Summery of a Microbiological In Vivo Comparison of Conventional Periodontal Treatment and Periodontal Treatment Assisted by KTP Laser

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_Abstract

The study aim was to compare the results of a KTP laser therapy used in adjunct to scaling and root planning (SRP), and of SRP alone, in a small group of patients with early to moderate periodontitis.

Ten adult patients with periodontitis were treated according to split-mouth design, using Protocol A (KTP laser therapy combined with SRP) or, Protocol B (SRP alone). At baseline, and three months after the treatment four different periodontal pocket pathogenic populations growth pattern was evaluated.

The statistical analysis of the collected date has been achieved using Wilcoxon test (paried sample at chosen significant level of 0.05).

The Results revealed that there was statistically significant difference in the bactericidal efficiency of both treatment protocols noted before and after the treatment between the treated quadrants on the stage of 3 months post-operative investigation, while the differences was not significant at the immediate investigating stage. Moreover, the results showed a significant difference in the efficiency of KTP laser therapy combined with SRP in suppressing the isolated pathogenic germs re-growth compared to SRP alone therapy.

On conclusions, Non-surgical periodontal therapy using a KTP laser + SRP lead to significant improvements in all the investigated clinical parameters. The combined treatment using laser as an adjunct to scaling and root planning seemed to be advantageous when compared to SRP alone, due to more efficient bactericidal efficiency.

_Aim of the Study

The aim of our clinical study was to investigate a closed curettage therapy assisted by KTP-laser

Fig. 1_SmartLite KTP laser machine, DEKA, Italy.
Fig. 2_KTP laser system display screen demonstrating laser treatment parameters.



Fig. 1



Fig. 2





Fig. 3_Representative photographs.
Fig. 4_Representative Photographs demonstrating the sample collection.

system in comparison with conventional therapy. Our purpose was to answer the following questions:

1. Investigate the bactericidal effect of KTP laser assisted periodontal treatment on different bacterial species including *Aggregatibacter actinomycetemcomitans*, *Tannerella forsythia*, *Porphyromonas gingivalis*, and *Prevotella intermedia*.
2. Would KTP laser assisted treatment enhance periodontal healing after debridement?
3. Would KTP laser assisted treatment facilitate instrumentation and root planning?
4. Would KTP laser assisted treatment provide sufficient analgesia during the application?

_KTP Laser system

If a Nd:YAG laser is combined with a non-linear crystal (such as KDP, KTP etc.) light can be emitted at other wavelengths.

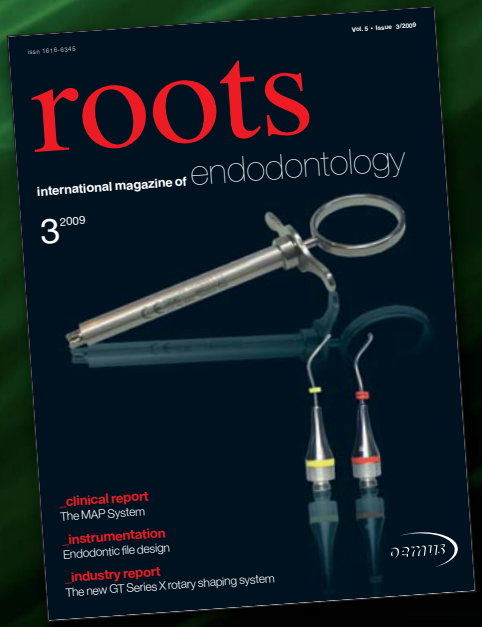
One of the newest laser wavelengths which have been established in dentistry is KTP laser system.

It is a combination of Nd:YAG laser (1,064 nm) and a KTP crystal. The system emitting at 532 nm, representing a frequency-doubled Nd:YAG device (green-light laser). The abbreviation "KTP" stands for "Kalium-Titanyl-Phosphat" meaning Potassium-Titanyl-Phosphate.

The systems has been introduced mainly for tooth-bleaching procedures but still studies showed that this specific wavelength have a promising antibacterial

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Figs. 5a–b_Representative photographs demonstrating the control group SRP treatment.


Fig. 5a


Fig. 5b

capability and it is suitable for the disinfection of even the deeper layers of dentin and equal the results achieved by established wavelengths in state-of-the-art endodontics.

Its way of action/ working is the same as other diode lasers. There is no real pulsing. Real pulsing means, the shorter the pulse at a certain pulse energy, the higher the peak power, so the average power output stays the same. In diode lasers, the laser beam is not pulsed but just interrupted, gated with a shutter, which means that the pulse power has no peaks and the average power output at the end of the fibre decreases.

The use of KTP laser beams in dentistry and especially as a root planning complement may be of some interest because, after conventional scaling, it might be ideal to sterilise the root surface without pulpal damage, especially in the case of chronic infection with bone defects and pocket formation.

Before any eventually clinical use, it is wise to define the safety parameters and harmless irradiation conditions for the use of KTP laser beam in order to avoid any overheating of vital tissue.

_Study design

The study was performed according to a split-mouth design. A total of 15 maxillary and 5 mandibular pairs of teeth, of contra-lateral single- and multi-rooted teeth were included. The mouth quadrants have been divided to receive certain treatment protocol as follow:

1. Quadrant 1 & 4: received conventional scaling and root planning (SRP) using periodontal hand instruments. In this current study this group will be referred to as "Control group".
2. Quadrant 2 & 3: received conventional scaling and root planning (SRP) + laser treatment with KTP laser system. In this current study this group will be referred to as "KTP laser group".

Each tooth of each contra-lateral pair had to exhibit gingival inflammation with a positive BOP, subgingival calculus and a PD of 4–7mm on at least one aspect of the tooth. In each contra-lateral pair one tooth was randomly treated with the combination of a KTP laser and subgingival scaling and root planning using hand instruments, while the other tooth was treated conventionally using hand instrument alone. The distribution of the two treatment modalities was equally divided between the right and left sides. All patients were treated by a highly experienced operator.

_Oral hygiene program (pre-treatment sessions)

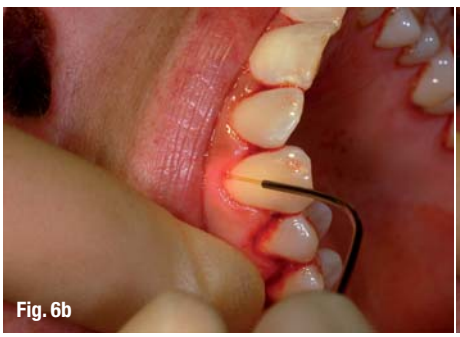
For 4 weeks before treatment all patients were enrolled in a hygiene program and received oral hygiene instructions on 2.4 appointments, as well as professional tooth cleaning according to individual needs.

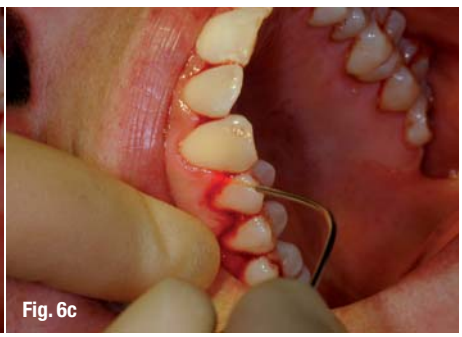
All patients individually have received a care-plan and was informed and showed how to clean their teeth & mouth emphasizing on the teeth quadrants included the test with help of inter-dental-brushes (Curadent). Moreover, pocket depth measurement by our clinic dental-hygienist in the chosen teeth has been obtained.

Finally, all participants have been informed to NOT use chlorhexadine for mouth-wash. as well NO intake of antibiotic and NO anti-depressive medicine.

Figs. 6a-c_Representative photographs demonstrating the KTP laser treatment protocol.


Fig. 6a


Fig. 6b


Fig. 6c

_Treatments protocols

SmartLite KTP laser (SmartLite, DEKA, Galenzano, Italy); frequency-doubled Nd:YAG laser, emitting at wavelength of 532 nm (visible green) (Fig. 1) was selected for laser treatment. The machine was used in pulse wave mode with an energy level of 150 mJ/pulse, 0.6 W , 50 ms pulse duration and a repetition rate of 10 Hz according to the instructions given by the manufacturer (Fig. 2).

The fiber tips of 300 mμ (DEKA) were chosen by the operator for periodontal pocket lasing. The treatment was performed from coronal to apical in parallel paths with a movement speed of approximately 1 sec. per each mm of measured pocket depth and with inclination of the fiber tip of 15.20 to the root surface.

The control group received conventional periodontic treatment procedure: SPR, scaling and root planning. The mechanical subgingival instrumentation was performed using Columbia LM curettes (LM-DENTAL, Rydontie 12A, Turku, Finland).

_Clinical flow chart

A. Treatment day

In each specific treatment day, the treatment was started by professional cleaning (to assure removing of all the plaque) and polishing, following that three pieces of sterile paper points (size 40) were introduced through the pocket sulcus of each individual selected teeth as far apically as possible and kept still for 15 seconds. On withdrawal of the paper point from the periodontal pocket, each piece was placed in a sterilized special laboratory plastic container in order to be used later on for the determination of the pre-treatment bacterial population (Figs. 3, 4).

Following that the full mouth treatment and the instrumentation for both test and control teeth was performed until the operator felt that the root surfaces were adequately debrided and planed (Fig. 5).

Only for the testing group this step was followed by insertion of the 300 μm periodontal laser tip/fiber inside the pocket and the device was activated and the whole root surface and the pocket area has been irradiated according to the parameter and protocol explained previously (Fig. 6). Each selected root surface was irradiated approximately for 15 sec. pro site (2 sec./mm pocket-depth) the procedure was applied twice; once before SRP and the other after SRP.

The time needed for treatment in the test groups, on average, was 6 min. for the SRP+ Laser group per each root. For the control group an average of 5 min. for each root was recorded.

The treatment procedure has been done completely free of anesthesia except for one patient.

Finally, for each treatment teeth for both group in all four quadrants, pockets were probed again by three pieces of sterile paper points for 15 second inside the deepest pocket, then were withdrawn slowly and placed in the laboratory plastic container in order to be used later on for the determination of the post treatment bacterial population indicating the immediate action feature for both treatment protocols.

B. Fourteen days recall session

In this session measurement of periodontal pocket-depth has been obtained for all treated teeth. Re-instruction has been done.

C. Three months recall session

In this session and depending on our previous experiences, instead of conventional cleaning of the relevant teeth, the teeth were just gently dried with a cotton pellet to remove the attached dental plaque and saliva in order to prevent any contamination that may lead to the alteration of the normal bacterial population, caused by pocket and gingival bleeding.

_Microbiological evaluation

The collected bacterial samples were divided according to the previously mentioned groups and subgroups. Then they were posted to LCL, Aachen Uniklinikum, Aachen, Germany.

For determination of the bacterial population and bacterial growth, each inoculated paper point cone removed carefully from the sterilized plastic box and analyzed using DNA probes & hybridization assay technique.

The DNA probes used (LCL Biokey GmbH, Aachen) were developed in a computerized comparison against 12,000 bacterial 16S rRNA/DNA sequences and then tested empirically against many bacterial species as well as against the human genome.

They proved to be (>99.99%) specific for *Aggregatibacter (*formerly *Actinobacillus) actinomycetemcomitans, Tannerella forsythia (*formely *Bacteroides forythus), Porphyromonas gingivalis,* and *Prevotella intermedia* respectively.

Nucleic acids were isolated by the aid of a QIAamp Blood & Tissue kit (QIAGEN, Hilden, Germany).

The dot blot hybridisation for (semi-)quantifying was performed according to the manufacturer (LCL biokey GmbH, Aachen) and standard procedures for the four following periodontal pocket pathogens:

1. *Actinobacillus actinomycetemcomitans*, gram-negative facultative anaerobe bacterial species.
2. *Bacterocides forsythus*, fastidious anaerobic gram-negative rod bacterial species.
3. *Porphyromonas gingivalis*, gram-negative oral anaerobic bacterial species.
4. *Prevotella intermedia*, a gram-negative, black-pigmented, obligate anaerobic rod bacterial species.

_Statistical analysis

After completing the final examination, the statistical evaluations were conducted by the statistical

programs MedCal version 9.2.1.0 and Origin version 6.0. For all groups and as well subgroups the mean values and the standard deviation for different bacterial populations were calculated.

Furthermore; different inferential statistical functions at a chosen significance level of a = 0.05 was applied to identify the statistical differences between the main investigation groups as well as the subgroups.

Paired sample Wilcoxon test was used to determine significant differences between and within the groups. The level of statistical significance was set at P = 0.05.

_Discussion

The principal objective of periodontal therapy is to eliminate calcified deposits from periodontally diseased root surfaces and to minimize or reduce colonization of the subgingival compartment by periodontal pathogenic bacteria.

A variety of surgical and non-surgical modalities are available for the treatment of inflammatory periodontal diseases. Subgingival scaling and root planning are the most important procedures and clinical efficacy has been demonstrated in numerous clinical studies. This is in particular true for periodontal pockets with a probing depth of below 6 mm. With rising pocket depth, however, calculus removal and plaque control is often difficult and surgical flap procedures are recommended, allowing a better access and visual control of the root surface. Beside conventional scalers and curettes, ultrasonic systems are commonly used for the removal of subgingival calculus and bacterial plaque. Bactericidal chemicals as Chlorhexidine digluconate are useful adjuncts in the treatment of periodontitis.

On the other hand, laser applications in the field of periodontology have been of enormous scientific interest throughout the last decade and a variety of laser systems have been investigated in numerous in vitro and in vivo studies. In the treatment of inflammatory periodontal diseases, lasers may contribute to the bacterial reduction in periodontal pockets as well as to the removal of calculus and granulation tissue and can be used for contouring hyperplastic gingiva.

In this context, the laser mode of antisepsis has several potential advantages over traditional biochemical antibiotics in root disinfection, i.e. no side effect could be encountered, no evidence for development of bacterial resistance, no critical negative reactions; the local delivery mode is through light diffusion with spectrum of activity which covers a wide range of bacteria specially the dark pigmented pathogens.

The favorable mode of action of laser is contributed to the following points:

(1) A therapeutic dose can be delivered to a greater depth immediately and leaves no residual concentration.
(2) Laser radiation affects equally extracellular and intracellular pigmented pathogens and can access other privileged sites such as calculus and dentinal tubules.
(3) Laser antisepsis has no known systemic side-effects, resistances, or negative interactions with other modes of therapy.
(4) Laser energy has the potential to breach the protective mechanisms of biofilms.

However, in spite of many published articles concerning the effect of different laser systems in the periodontal therapy, our literature review of scientific and peer-reviewed literature revealed that no systematic comparative investigation has been performed to investigate the effect of 532 nm-visible green light laser wavelength in the field of periodontology. So it was the aim of our current in vivo clinical study to evaluate the effectiveness of the KTP laser as an adjunct therapeutic mean in combination with conventional SRP during periodontal closed curettage therapy and to investigate the bactericidal efficiency of this new laser system on the dominate pathogens present in the periodontal pockets.

Furthermore, according to Professor, Dr Conrads, LCL Biokey, the laser does not kill all the bacteria. It can be observed that the number of bacteria sampled from some sites is even higher immediately after treatment, especially when a laser has been used in the treatment procedure. This may be due to an increased sulcus fluid rate or by the release of more bacteria, that have been killed and thereby looses the ability to adhere to the sulcus or gingival since the used bacterial detection DNA-based method detects dead cells also.

Among all tested groups the only recorded statistical difference was found in *Porphyromonas gingivalis* species at three months post therapy stage.

_Conclusions

Under the circumstances of this clinical study and investigation, time limitations and the specification of the treatment protocol that have been used, it is our groups belief that the result of the study strongly indicate, that it is recommended to use a KTP-laser as a supplement in the treatment of periodontitis to assure an effective reduction of the periodontal pocket pathogens, and also in order to prevent a quick re-colonization of those pathogens in the pockets. In this way one can reduce the amount of antibacterial detergents and medical treatment.

Moreover, our clinical observations indicate that laser treatment reduced the need for conventional anaesthetics, resulted in diminished bleeding and enhanced visual control at debridement. The calculus deposits were very easy to remove after lasing._

_contact laser

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