Effects of KTP Laser Irradiation, Diode Laser, and LED on Tooth Bleaching: A Comparative Study.


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Objective: This in vitro study examines the whitening efficacy of a light-emitting diode (LED), a diode laser, and a KTP laser irradiation in dental bleaching by analyzing the change in color achieved from the treatment, the temperature increase induced in the pulpal cavity, as well as enamel microhardness measurement after treatment.

Background Data: Bleaching techniques achieved significant advances with the use of coherent or incoherent radiation sources to activate the bleaching agents.

Methods: A hydrogen peroxide bleaching agent, Hi-Lite, was stimulated with an LED, a 980-nm diode laser at 0.8 W, or a 532-nm KTP laser at 1.0 W for 30 sec on 64 extracted human incisors. During irradiation, the temperature in the pulpal cavity was monitored. The color change was evaluated using the CIE L()a()b() color space measurement system, and Vickers enamel microhardness was tested after treatment.

Results: A mean total color difference value (DeltaE()) greater than 5.0 was obtained in each group. KTP-laser-induced bleaching gave a significantly higher DeltaL() (8.35) after treatment (p < 0.01). Neither LED nor the two lasers produced significant differences in the enamel microhardness after treatment (p > 0.01). Mean maximal pulpal temperature rise was 2.95 degrees C for LED, 3.76 degrees C for KTP laser, and 7.72 degrees C for diode laser, respectively.

Conclusion: The results of this study suggest that KTP laser is effective at providing brighter teeth. According to the conditions used in this study, the LED and KTP laser induced a safer pulpal temperature increase when assisted with Hi-Lite bleaching gel.

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External bleaching therapy with activation by heat, light or laser: a systematic review.

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OBJECTIVE: External bleaching procedures utilizing highly concentrated 30-35% hydrogen peroxide solutions or hydrogen peroxide releasing agents can be used for tooth whitening. To enhance or accelerate the whitening process, heat-activation of the bleaching agent by light, heat or laser is described in the literature. The aim of the present review article was to summarize and discuss the available information concerning the efficacy, effects and side effects of activated bleaching procedures.

SOURCES: Information from all original scientific full papers or reviews listed in PubMed or ISI Web of Science (search term: (bleaching OR brightening OR whitening OR colour) AND (light OR laser OR heat OR activation)) were included in the review.

DATA: Existing literature reveals that activation of bleaching agents by heat, light or laser may have an adverse effect on pulpal tissue due to an increase of intra-pulpal temperature exceeding...
the critical value of 5.5 degrees C. Available studies do not allow for a final judgment whether
tooth whitening can either be increased or accelerated by additional activation.

CONCLUSION: Therefore, application of activated bleaching procedures should be critically
assessed considering the physical, physiological and patho-physiological implications.

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Surface and pulp chamber temperature rises during tooth
bleaching using a diode laser: a study in vitro.

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OBJECTIVE: To measure the surface and pulp chamber temperature increases in vitro on upper
and lower anterior teeth during a tooth whitening procedure using a diode laser.

METHOD: A thermocouple was used to measure the temperature increase on the surface of an
extracted upper central incisor tooth. Pulp chamber temperature readings were made on upper
and lower central incisors, lateral incisors and canines. A diode laser recommended for tooth
bleaching was tested at three different power settings (1W, 2W, 3W). Temperature measurements
were made with and without the bleaching agent present on the labial tooth surface.

RESULTS: The increase in surface temperature readings ranged from 37 degrees C (1W) to 86.3
degrees C (3W) with no bleaching gel present. Pulp chamber temperature increases ranged from
4.3 degrees C (1W) to 16 degrees C (3W). The presence of the bleaching gel reduced temperature
increases seen at the tooth surface and within the pulp.

CONCLUSIONS: The increase in the pulp chamber temperature with the laser used at 1-2W was
below the critical temperature increase of 5.5 degrees C thought to produce irreversible pulpal
damage. However, a power setting of 3W produced a pulp chamber temperature increase above
this threshold (16 degrees C) and caution is advised when using this setting.

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Influence of fluorescence-controlled Er:YAG laser radiation,
the Vector system and hand instruments on periodontally
diseased root surfaces in vivo.

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OBJECTIVES: The aim of the present study was to evaluate the effects of fluorescence-controlled
Er:YAG laser radiation, an ultrasonic device or hand instruments on periodontally diseased root
surfaces in vivo.

MATERIAL AND METHODS: Seventy-two single-rooted teeth (n=12 patients) were randomly
treated in vivo by a single course of subgingival instrumentation using (1-3) an Er:YAG laser
(ERL1: 100 mJ; ERL2: 120 mJ; ERL3: 140 mJ; 10 Hz), or (4) the Vector ultrasonic system (VUS) or (5) hand instruments (SRP). Untreated teeth served as control (UC). Areas of residual subgingival calculus (RSC) and depth of root surface alterations were assessed histo-/morphometrically.

**RESULTS:** Highest values of RSC areas (%) were observed in the SRP group (12.5+/−6.9). ERL(1-3) (7.8+/−5.8, 8.6+/−4.5, 6.2+/−3.9, respectively) revealed significantly lower RSC areas than SRP. VUS (2.4+/−1.8) exhibited significantly lower RSC areas than SRP and ERL(1, 2). Specimens treated with SRP revealed conspicuous root surface damage, while specimens treated with ERL(1-3) and VUS exhibited a homogeneous and smooth appearance.

**CONCLUSION:** Within the limits of the present study, it may be concluded that ERL and VUS enabled (i) a more effective removal of subgingival calculus and (ii) a predictable root surface preservation in comparison with SRP.

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**Treatment of periimplantitis with laser or ultrasound. A review of the literature** [Article in German]

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In addition to conventional treatment modalities (mechanical and chemical), the use of different lasers has been increasingly proposed for the treatment of peri-implantitis. Results from both controlled clinical and basic studies have pointed to the high potential of an Er:YAG-laser. Its excellent ability to effectively ablate dental calculus without producing major thermal side-effects to adjacent tissue has been demonstrated in numerous studies. Recently, a new ultrasonic device has been used for the treatment of periodontal and peri-implantitis infections. Preliminary clinical data indicate that treatment with both treatment procedures may positively influence peri-implant healing. The aim of the present review paper is to evaluate, based on the available evidence, the use of an Er:YAG-laser and a newly introduced ultrasonic device for treatment of peri-implantitis in comparison to a conventional treatment approach.

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**Periodontal treatment with an Er:YAG laser or scaling and root planing. A 2-year follow-up split-mouth study.**  
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**BACKGROUND:** Non-surgical periodontal treatment with an Er:YAG laser has been shown to result in significant clinical attachment level gain; however, clinical results have not been established on a long-term basis following Er:YAG laser treatment. Therefore, the aim of the present study was to present the 2-year results following non-surgical periodontal treatment with an Er:YAG laser or scaling and root planing.

**METHODS:** Twenty patients with moderate to advanced periodontal destruction were treated under local anesthesia, and the quadrants were randomly allocated in a split-mouth design to either 1) Er:YAG laser (ERL) using an energy level of 160 mJ/pulse and 10 Hz, or 2) scaling and root planing (SRP) using hand instruments. The following clinical parameters were evaluated at baseline and at 1 and 2 years after treatment: plaque index (PI), gingival index (GI), bleeding on probing (BOP), probing depth (PD), gingival recession (GR), and clinical attachment level (CAL). Subgingival plaque samples were taken at each appointment and analyzed using dark-field microscopy for the presence of cocci, non-motile rods, motile rods, and spirochetes. The primary outcome variable was CAL. No statistically significant differences between the groups were found at baseline. Power analysis to determine superiority of ERL treatment showed that the available sample size would yield 99% power to detect a 1 mm difference.

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RESULTS: The sites treated with ERL demonstrated mean CAL change from 6.3 +/- 1.1 mm to 4.5 +/- 0.4 mm (P < 0.001) and to 4.9 +/- 0.4 mm (P < 0.001) at 1 and 2 years, respectively. No statistically significant differences were found between the CAL mean at 1 and 2 years postoperatively. The sites treated with SRP showed a mean CAL change from 6.5 +/- 1.0 mm to 5.6 +/- 0.4 mm (P < 0.001) and to 5.8 +/- 0.4 mm (P < 0.001) at 1 and 2 years, respectively. The CAL change between 1 and 2 years did not present statistically significant differences. Both groups showed a significant increase of cocci and non-motile rods and a decrease in the amount of spirochetes. However, at the 1- and 2-year examination, the statistical analysis showed a significant difference for the CAL (P < 0.001, respectively) between the 2 treatment groups.

CONCLUSION: It was concluded that the CAL gain obtained following non-surgical periodontal treatment with ERL or SRP can be maintained over a 2-year period.

Clinical evaluation of an Er:YAG laser for nonsurgical treatment of peri-implantitis: a pilot study
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The aim of this controlled, parallel design clinical study was to compare the effectiveness of an Er:YAG laser (ERL) to that of mechanical debridement using plastic curettes and antiseptic therapy for nonsurgical treatment of peri-implantitis. Twenty patients with moderate to advanced peri-implantitis lesions were randomly treated with either (1) an ERL using a cone-shaped glass fiber tip at an energy setting of 100 mJ/pulse and 10 pps (ERL), or (2) mechanical debridement using plastic curettes and antiseptic therapy with chlorhexidine digluconate (0.2%) (C). The following clinical parameters were measured at baseline, 3 and 6 months after treatment by one blinded and calibrated examiner: Plaque index (PI), bleeding on probing (BOP), probing depth (PD), gingival recession (GR) and clinical attachment level (CAL). At the baseline examination, there were no statistically significant differences in any of the investigated parameters. Mean value of BOP decreased in the ERL group from 83% at baseline to 31% after 6 months (P < 0.001) and in the C group from 80% at baseline to 58% after 6 months (P < 0.001). The difference between the two groups was statistically significant (P < 0.001, respectively). The sites treated with ERL demonstrated a mean CAL change from 5.8 +/- 1 mm at baseline to 5.1 +/- 1.1 mm (P < 0.01) after 6 months. The C sites demonstrated a mean CAL change from 6.2 +/- 1.5 mm at baseline to 5.6 +/- 1.6 mm (P < 0.001) after 6 months. After 6 months, the difference between the two groups was statistically not significant (P > 0.05). Within the limits of the present study, it was concluded that (i) at 6 months following treatment both therapies led to significant improvements of the investigated clinical parameters, and (ii) ERL resulted in a statistically significant higher reduction of BOP than C.

INFLUENCE OF AN ER:YAG LASER ON THE REESTABLISHMENT OF THE BIOCOMPATIBILITY OF CONTAMINATED TITANIUM IMPLANT SURFACES

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BACKGROUND: The aim of the present study was to evaluate the influence of an erbium, chromium-doped yttrium, scandium, gallium, and garnet (Er,Cr:YSGG) laser on the reestablishment of the biocompatibility of contaminated titanium implant surfaces.
surface structure and biocompatibility of titanium implants and 2) the removal of plaque biofilms and reestablishment of the biocompatibility of contaminated titanium surfaces.

**METHODS:** Intraoral splints were used to collect an in vivo supragingival biofilm on sand-blasted and acid-etched titanium disks for 24 hours. ERCL was used at an energy output of 0.5, 1.0, 1.5, 2.0, and 2.5 W for the irradiation of 1) non-contaminated (20 and 25 Hz) and 2) plaque-contaminated (25 Hz) titanium disks. Unworn and untreated non-irradiated, sterile titanium disks served as untreated controls (UC). Specimens were incubated with SaOs-2 osteoblasts for 6 days. Treatment time, residual plaque biofilm (RPB) areas (%), mitochondrial cell activity (MA) (counts per second), and cell morphology/surface changes (scanning electron microscopy [SEM]) were assessed.

**RESULTS:** 1) ERCL using either 0.5, 1.0, 1.5, 2.0, or 2.5 W at both 20 and 25 Hz resulted in comparable mean MA values as measured in the UC group. A monolayer of flattened SaOs-2 cells showing complete cytoplasmatic extensions and lamellopodia was observed in both ERCL and UC groups. 2) Mean RPB areas decreased significantly with increasing energy settings (53.8 +/- 2.2 at 0.5 W to 9.8 +/- 6.2 at 2.5 W). However, mean MA values were significantly higher in the UC group.

**CONCLUSION:** Within the limits of the present study, it was concluded that even though ERCL exhibited a high efficiency to remove plaque biofilms in an energy-dependent manner, it failed to reestablish the biocompatibility of contaminated titanium surfaces.

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**Desensitizing effects of an Er:YAG laser on hypersensitive dentine.**

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**AIM:** The aim of the present study was to evaluate and compare the desensitizing effects of an Er:YAG laser (KEY II(R), KaVo, Germany) and Dentin Protector (Vivident, Germany) on cervically exposed hypersensitive dentine.

**METHOD:** A group of 30 patients showing a total of 104 contralateral pairs of hypersensitive and caries-free teeth was selected and randomly allocated in a split-mouth design to either (1) Er:YAG laser (80 mJ/pulse, 3 Hz), or (2) the application of Dentin Protector (polyurethane-isocyanate 22.5%; methylenechloride 77.5%) whereat one pair served as an untreated control in each patient. The degree of sensitivity to a thermal stimulus was determined qualitatively with an evaporative stimulus defined as a 3-s air blast at a distance of 2 mm from each site to be tested. A qualitative registration of the degree of discomfort was determined according to an arbitrary pain scale in 4 degrees. Recordings were assessed before treatment, immediately after, 1 week, 2 and 6 months after treatment by 1 blinded examiner.

**RESULTS:** Both treatment forms resulted in significant improvements of discomfort immediately after and 1 week post treatment. After 2 months, the discomfort in the Dentin Protector(R) group increased up to 65% of the baseline score and even up to 90% after 6 months, whereas the effect of the laser remained at the same level that was achieved immediately after treatment. The differences immediately after, 1 week, 2 and 6 months post treatment between both groups were statistically high significant (p< or =0.001; respectively). Compared to the untreated control group, both treatment forms resulted in a significant reduction of discomfort at each follow-up examination.

**CONCLUSION:** It was concluded that desensitizing of hypersensitive dentine with an Er:YAG laser is effective and the maintenance of the positive result was more prolonged than with Dentin Protector.