid in certain orthodontic treatments, such as gingivectomies in cases of hypertrophy, thus improving the dental hygiene of young patients, and also for gaining traction on impacted teeth (Figs. 6a to 6c) and for frenectomies (Figs. 6d to 6h).

Surgical exposure with a 970 nm 3 W laser and bonding of the bracket at 23 is shown in Figure 6a. Follow-up at D+1 month is seen in Figure 6b. Follow-up at D+5 months in Figure 6c and the initial frenulum is shown in Figure 6d. Rapid frenectomy with 445 nm 2 W laser under local anaesthesia is shown in Figure 6e, along with the follow-up at D+5 in Figure 6f. The lateral view of the tongue before is displayed in Figure 6g and after in Figure 6h.

Realignment of crowns

Preprosthetic treatment of mucous tissue with diode laser promotes rapid, painless wound healing; healing times are faster and fewer dental appointments are required. The initial state is depicted in Figure 7a. The crowns at 21, 22 and 23 must be realigned after determination of the depth of the biological space and of the gingival heights.

The mock-up serves as a guide for marking out the new crowns with the 445 nm 2 W diode laser (Figs. 7b and 7c). Preparation and digital impression are completed on the same day under periapical anaesthesia. Examination of the surgery and CEREC

Fig. 7a: Initial state.
Figs. 7b & c: The mock-up serves as a guide for marking out the new crowns with the 445 nm 2 W diode laser.
Fig. 7d: Examination of the surgery and CEREC walls at 13 to 23.
Fig. 7e: Follow-up examination of the gingiva after one month.
Fig. 7f: Patient's smile before surgery.
Fig. 7g: Patient's smile after surgery.

walls at 13 to 23 shows that the fibrin is already visible (Fig. 7d). Follow-up examination of gingiva D+1 month is shown in Figure 7e. The patient's smile before the surgery is shown in Figure 7f and after the surgery in Figure 7g.

Conclusion

Patients treated with diode lasers unanimously agree that the surgery causes them no discomfort. Clinically, we observe rapid wound healing and high-quality results from diode lasers. Surgeries performed with a wavelength of 445 nm are effective because they are completed faster and cause less contact bleeding than surgeries using a wavelength of 970 nm. Use of the laser in general dental practices increases the level of operating comfort for the dental team and considerably increases patient satisfaction as well._

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Die Autorin stellt im Artikel das breit gefächerte mikrochirurgische Anwendungsspektrum des Diodenlasers vor. Dabei werden unterschiedliche Laserwellenlängen zwischen 445 nm und 970 nm evaluiert. Anwendungsfelder wie das Erstellen von Pontics, Sulkuserweiterungen, das Herausnehmen von Implantaten oder Implant-Abutments, die Hämostase, die Neusausrichtung von Kronen und der Lasereinsatz in der Kieferorthopädie werden anhand von Beispielfällen umrissen. Abschließend fasst die Autorin zusammen, dass Patienten durch den Einsatz des Diodenlasers weniger Unannehmlichkeiten nach einer chirurgischen Behandlung verspüren. Klinisch wurden nach Anwendung des Diodenlasers eine schnellere Wundheilung und hochqualitative Behandlungsergebnisse beobachtet. Außerdem werden laut Artikel operative Eingriffe, die mithilfe eines 445 nm-Diodenlasers durchgeführt wurden, effektiver umgesetzt, da sie in kürzerer Zeit beendet werden können und dabei weniger Kontaktblutungen auftreten als bei einer Wellenlänge von 970 nm. Die Anwendung von Lasern in allgemeinzahnmedizinischen Praxen habe den Anwenderkomfort auch für das Praxisteam erhöht und die Patientenzufriedenheit deutlich verstärkt.

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The application of erbium laser in dental surgery

Author: Dr Kinga Grzech-Lesniak, Poland

Laser therapy has become a real and extremely promising alternative to classical surgical approaches in dental surgery. Beside their cutting and tissue ablating power, the lasers have a number of effects on tissues which can be used in healing enhancement. The application of high-power lasers in dental surgery has been known for many years. The literature gives the examples of laser usage in procedures such as frenectomy, operculectomy, preparation of the prosthetic field, removal of the lesions of the oral mucosa. Lasers are described as particularly useful tools because of their coagulation properties, especially in hard-to-reach areas, where suturing or hemostasis is difficult.

The use of Er:YAG laser with a wavelength of 2,940 nm to perform almost end-to-end flap procedures is no more a novelty described in the literature and neither is it controversial. On the contrary, it has been observed that the time needed for the procedure and wound healing is shorter and generates lower cost.

Figs. 1–3: Pre-op situation.
Figs. 4–6: Incision along the bursa gingivalis from the vestibular side with the use of Varian/H14 fiber (Fotona).


Fig. 1


Fig. 2


Fig. 3


Fig. 4

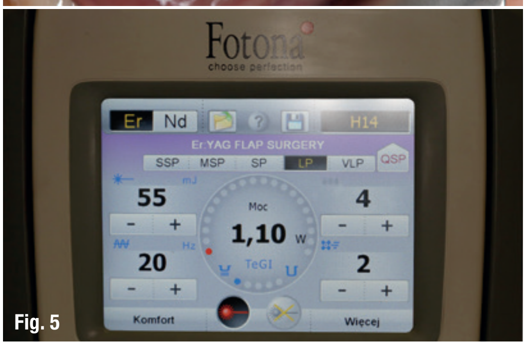


Fig. 5


Fig. 6


Fig. 7


Fig. 8


Fig. 9


Fig. 11


Fig. 10

Fig. 12


Fig. 13

Figs. 7–9: Incision from the palatal side.
Figs. 10–13: After separating the full-thickness flap, the flap and the bone cavity is cleaned from the granulation tissue.

This laser is used in surgery, because, besides of the cutting process, there are effects of photocoagulation and ablation obtained by evaporation of the tissues. Absorption and penetration of laser light depends on its physical parameters, such as wavelength, power, dose of energy, water, haemoglobin and melanin content in the tissue, extent and type of lesion.[1] Advantages of this tool are high precision of cutting due to the possibility of strong focusing of the laser beam and high selectivity, that is, affecting only the tissues absorbing a specific wavelength. Another advantage is the possibility of non-contact treatment of tissues (with non-contact laser tips).

Due to the use of laser therapy the procedures until now performed with classical surgery, which had previously been very onerous for the patient, now are safer, less invasive and often more successful than classic ways of treatment.[2] High-power laser is also effective in removing laesions such as epulis, fibroma, papilloma, and precise treatment of the periodontium, such as gingivectomy and the removal of vascular lesions.[3,4]


Fig. 14


Fig. 15

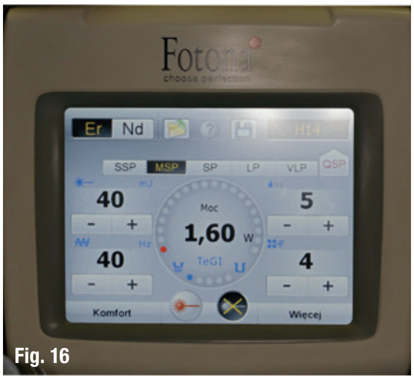


Fig. 16

Figs. 14–16: Periodontal debridement, removal of subgingival calculus and from the root surface.

Figs. 17–19: View of the cavity cleaned by Er:YAG laser just before the closing of the flap.
Figs. 20–21: Stitching up the surgical area.
Figs. 22–23: Check-up two weeks post-op.
Fig. 24–27: Pre-op situation.
Figs. 28 & 29: Patient after hygienic procedures, prepared for the surgical procedure.


Fig. 17


Fig. 18


Fig. 19


Fig. 20


Fig. 21


Fig. 22


Fig. 23


Fig. 24


Fig. 25


Fig. 27

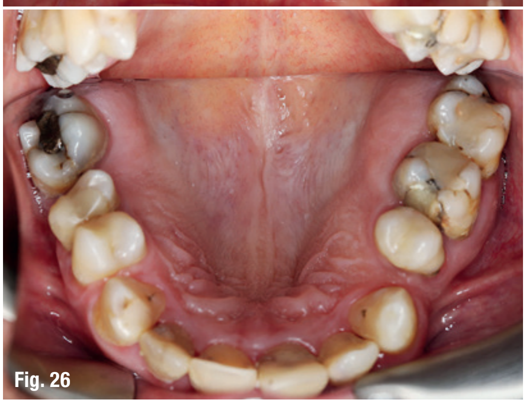
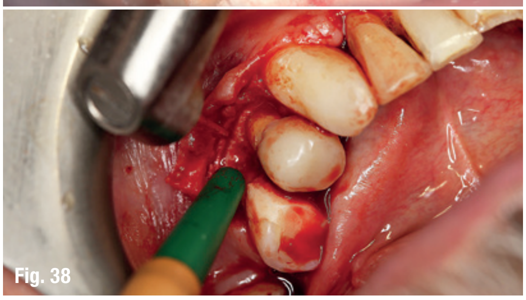


Fig. 26


Fig. 28


Fig. 29



Figs. 30–32: Laser incision of the soft tissue.
Figs. 33–38: Osteoplasty, laser crown lengthening.
Fig. 39: Stitching up the surgical area.

Vescovi et al. described the surgical treatment of osteonecrosis of the jaws (ONJ) by means of Er:YAG laser in patients during bisphosphonates therapy (BPT). They documented that early surgical treatment with the use of Er:YAG laser associated with LLLT laser therapy, bisphosphonates therapy in patients with osteonecrosis of the jaws (ONJ) is more successful, compared to the conventional therapy.[5]

Lasers are also sucessfully used in surgical crown lenghening. Stages of these procedure include:

– Performing an incision in order to create a flap. In these cases Er:YAG LightWalker (Fotona) laser was used, with the handle H14 with Varian tip (in Case 1) and sapphire tip (in Case 2). The energy of 55 mJ, 20 Hz, power of 1.10 W with Varian tip, and 40 mJ, 10 Hz, 0.4 W using the tip intended for cutting soft tissues (contact mode).

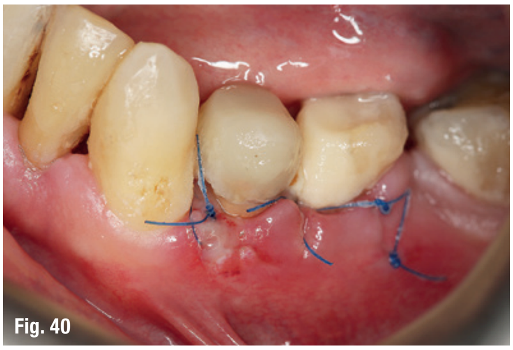


Fig. 40: Situation two days post-op.

- Removal of granulation tissue with the chisel type tip (1.5 x 0.5 mm) with 180 mJ, 20 Hz, 3.6 W.
- Laser periodontal debridement—40 mJ, 40 Hz, 1.6 W (Varian tip).
- Deepithelialisation of the flap, suturing with micro-surgical sutures and post-op patient instruction.

Case 1

A 43-year-old female patient has been referred by her dentist in order to perform surgical crown lengthening because of tooth 14 distal part of the root caries. Due to the fact that the patient is a diabetic, the procedure was performed with a Er:YAG laser with a wavelength of 2,940 nm (LightWalker, Fotona). Each surgical procedure in patients with diabetes involves high risk of complications, thus reduction of bacteremia, increased sterility and immediate disinfection of soft- and hard-tissues are advisable.

Case 2

A 52-year-old male patient was referred by his dentist for surgical crown lengthening flap procedure due to teeth 34 and 35 root caries. Laser incision, cleaning of granulation tissue from the flap and the bone defect with the use of laser (periodontal debridement) and osteoplasty were performed. In this case a conventional laser tip was used (chisel sapphire tip 1.5 x 0.5 mm).

Summary

In the presented cases, flap procedures performed with the use of Er:YAG LightWalker improved the healing-tissue parameters significantly, shortened the healing time, and reduced the costs of the surgery. From the patient's point of view, there was a significant improvement in the treatment comfort and effectiveness through the anti inflammatory and sanitising effect of the laser.

Nowadays the usefulness of erbium lasers both in surgical procedures in daily work of the dentist is highly estimated and will grow significantly in future years. The enhanced effects of the procedure and better healing of soft- and hard-tissues afterwards undoubtedly affects comfort, mental well-being, and the quality of life of the patient._

contact

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Kurz & bündig

Nachdem die Autorin die Vorteile von Laseranwendungen im Dentalbereich beschreibt, geht sie auf die einzelnen Behandlungsschritte der laserbasierten chirurgischen Kronenverlängerung ein. Dabei wird in einem ersten Schritt ein Einschnitt für die Lappenbildung gemacht. In den später vorgestellten Patientenfällen wurde dazu ein Er:YAG-Laser der Firma Fotona (LightWalker) mit einem H14-Handstück sowie der Varian-Spitze (Fall 1) und Saphirspitze (Fall 2) verwendet. In Fall 1 wurden eine Energiestärke von 55 mJ, 20 Hz und eine Leistung 1,10 W, in Fall 2 40 mJ, 10 Hz, 0,4 W verwendet. Dabei wurde die Spitze für einen sanften Gewebeschnitt (Kontaktmodus) genutzt. Es folgte die Entfernung von Granulationsgewebe mit der Saphiermeißel-Arbeitsspitze (1,5 x 0,5 mm) mit 180 mJ, 20 Hz und 3,6 W. Nach dem Laserscaling der Wurzeloberfläche (Varian-Spitze, 40 mJ, 40 Hz, 1,6 W) wurde abschließend eine Deepitheliasierung des Lappens durchgeführt. Vernäht wurde mit mikrochirurgischem Nahtmaterial 6/0. Abschließend erhielt der Patient Empfehlungen für die Nachsorge. Nachdem die Autorin kurz zwei Fallbeispiele erläutert, fasst sie abschließend die Vorteile der Laseranwendung zusammen: Durch die Laseranwendung habe sich in den vorgestellten Fällen die Gewebeheilung erheblich verbessert, die Heilungsdauer und die Behandlungskosten reduziert. Weiterhin führe der Laser zusätzlich zu entzündungshemmenden und desinfizierenden Effekten, sodass sich insgesamt der Behandlungskomfort für den Patienten deutlich verbessere.

Literature

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BIC.: AACSDE 33

Membership application form

Name/title: ______________________________

Surname: ______________________________

Date of birth: ______________________________

Approbation: ______________________________

Status: ☐ self-employed ☐ employed ☐ civil servant ☐ student ☐ dental assistant

Address:

Street: ____________________ Phone: ____________________

ZIP/city: ____________________ Fax: ____________________

Country: ____________________ E-Mail: ____________________

With the application for membership I ensure that

☐ I am owing an own practice since ______________ and are working with the laser type ____ (exact name).

☐ I am employed at the practice ____

☐ I am employed at the University ____

I apply for membership in the German Association of Laser Dentistry (Deutsche Gesellschaft für Laserzahnheilkunde e.V.)

____

Place, date Signature

Annual fee: for voting members with direct debit € 150

In case of no direct debit authorisation, an administration charge of € 31 p.a. becomes due.

DIRECT DEBIT AUTHORISATION

I agree that the members fee is debited from my bank account

Name: ____________________ IBAN: ____________________

BIC: ____________________ Credit institute: ____________________

____

Signature of account holder This declaration is valid until written notice of its revocation

reddot award 2016
winner

A novel Er:YAG dental laser-in-handpiece technology

Author: Georg Isbaner, Editorial Manager

Fig. 1

Fig. 1: Eric Ben Mayor, CEO of Light Instruments Ltd.

During the upcoming IDS show taking place on 21–25 March in Cologne, Germany, Light Instruments Ltd., the inventor of the revolutionary Laser-in-Handpiece™ technology, will unveil a new LiteTouch™ model. In a recent interview with the CEO of Light Instruments Ltd., Eric Ben Mayor, Georg Isbaner, Editorial Manager of laser international magazine of laser dentistry, talked about the company, the new management, vision of the company and the new LiteTouch model.

Ben Mayor, an Advocate with two and a half decades of experience at senior executive management and international business, provides ongoing consultancy and legal services to multinational companies, mainly in the field of acquisitions, mergers and international business development in the medical and dental field. He also advises large corporations on building strategic corporate visions and creating shareholder value for multinational companies. We asked Ben Mayor to tell us about Light Instruments Ltd.

Ben Mayor: Light Instruments Ltd. is the world's leading provider of next-generation dental laser technology for soft- and hard-tissue treatments. In 2007, Light Instruments introduced its revolutionary and innovative Laser-in-Handpiece™ technology as part of its flagship LiteTouch™ product, the world's versatile non-fiber Er:YAG dental laser device for soft- and hard-tissue dental treatments. The company was recently acquired by Sino-Lite Ltd., an Israeli corporation specialising in acquisitions, development and management of medical and dental companies. Since the acquisition, the company's business model has been evolving and the new model reflects and supports our customers' needs. We have made a significant investment to upgrade interactions with our clients and to give them what they need. This is part

of our commitment to provide industry-leading customer service.

Light Instruments is famed for its flagship product—LiteTouch™. What makes it valuable to the dental laser market?

LiteTouch™ is the world's smallest Erbium YAG dental laser for both soft- and hard-tissue dental treatments. The unique "Laser-in-Handpiece™" technology houses the entire laser mechanism within a small sized chamber (12 cm long and 2.5 cm in diameter). This innovative solution mimics the feel of the turbine drill, yet incorporates the laser's unique benefits: micro surgery, faster healing, minimal invasive treatments and higher acceptance of patients to dental treatments.

Please share with us the highlights of the new LiteTouch™ model.

Among the new model's features is an intuitive touchscreen for complete control with various adjustable pre-set options and comprehensive status updates. This powerful function in an addition to our LiteTouch™ applicator's manœuvrability, allowing dental practitioners easy and rapid operations. Thanks to this unique utility LiteTouch™ new users will definitely enjoy a very short learning curve. The new development includes improved and robust hardware architecture, composed of sub-assemblies for easier service, as well as an integrated built-in power meter (energy tester). The company has also optimised the LiteTouch™ software and included lower energy options as well as different language possibilities.

Has the new LiteTouch™ model gained any industry award?

Yes, the new LiTeTouch™ model was given the important Red Dot Award for product design. This new model is significantly smaller, compact in size, lightweight and with small footprint. Thanks to its design, it is easily portable and has a streamlined look. It is sold in a variety of different colours and modern lasing illumination and contributes to the welcoming atmosphere in the clinic.

How has the new LiteTouch™ model introduction to the market been so far?

Our new LiteTouch™ was first launched at the Greater New York Dental Meeting in November 2015 in the USA. AMD Lasers, our distributor in the US, is the most experienced player in the US dental laser market and is already gaining a huge market share with strong penetration percentages.

We asked Prof. Roly Kornblit—DMD DDS Ms.—Light Instruments' Scientific Advisor: Based on your experience, what in your opinion is LiteTouch™ future contribution to the dental laser market?

With LiteTouch™, dentists can improve treatment results and increase patients' satisfaction in restorative dentistry, periodontics, endodontics, pedodontics, aesthetic dentistry and implantology. LiteTouch™ abilities for ablative and sub ablative procedures, with different treatment modes, Hard/Soft/Gentle, provide a wide range of applications. Thanks to the new generation of Er:YAG laser, every dentist can enjoy laser benefits and truly perform soft- and hard-tissue procedures, with full and free expression of their dental mastery and experience. The growing number of users and key-opinion leaders worldwide, adopting this technology is vital proof of it.

What can customers expect from your IDS presentation in March?

We are pleased to launch the new LiteTouch™ model at the IDS, continuing to execute our vision of developing the latest cutting edge technologies and products. We believe that the new LiteTouch™ model is a breakthrough product. We will continue to provide superior products with the highest technology in the near future. I would like to use this opportunity to invite all dentists to participate in Light Instruments` Scientific Conference in August 2017, on board the luxurious Celebrity Infinity cruise to Alaska, an exclusive opportunity to learn more about Laser Dentistry with world renowned experts, while enjoying the spectacular scenery of Alaska. The new LiteTouch™ model will definitely be there rising above technology!

The new LiteTouch™ model will be unveiled at the IDS in Cologne, Germany, during 21–25 March 2017. R.S.V.P at Office@light-inst.com. For more information, please visit: http://light-inst.com._

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Successful communication in your daily practice

Part I: Grumbling patients

Author: Dr Anna Maria Yiannikos, Germany & Cyprus

Imagine getting to your clinic every day and feeling confident that whatever happens to you, you will be able to resolve it. Resolve a problem easily—in a way that not only you will feel happy with yourself but also your patients and staff will stay loyal to you, because they will also be happy with the service and solutions you provide them!

You might be one of the best dentists in your area that has all the knowledge, the experience and the latest technology. But your clients do not see that, they might not understand it. Maybe they cannot see your expertise because of the way you are dealing and communicating with them; maybe your way of communication is not clear enough or not at the level that some of your clients desire!

This is my gift for you today: A whole new series of the most popular and challenging scenarios that might happen at your dental practice and how you will deal with them so that your patients will leave your practice with the feeling: "My dentist is THE BEST!"

How to deal with...grumbling patients?

Let's start with the first script: How to deal with a patient that complains just for the sake of complaining? In the following, I will introduce to you 5 steps of how to deal with this problem successfully and peacefully.

How many times have we completed an excellent work or have we followed every step of the treatment protocol (for example whitening)? How many times have we informed our patient in detail regarding any discomfort that he or she might feel during a treatment? But the patient still loves to grumble: "Doc, I feel..., the bleeding is excessive..., I have such sensitivity after the whitening..." and so on.

5 steps for a successful communication

Of course, in view of such a patient you might get upset, angry or frustrated; this is absolutely normal and an expected reaction. The important thing is to deal with your patients, to keep them and nothing else. Let's investigate now the steps that we can apply to get a successful result.

Step 1: Breath

I know it's hard to not get angry with grumbling patients, but let's vision ourselves as the conductor

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of an orchestra: We are responsible to guide them all in the path that we desire.

Step 2: Listen

What is the real problem? Maybe the patient just wants to be listened at and pampered a little bit? Or she wants her 'problem' to be resolved by giving her something back (see Step 3). Of course, she has nothing to complain about, everything is normal and expected, but you will never say that to her!

Step 3: Act accordingly

Give your patient something so that she will feel that her problem is acknowledged and that it will be resolved immediately by you—her trusted doctor! This could be an advice like "Do not rinse for 6 hours", or a prescription as "Use this cream, it will reduce the sensitivity".

Step 4: Follow-up

Of course, it is a must to call her and check that she is all right some hours before she calls you (which might the same or the next day, it depends on the case).

Step 5: Ask the right question!

Do never ask her: "Is everything all right?" Why not? Just because of the fact that she will then start complaining again. Ask instead: "I just call to check that everything is ok!" By using this phrase you will not allow space or thought for more complains.

It is so simple!

Start using the described 5 steps each time that you have this 'invisible problem'. At least, try it as an experiment and see if it works for you as well! Write me your comments or even add-ins. I will love to hear them!

In the next issue of laser magazine, I will present you the second part of this new series of communication concepts that will teach you with 5 simple steps how to shush the patients that have too many questions with courtesy and caring. Until then, remember that you are not only the dentist of your clinic, but also the manager and the leader. You can always send me your questions and request for more information and guidance at dba@yiannikosdental.com or via our website www.dbamastership.com. Looking forward to our next trip of business growth and educational development!_

contact

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Kurz & bündig

Im ersten Teil ihrer neuen Serie zum Thema erfolgreiche Kommunikation im Praxisalltag gibt unsere Autorin fünf Tipps, wie Zahnärzte erfolgreich mit notorisch unzufriedenen Patienten umgehen können. Denn ein grundlos meckernder Patient kann aufseiten des Behandlers schon mal schlechte Laune hervorrufen. Der erste Schritt für eine harmonische Kommunikation ist daher: Durchatmen! Im zweiten Schritt rät die Autorin, genau darauf zu hören, was der Patient eigentlich will. Oftmals möchte er oder sie einfach ein bisschen mehr Aufmerksamkeit. Diesem lässt sich wie in Schritt drei beschrieben, mit einigen zusätzlichen Empfehlungen oder Handlungsvorschlägen begegnen. Im vierten Schritt geht es dann darum, den Patienten nach seinem Befinden zu fragen, noch eher dieser es geäußert hat. Ganz wichtig dabei: Keine Frage stellen – wie in Schritt 5 beschrieben –, sondern eine Aussage im Sinne von „Ich wollte nur mal hören, ob alles ok ist" formulieren. Auf diese Weise nehmen Sie Ihrem Patienten den Wind aus den Segeln und geben ihm, was er braucht. In der nächste Ausgabe gibt die Autorin Tipps, wie Sie Patienten mit vielen Fragen elegant begegnen können.

Fig. 1

6th Laser Dentistry Congress of WFLD-ED

Author: Dr Dimitris Strakas, Greece

Fig. 1: The 6th Laser Dentistry Congress of WFLD-ED will be held in Thessaloniki, Greece. For this reason, the congress logo is designed after the Thessaloniki "Umbrellas", a famous artwork by sculptor Giorgios Zoggolopoulos.

The World Federation for Laser Dentistry (ISLD before 2006) has been founded in 2008 and its aim is to serve as a non-profit medium for the exchange, advancement and dissemination of scientific knowledge, elated to the use of lasers for application and research in the oral and dental environment.

After almost 30 years, it is the foremost known organisation for laser dentistry. The European Division of WFLD is one of the most active divisions and had its first congress in Nice already in 2007. The successful event was continued every two years and the cities that hosted it were Istanbul in 2009, Rome in 2011, Brussels in 2013 and Bucharest in 2015.

With the moto "Bringing Laser to Sunlight", the second largest city of Greece, Thessaloniki, is hosting the upcoming 6th Laser Dentistry Congress of WFLD-ED, on 22 and 23 September 2017.

The Congress Logo is a mix of the well-known landmark of "The Umbrellas" in Thessaloniki and the wavelength analysis of the visible spectrum. Thessaloniki has been selected not only for the stunning views, the fabulous promenade by the port, the easy access via the Makedonia Airport (SKG), the wonderful culinary experiences and the numerous modern bars and cafes, but, more importantly, for the Dental School of the Aristotle University of

WFLD-ED 2017 THESSALONIKI GREECE BRINGING LASER TO SUNLIGHT

Thessaloniki which has had its own Dental Laser Clinic since 2012.

With this big step towards laser dentistry, Thessaloniki is pioneering as the only dental school in Greece offering under-graduate and post-graduate education on lasers for future dentists. Thessaloniki's Aristotle University and its Dental School give us their full support for our upcoming congress.

Taking a look back on the past congresses and fully understanding the current financial problems in Europe, we decided to lower the registration fees and sponsor fees without lowering the quality of the congress. The aim is to attract many dentists to make Thessaloniki Congress a milestone for our federation.

Our official website (wfld-thessaloniki2017.com) is fully functional and has all the information that a participant needs, including call for abstracts, registration form and a direct link to the hotel reservation page, where a discounted room price for congress participants can be found. Of course you can find us on Facebook where we update frequently news on our upcoming event.

We are very happy to already have many sponsors that will also be present with their booths in our congress exhibition area and we are confident that all laser companies will be present with their current and new devices being introduced to the dentists and which are involved in one of the most advanced technological fields in our profession, dental lasers.

Call for papers is already open and we invite all laser clinicians to show and share their knowledge, techniques and experimental findings in the fields of laser dentistry. We are expecting all of you for a magnificent event, not only scientifically due to our prestigious invited speakers, but also in form of social events.

So let us bring laser light to sun light! You are all cordially invited._

contact

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manufacturer news

BIOLASE

Worldwide launch of new all-tissue laser system

BIOLASE, the global leader in dental lasers, announced today that its new, fifth-generation Waterlase Express™ all-tissue laser system, having received 510(k) clearance for commercial distribution from the US Food and Drug Administration (FDA), is available for immediate sale to dentists in the US as well as select international markets in Europe, the Middle East and Asia. Waterlase Express will first be unveiled internationally in Cologne, Germany, at the International Dental Show (IDS), which is the world's leading trade show for the dental industry.
With extensive qualitative and quantitative research from a team of dentists around the world guiding the design of the system, Waterlase Express represents the new foundation of the Company's strategy to greatly expand all-tissue laser use in dentistry.

Biolase
4 Cromwell
Irvine, CA 92618, USA
www.biolase.com

LASOTRONIX

SMART^{M} laser—Versatile and functional

LASOTRONIX is proud to present the diode-based laser platform especially designed for dentistry. SMART^{M} laser is offered as a combination of two lasers in one package: 10 W at 980 nm wavelength for a wide range of applications in microsurgery, endodontics, periodontology, pain therapy and whitening as well as 400 mW at 635 nm wavelength for cold therapies like biostimulation and PAD (Photoactivated Disinfection). Combining two wavelengths in one device made SMART^{M} laser a unique and advanced application for all soft tissue procedures in dentistry.
Thanks to thoughtful design that allows integration with the dedicated workstation or a dental unit, SMART^{M} laser meets the needs of every dental office. In addition, accessories such as a wide range of fiber delivery systems, application end tips and a variety of surgical handpieces provide maximum versatility.

LASOTRONIX
Żytnia 1 str.
05-500 Piaseczno, Poland
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Convergent Dental

Revolutionary laser technology

Convergent Dental, Inc., is the developer of the revolutionary Solea, the world's first CO_2 9.3 µm, computer-aided dental laser with CE clearance to cut hard-, soft- and osseous-tissue. A two-time winner of the Gold Edison Award for innovation and development, Solea is a unique type of carbon dioxide laser.
Its unique wavelength and computer controls enable any dentist to work without anaesthesia for nearly any cavity preparation and without bleeding or sutures for most soft tissue surgeries, thus performing several more procedures per day. Providing a unique patient experience enables substantial practice growth for the hundreds of dentists who use Solea every day.

See Solea for the very first time at IDS hall 2.2, booth F050. To schedule your personal Solea hands-on session during IDS, please write us at: soleaidesoe@convergentdental.com.

CONVERGENT DENTAL
140 Kendrick Street, Bldg C3
Needham, MA 02494, USA
www.convergentdental.com

LASERVISION

The light laser safety goggle with magnifier

Especially in dentistry and its modern dental therapies, laser safety magnifiers are necessary for precise laser treatments. With the newly-developed adapter, LASERVISION has succeeded to combine the well-known LASERVISION goggle F18/F22 with a magnifier by a popular German manufacturer.
The lenses can be individually adjusted and matched to the pupil distance. Due to the large number of available laser safety filters for this eyewear, it is possible to support almost every laser safety treatment with a suitable magnifier. In particular, the combination with the HR2.5x/380 binocular magnifier covers nearly all micro-laser treatments within the dental or dermatological range. More information regarding this innovation can be found on the web site: uvex-laservision.com, at your local LASERVISION distributor or LASERVISION directly.

LASERVISION GmbH & Co. KG
Siemensstr. 6
90766 Fürth, Germany
www.uvex-laservision.de

Light Instruments

New laser-in-handpiece model announced

Light Instruments launched a new LiteTouch™ laser-in-handpiece model, a significantly smaller size version of Er:YAG dental lasers for hard- and soft-tissue dental treatments. This LiteTouch™ Laser-in-Handpiece™ technology houses the entire laser mechanism within a small-sized chamber, avoiding energy lose and allowing free-hand movement. The LiteTouch™ new model software provides three treatment modes: "Hard Tissue", "Soft Tissue" & "Gentle Treatment".
The purpose of the "Gentle Treatment" mode is to give the users the opportunity to use low laser energies between 20–40 mJ with frequencies of 10–50 Hz for sub-ablative treatments. To mention a few: caries prevention, sulcus preparation for impression, biofilm removal, enamel conditioning, pulp capping, laser-activated endodontic irrigation, pocket debridement and decontamination, implants decontamination.
The new LiteTouch™ is a breakthrough product, as noted by Mr. Eric Ben Mayor, Light Instruments' CEO: "It provides the company with the opportunity to continue and strengthen our tradition of developing the latest advanced technologies and products."

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Wellenlängen-variation

Prof. Dr. Norbert Gutknecht

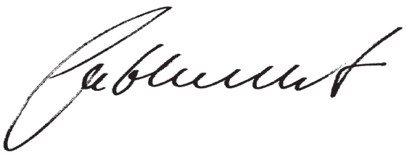
Sehr geehrte Frau Kollegin,
sehr geehrter Herr Kollege,
liebe DGL-Mitglieder,

Immer mehr Laserhersteller bieten Lasersysteme mit mehreren Wellenlängen für Indikationen in der Zahnheilkunde an. Diese Entwicklung lässt uns hoffen, dass das Verständnis von Absorption, Transmission, Reflexion und Streuung in den unterschiedlichsten Geweben nach Bestrahlung mit unterschiedlichen Wellenlängen unterschiedliche Auswirkungen auf das jeweilige Gewebe zunimmt. Andererseits stellt sich jetzt die Frage, inwieweit unterschiedliche Wellenlängen alternierend oder zeitlich versetzt eingesetzt werden sollen oder können.

Die vor uns liegende IDS wird mit Sicherheit neue und interessante Laserwellenlängenkombinationen vorstellen, mit hoffentlich gut untersuchten und differenzierten Aussagen zu deren klinischen Anwendungen. Je größer die Anzahl unterschiedlicher Laserwellenlängen für den Einsatz in der Zahnheilkunde wird, desto größer wird die Wahrscheinlichkeit, diese Wellenlängen viel spezifischer hinsichtlich der gestellten Indikation einsetzten zu können. Es freut mich, dass wir sie in der vorliegenden Ausgabe mit einem Beitrag zu dieser Thematik konfrontieren dürfen.

Denjenigen unter unseren Lesern, welche die IDS besuchen, wünsche ich viel Freude bei der Inspektion dieser neuen Dentallaser-Generation.

Ihr



Prof. Dr. Norbert Gutknecht

Laserzahnmedizin kompakt

Das Jahrbuch Laserzahnmedizin 2017

Das kürzlich umfassend überarbeitete und aktualisierte Jahrbuch Laserzahnmedizin in seiner 18. Auflage ist die einzige rein deutschsprachige Laserzahnmedizin-Publikation am Markt. Hinzu kommt, dass es in der Fülle an Fachartikeln, Grundlagenbeiträgen sowie den aktuellsten Lasermarktübersichten einen fundierten Einblick sowohl für Einsteiger als auch erfahrene Anwender der Laserzahnmedizin ermöglicht. Neben bewährten Verfahren greift das neue Jahrbuch Laserzahnmedizin 2017 in mehreren Artikeln auch die Ultrakurzpulslasertechnologie auf, welche entscheidende Verbesserungen auf dem Gebiet der Laserzahnheilkunde ermöglichen könnte. Zusätzlich stellen sich erfahrene Industriepartner der Laserzahnmedizin vor und führen in ihre Produkte und Services auf diesem Gebiet ein. Einen besseren und aktuelleren Überblick, als es das Jahrbuch Laserzahnmedizin 2017 bietet, gibt es nicht.
Das Jahrbuch Laserzahnmedizin 2017 ist zum Preis von 49 Euro (zzgl. MwSt + Versand) im Onlineshop der OEMUS MEDIA AG erhältlich oder kann über grasse@oemus-media.de angefordert werden.

Quelle: OEMUS MEDIA AG

Zum OEMUS Onlineshop

Photodynamische Therapie

Gericht bestätigt Analogberechnung

Eine private Krankenversicherung verweigerte einem Versicherungsnehmer die vollständige Erstattung der Kosten für eine durchgeführte Parodontaltherapie durch die antimikrobielle Photodynamische Therapie (aPDT) mithilfe des PACT®-Systems. Der Versicherungsnehmer wünschte eine gerichtliche Klärung. Ein gerichtlich bestellter Gutachter stellte fest, dass in dem vorliegenden Behandlungsfall die medizinische Notwendigkeit der aPDT bestanden habe, da sich aus den Behandlungsunterlagen zweifelsfrei ein Bedarf an Keimzahlreduzierung ergeben habe (Bakterienanalyse – ParoCheck® – Diagnostik) und genau dafür die aPDT als schulmedizinisch anerkannte Behandlung zur Verfügung stehe. Weiterhin führte er aus, dass hierbei „Farbstoff und Laserlicht" im Unterschied zu den in der GOZ beschriebenen Behandlungsverfahren in Zahnfleischtaschen eine Keimzahlverringerung bewirke. Das Gericht stellte fest (AG Düsseldorf, Az: 22 C 11392/12 vom 16. Feb. 2015), dass der Gutachter in seinem Gutachten und der folgenden Ergänzung überzeugend eine analoge Abrechnung dieser Behandlung als die alleinige Möglichkeit der Gebührenberechnung bestätige.

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Quelle: ludwig-ra.de

Henry Schein präsentiert

Mobiles Digitalformat

Henry Schein MAG heißt das neue, mobile Digitalformat, mit dem Henry Schein seit dem 1. März rund um die IDS und die wichtigsten dentalen Trends und Neuheiten informiert. Das Online-Magazin richtet sich an Messebesucher oder Praxis- und Laborinhaber, die sich von zu Hause über die Produktneuheiten und Trends der Messe informieren möchten. Guides zu verschiedenen Themen zeigen den Besuchern, welche Messeneuheiten sie nicht verpassen sollten. Neu ist bei Henry Schein in diesem Jahr auch das Live-Format „Meet the Experts". In kompakten Vorträgen geben Spezialisten am Messestand täglich wertvolle Tipps zu Themen wie „Einstieg in CEREC – Warum und wie?", „Vielfältigkeit des Lasersystems" oder „Wasser an der Einheit: So wird's sauber und sicher ohne Chemie". Die Anmeldung erfolgt seit dem 1. März 2017 über das Online-Magazin unter www.henryschein-mag.de.

Quelle: Henry Schein

Einladung zum DGL Workshop-Kongress 2017

Freitag, 23.06.2017, 08.00–18.00 Uhr
Aachen – Universitätsklinikum

Sehr geehrte Frau Kollegin, sehr geehrter Herr Kollege, liebe DGL-Mitglieder,

der Vorstand und Sie, als Mitglieder der Deutsche Gesellschaft für Laserzahnheilkunde, haben anlässlich der letzten Mitgliederversammlung im September 2016 in München beschlossen, im Jahre 2017 einen Workshop-Kongress ganz anderer Art zu organisieren. Dies entsprach dem Wunsch nach mehr praxisrelevanter Information. Unser Workshop-Kongress wird am 23. Juni 2017 in den Räumlichkeiten des Universitätsklinikums Aachen stattfinden.

Die ausstellenden Firmen werden nicht nur ihre Lasersysteme demonstrieren, sondern auch mit qualifizierten Kollegen Workshops zu unterschiedlichen Indikationsbereichen anbieten.

Damit möglichst viele Kongressteilnehmer die jeweiligen Workshops besuchen können, haben wir die Zeit eines einzelnen Workshops auf 1,5 Stunden begrenzt. Somit können einzelne Workshopthemen mehrfach angeboten werden, wodurch Sie in der Lage sind, unterschiedliche Workshops zu belegen.

Neben den klinisch relevanten Workshops werden wir auch einen Abrechnungsworkshop und ein Auffrischungsseminar über die neuen Bestimmungen des Laserschutzbeauftragten in unseren Kongress integrieren. Alle Kongressteilnehmer erhalten neben ihrer Teilnahmebescheinigung auch Zertifikate zu den jeweils absolvierten Workshops.

Es wird uns freuen, wenn Sie dieses Vorhaben durch Ihre Teilnahme bereichern.

Ich grüße Sie alle recht herzlich, auch im Namen des DGL-Vorstandes.

Ihr

Prof. Dr. Norbert Gutknecht
Präsident der DGL

Einladung zur DGL-Mitgliederversammlung

Freitag, 23.06.2017, 14.00–15.00 Uhr
Aachen – Universitätsklinikum

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Assoziierte Gesellschaft der DGZMK

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Formerly ISLD, founded 1988

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Vorname: ______________________

Geb.-Datum: ______________________

Approbation: ______________________

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Aufgrund des bestehenden Assoziationsvertrages zwischen der DGL und der DGZMK fällt zusätzlich ein reduzierter Jahresbeitrag für die DGZMK an (85,00 € p.a., falls Sie noch nicht Mitglied der DGZMK sind). Der Beitragseinzug erfolgt durch die DGZMK-Geschäftsstelle, Liesegangstr. 17a, 40211 Düsseldorf. Sie werden hierfür angeschrieben.

Mit der Stellung dieses Aufnahmeantrages versichere ich, dass ich

☐ seit dem ______________________ in der eigenen Praxis
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Ich beantrage die Aufnahme in die Deutsche Gesellschaft für Laserzahnheilkunde e.V.

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