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The Use of Lasers for Endodontic Applications in Dentistry

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Summary

Several applications of lasers in clinical procedures for dental hard tissues are either currently in practice or being developed since newer wavelengths as well as different methods and delivery systems are being applied in the field of dentistry.

In endodontic therapy lasers have been used as treatment coadjuvant with reference to both, low intensity laser therapy (LILT) and high intensity laser treatment (HILT) to increase the success rate of the clinical procedures. The purpose of this article is to review in vitro studies and clinical procedures for the use of lasers in endodontics. Low intensity laser therapy has the ability to produce analgesic, anti-inflammatory and biomodulation effects on the irradiated soft tissue thereby improving the wound healing process and giving the patient a better condition of the postoperative experience. High intensity laser irradiation on soft tissue in a defocused mode could have similar effects to low intensity laser therapy. Depending on the wavelength, high intensity laser irradiation may be used on hard dental tissues such as on the root canal dentine or on the dentine cut surface after apicoectomy to produce structural morphological changes, to remove the smear layer, to melt and recrystallize dentine or to expose dentinal tubules. Previous endodontic studies using different wavelengths of high intensity laser irradiation have demonstrated the efficiency of their thermal effect in the ablation process of hard dental tissues in apicectomies as well as in the bacterial reduction at the surgical site or even in contaminated root canals. This has been considered a great advantage over the traditional root canal disinfection procedures.

Key words
Laser, endodontics, bacterial reduction, Nd:YAG laser, Er:YAG laser, Ho:YAG laser, 9.6 μm CO_2 laser, apicectomy

Introduction

One of the major concerns in endodontic therapy is to clean and to shape the root canal together with an adequate disinfection procedure so that the root canal filling properly seals avoiding fluid and microorganism percolation from the root canal system to the periapical region.

Nowadays most of the pulpal and periapical pathological processes have been solved with the traditional methods of endodontic treatment due to the development of new instruments and techniques, however failures may occur even when the treatment is performed thoroughly. Such cases are still considered a challenge to the specialist and this may be the reason that researchers and clinicians continue to explore and search for more effective material, methods and techniques offering the patient minimal postoperative discomfort as well as an higher success rate outcome.

In the last past years several laser systems have been studied for endodontic use. The first one, a pulsed ruby laser was built by Maiman (36), emitting

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light of 0.694 μm wavelength. The pioneers performing the dental laser research with interest focused on the replacement of the high speed were Stern and Sognnaes (55). However the ruby laser was not promising for that purpose since dental tissue is largely transparent at this wavelength. Ten years later the Nd:YAG dental laser was developed and the endodontic laser research started only in the late 70's decade with Adrian (2) in 1977, evaluating the effects of the Nd:YAG laser on dental pulp of rhesus monkeys. However, only after the development of the fiber optic direct contact delivery system for the Nd:YAG laser was it possible not only to cut soft tissue but to perform bacterial reduction and to seal the dentinal tubules with relatively low power.

Today there is already sufficient research to confirm that lasers systems such as the Nd:YAG, Er:YAG, Ho:YAG, CO_2 at 9.6 μm, diode and low intensity lasers may be considered potential tools for endodontic therapy. The performance of different wavelengths and the use of safe energy parameters related to a comfortable postoperative outcome, a sufficient bacterial reduction and morphological structural changes with concern for the temperature rise have been well documented. The use of laser technology in in vitro research as well as in clinical procedures in endodontic applications has been reported with both low intensity laser therapy and high intensity laser treatment.

Low intensity laser therapy (LILT)

Low intensity laser therapy, since first described by Mester (39), it has been reported as useful in medical applications in the field of wound healing, stimulating the regenerative processes of human tissue. It has been considered as a non-invasive, painless and an athermal therapy which restores functional ability based on the biostimulative-regenerative, anti-inflammatory and analgesic effects.

The energy fluences range from 1–10 J/cm^2 and frequently, bio-stimulation is also attributed to photochemical interactions, that take place at very low power densities typically from 0.01 to 50 W/cm^2, and long exposures times ranging from seconds to continuous wave (45).

Low intensity laser irradiation, including the Ga-Al-As (Gallium-aluminium-arsenide) diode laser, at wavelength of 790 nm with a continuous output power of 30 mW, on soft tissues has been used clinically for pain reduction and to improve the wound healing process by the stimulation of fibroblast proliferation (22). Previous studies have shown that energy levels and frequencies transmitted by low intensity laser irradiation do not cause damage to mammalian tissues which the therapy can be conducted with success, if a correct diagnosis, suitable technique and method of application with optimal energy densities and frequencies of therapy sessions are thoroughly followed (1, 3, 28, 29).

The effect of the laser beam on the target tissue is determined primarily by the absorption properties of the irradiated tissue and the ability of laser irradiation to affect the target molecules is dependent on the absorption spectra of biomolecules and tissue optics. The basic mechanism for the bio-stimulation seems to occur at the molecular level. Laser light at these wavelengths penetrates through tissue and strikes a chromophore, or photosensitive molecule, which is a cytochrome contained within the mitochondria (40).

Therefore, the use of low intensity laser irradiation may reduce the pain consequent to any clinical endodontic procedures, improving the wound healing process with a comfortable postoperative outcome. It may be considered useful in the following procedures: after root canal filling; after a pulpotomy procedure with the laser beam directly applied to the remaining pulp and on the mucosa toward the root canal pulp extension; after pulpectomy procedure with the laser irradiation on the mucosa toward the apical region, and in apical surgeries with the low intensity laser irradiation on the mucosa over the area corresponding to the apical lesion and on the sutures.

High intensity laser treatment (HILT)

The biologic effects of laser energy on the target tissues depend on the laser-tissue interaction, properties of the laser radiation (wavelength, energy density and pulse duration), as well as to the properties of the irradiated tissue (absorption, reflection, transmission and scattering effects).

High intensity laser treatment has a typical power densities ranging from 10 to 106 W/cm^2, based on the production of thermal effects, that can be induced by either continuous wave or pulsed laser radiation. The term thermal interaction stands for a large group of interaction types, where the increases in local temperature is the significant parameter change (45).

On soft tissue in defocused mode working as low intensity laser therapy

High intensity laser irradiation reaching the target tissue in a defocused mode with low power densities, works as low intensity laser therapy with analgesic, anti inflammatory and bio-modulation effects on wound healing process reducing the pain originally from clinical endodontic procedures (3, 8). Therefore, high intensity laser irradiation, including the Nd:YAG laser, wavelength of 1.064 nm, with the parameters of 1.5 W; 15 Hz; 100 mJ, in a defocused mode, with the fiber tip irradiating the laser light in a distance of 10 to 15 mm from the target tissue, could also be useful after pulpotomy, pulpectomy, root filling procedures as well as after apical surgeries.

High intensity laser treatment of hard tissue

The primary effects of high intensity laser irradiation on hard dental tissue are due to thermal changes. Since the energy is absorbed by the components of the target tissue it is transformed into heat energy due to photo thermal interaction which is responsible for the tissue effect. The effects of lasers on hard dental tissue depend on the laser wavelength, therefore, it is extremely important that the use of laser light is based on a knowledge of their biological interaction to provide a suitable and safe application. The use of lasers in the endodontic therapy must not be accompanied by undesirable thermal damage.

Current endodontic techniques such as ultrasonic cleaning of the root canal (4), filling the canal with thermoplasticized gutta-percha (26) or preparation of post space (48) have also been reported as causing high temperature rises. According to previous studies of Eriksson & Albrektsson (7), injury to the bone and to periodontal tissues with necrosis, ankilosis and external root absorption could occur when the temperature on the external root surface increases more than 10 °C for 1 minute.

For that reason, one of the main concerns for the safe use of lasers is the conduction of heat through dental hard tissue to the external root surface and the potential to cause damage to the surrounding periodontal tissue. As the effect of the laser beam depends on the wavelength and on the output of the laser used, energy parameters for root canal laser irradiation must not cause a temperature rise of more than 10 °C on the external root surface to avoid thermal damage to surrounding tissues (7, 57, 68). Furthermore, the laser radiation of hard dental tissues is best done with a pulsed laser and short pulse widths, with which it is possible to operate with short pulses of high power with relatively long rest periods.

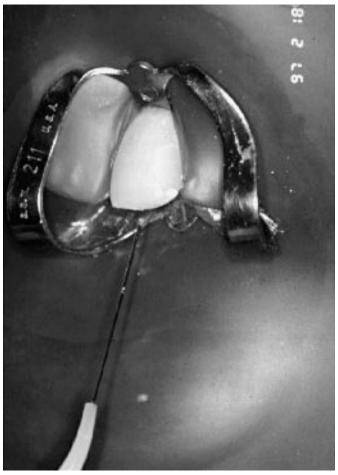
Another question that must be taken into account is that root canal laser irradiation requires a laser beam delivery system through a flexible fiber optical probe with diameter suitable for efficient apical irradiation. For this reason authors have been reported a preliminary root canal preparation by conventional instrumentation before introducing the laser fiber optic into the canal to reach the apical region properly (24). Furthermore, researchers are attempting to develop new flexible fiber optic probes with lateral holes or a spherical probe, which could efficiently emit the laser beam perpendicular to the root canal dentine wall.

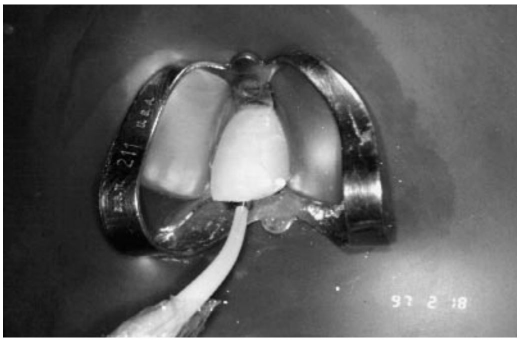
Over the past decades studies of lasers for endodontic applications have investigated different wavelengths for root canal preparation, for bacterial reduction in contaminated canals, for modification of the root canal dentine structure, as well as periapical surgery by ablation. In addition, studies have aimed at producing an impermeable dentine surface after apicoectomy to avoid fluid percolation between the apical region and the root canal system and vice-versa.

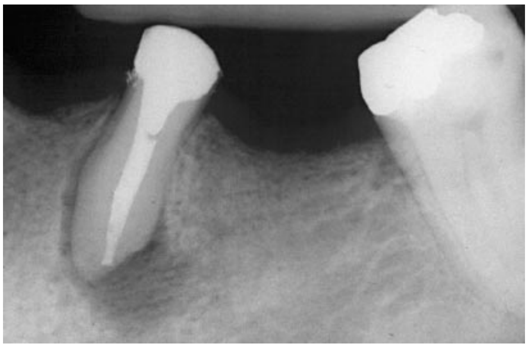
For these purpose, high intensity laser irradiation for endodontic applications is reviewed bellow:

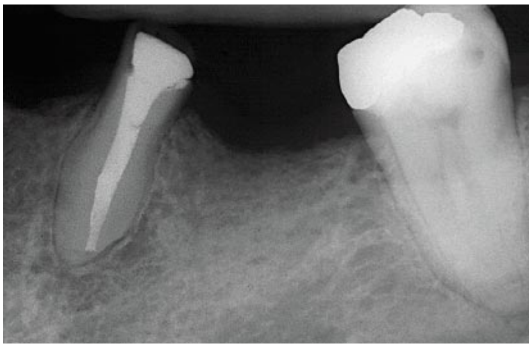
Root canal enlargement

Early *in vitro* studies in the endodontic area attempted to use the xenon chloride excimer, the Ho:YAG laser and the Nd:YAG laser for the enlargement of the root canal. However those results were unfavorable and not promising due to the very low absorption of those wavelengths by dental hard tissue. The published studies report that high energy levels will be required via a tip of a fiber optic for the removal of tooth structure, resulting in severe thermal damage to vital tissues on the external surface of the root canal (6, 11,









1	2
3	4
5	6

Fig. 1. Nd:YAG laser irradiation of root canal walls for bacterial reduction in contaminated root canals.

Fig. 2. The fiber tip inserted up to the work length with helicoidal movement from apical to cervical (4 times of 10 seconds) with parameters of 100 mJ/1.5 W and 15 Hz.

Fig. 3. Root canal filling after Nd:YAG laser irradiation of root canal walls.

Fig. 4. One year follow-up with bone healing and the lamina dura restored.

Fig. 5. Tooth 21, after conventional root canal preparation, Nd:YAG laser irradiation (100 mJ; 1.5 W and 15 Hz) for bacterial reduction.

Fig. 6. After the laser irradiation the root canal was filled with N-Rickert cement and gutta-percha points.

18, 35). In addition, the results of those studies showed a high rate of laser probe fractures into the root canal which will be not possible to removed. For these reasons, before the successful use of laser irradiation to enlarge the root canal, researchers must be focused on the development of suitable fiber optic probes associated with an appropriate wavelength/hard dental tissue interaction.

Bacterial reduction

It is assumed that the presence of bacteria in the root canals are critical for the development and maintenance of apical periodontitis. The efficacy of endodontic rinse solutions and medicaments against bacteria *in vivo* are limited and the infection can be resistant to traditional endodontic methods of treatment, jeopardizing the success of the therapy.

The successful outcome of endodontic therapy depends mainly on a thoroughly disinfection of the root canal, especially in the apical third. If the endodontic treatment fails, it leads to periapical surgery or to the loss of the tooth. The success rate of vital extirpation is approximately 80% or more, while the success rate of necrotic root canals retreated with periapical lesions is about 62% (51).

The causes for persistent infection in contaminated canals are frequently attributed to the typical, predominantly anaerobic root canal flora and their products invading the dentinal tubules and accessories canals (58, 63, 64). Teeth with large apical lesions usually harbor more bacterial species, have a higher density of bacteria in their root canal when compared with small lesions, and consequently heavier bacterial penetration occurs within the dentine depth. The elimination of those bacteria by traditional disinfection methods becomes more difficult (58). Another cause may be the presence of a bacterial biofilm on the external apical root surface establishing an extraradicular endodontic infection refractory to endodontic treatment (63, 64).

Laser irradiation of root canal walls, when absorbed, can produce a thermal effect capable of eliminating microorganisms from the inner region of the dentine layers. However, it is important to establish methods to minimize and control the undesirable effects attributed to the thermal interactions with the tissues. The extent of the thermal damage on the external root surface can be controlled by the laser energy parameters, spot size modifying the power density, exposure time as well as by the pulse duration.

Previous studies with high intensity lasers including Nd:YAG (neodymium: yttrium, aluminum, garnet), Ho:YAG (holmium: yttrium, aluminum, garnet), Er:YAG (erbium: yttrium, aluminum, garnet), Excimer, CO_2 (carbon dioxide) and diode laser have been recommended successfully as a coadjuvant step in the endodontic treatment of contaminated canals to remove bacteria from the root dentinal surface as well as from the deep dentinal layers (11, 20, 24, 31, 42, 43). An in vitro study of Moritz (43) demonstrated a bacterial reduction of 99.64%; 99.16% and 99.05% in root canal contaminated with *Enterococccus faecalis* and *Escherichia coli*, when irradiated with Er:YAG; Nd:YAG and Ho:YAG laser, respectively. Elimination of bacteria from deep dentinal layers increases the success rate of the endodontic therapy of contaminated canals, avoiding periapical surgery procedures.

Morphological changes

Laser irradiation in the endodontic field is being used mainly to clean the root canal walls to provide bacterial reduction and to vaporize granulation tissue. The effect of the root canal wall irradiation has been investigated to verify if the structural morphological modification given by a specific wavelength has any influence on the permeability of the surface as well as on the sealing ability of the root canal filling.

The temperature rise is the fundamental effect determining the extent of changes in the morphology and chemical structure of the irradiated tissue (66). The thermal effect of specific wavelengths associated with the tissue interaction may cause melting and recrystallization of the dentinal structure, or it may produce a surface with exposure of dentinal tubules (34, 52, 53, 61).

An *In vitro* study with Nd:YAG laser root canal irradiation before the obturation procedure showed higher sealing ability of the root filling materials when compared with non-laser treated canals (16).

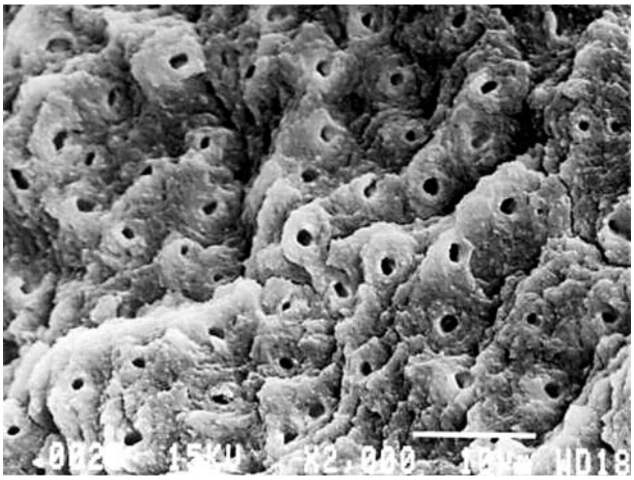


Fig. 7. Morphological changes of dentine root canal walls after Er:YAG laser irradiation. Evidence of the dentinal tubules.

Another similar study evaluating the methylene blue dye penetration between the filling materials and the root canal showed that the Nd:YAG laser root canal irradiation (1.5 W; 15 Hz; 100 mJ) after conventional canal preparation led to a higher sealing ability when compared with the samples not irradiated with laser and even with the samples irradiated with the Er:YAG laser (1.2 W; 10 Hz; 120 mJ) (5).

Internal root canal resorption

High intensity lasers with wavelength in the region of the near infrared band of 1.064 µm (Nd:YAG) are somewhat absorbed by melanin and hemoglobin and therefore their thermal effect has the ability to vaporize soft pigmented tissues.

The photo thermal effect occurs when the laser energy is absorbed by tissue and converted into heat,

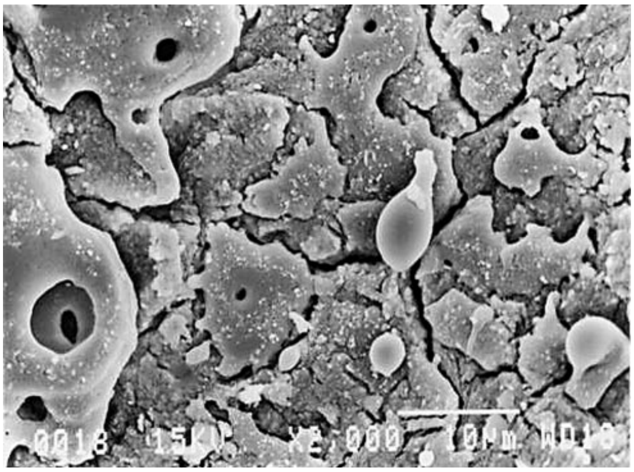


Fig. 8. Dentine of root canal walls after Nd:YAG laser irradiation. Melting and recrystallization of dentine structure.

Fig. 9. Tooth 22 with internal root resorption. Root canal irradiation with Nd:YAG laser to remove the granulation tissue by vaporization followed by the root canal filling.

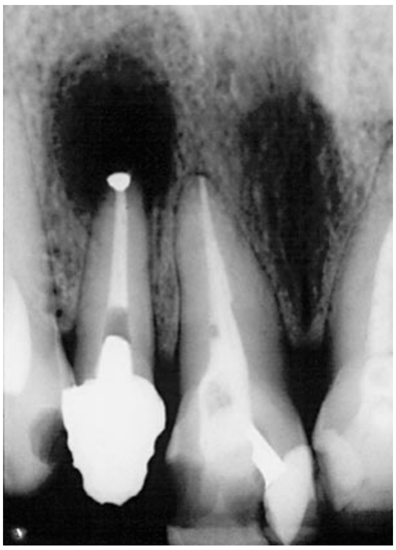


Fig. 10. Radiographic image immediately after apicoectomy with Er:YAG laser (tooth 12).

Fig. 11. Six month later a decrease in the size of the periapical lesion is noted.

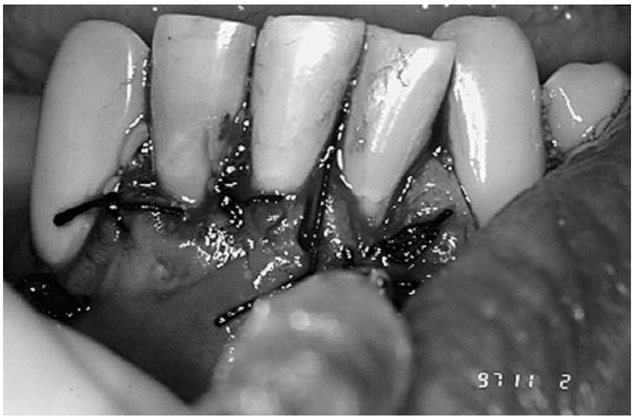
Fig. 12. Tooth 42 with extensive periapical lesion. After endodontic retreatment the tooth was submitted to periapical surgery.

therefore the use of safe laser parameters and a proper delivery system with a flexible fiber optic tip allows the removal of granulation tissue present in internal resorption of root canals. In addition, the disinfections will be achieved simultaneously in contaminated canals due to the bactericidal effect of high intensity laser irradiation.

Laser in apical surgeries

The non surgical conservative methods of endodontic therapy have solved a great part of periapical pathological processes from which a few percentage of apical surgeries are indicated. Therefore, in situations when the endodontic retreatment is not feasible or unfavorable, the apical surgery becomes the best clinical indication for the maintenance of the tooth.

The apicoectomy consists of the elimination of the periapical lesion, removal of the root apex and the performance of a retrograde root canal filling. The failures of the apical surgeries have been related to the percolation of remaining microorganism, their products and organic fluids from the root canal system to the periapical region, the possible penetration into the interface between the retrograde filling and cavity walls due to the reduced sealing capacity of the retro filling materials (47, 50, 65), or through the



13 | 14
15 | 16

Fig. 13. The root resection was performed with the Er:YAG laser (450 mJ; 4 Hz)

Fig. 14. Following the removal of the granulation tissue, the bacterial reduction was obtained with the Nd:YAG laser irradiating the surgical site (non contact mode – 1.5 W; 15 Hz).

Fig. 15. The dentine cut surface was irradiated in a contact mode with the Nd:YAG laser to produce the morphological changes with the melting and recrystallization of the dentine structure.

Fig. 16. Anti inflammatory and bio-stimulation effect with the low intensity laser therapy after the flap repositioning and suture (Ga-Al-As; 790 nm; 30 mW, during 6 minutes).

exposed dentinal tubules on the resection surface (17, 62). In addition, such remaining microorganisms are also capable of being present on extraradicular refractory infections (63, 64) and to invade the periapical tissues (25). For these reasons several techniques, methods and new materials have been developed to enhance the apical surgical treatment in order to increase the sealing ability of the retrograde filling material as well as of the dentinal cut surface providing biological conditions for tissue healing as well as the cement/tissue repositioning.

With the advent of laser technology and the spread of its use in dentistry numerous researchers demonstrated the capacity of specific high intensity laser wavelengths to remove the dental hard tissue by the ablation process because they are highly absorbed by the target tissue components (27, 30, 67). Due to this reason it is possible to use those specific wavelengths in apicoectomy.

In vitro studies of apicoectomies using the laser irradiation have been conducted to obtain a smoother and less permeable cut dentine surface producing the melting and recristallization of the dentinal structure with the closure of dentinal tubules (21, 22, 23, 38, 41, 42, 52, 53). Furthermore, lasers have been used clinically for periapical surgeries (46, 33) including a long term evaluation with clinical and radiographic follow-up (22). Besides the ability to cut the apical portion of the root through the ablation process, the laser light acts also as a bio modulation effect stimulating the cellular activity and improving the wound healing process as well as promoting the microbiological reduction at the surgical site.

Fig. 17. One-year follow-up with reduction of the periapical lesion size.

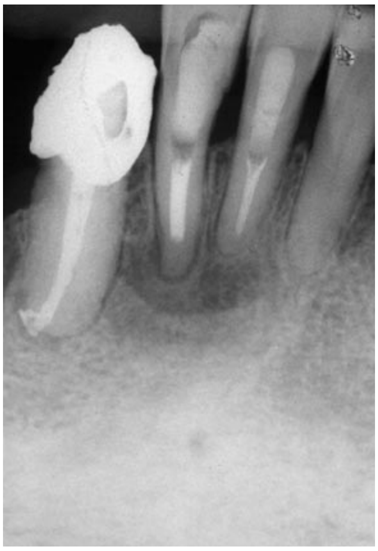


Fig. 18. Two-year follow-up. Bone healing with evidence of the restored lamina dura.

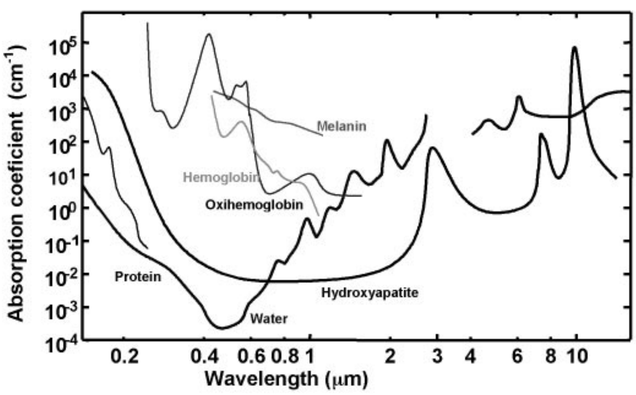
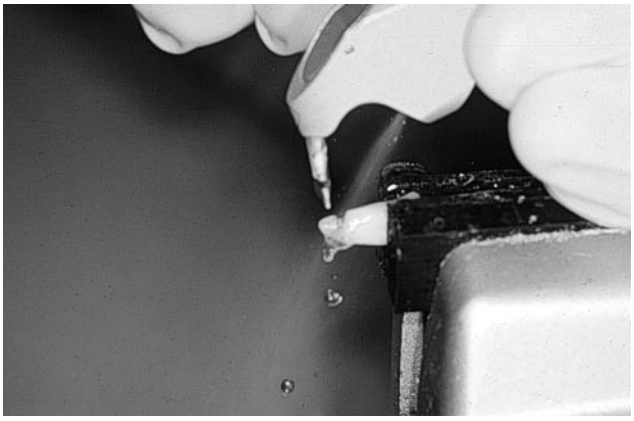


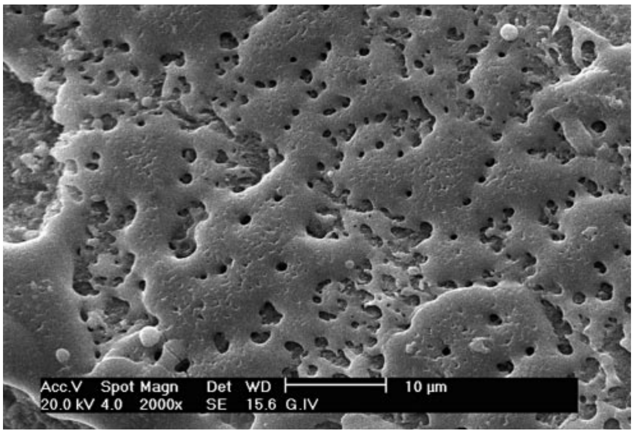
Fig. 19. Absorption spectrum (Maldonado et al., 2000)

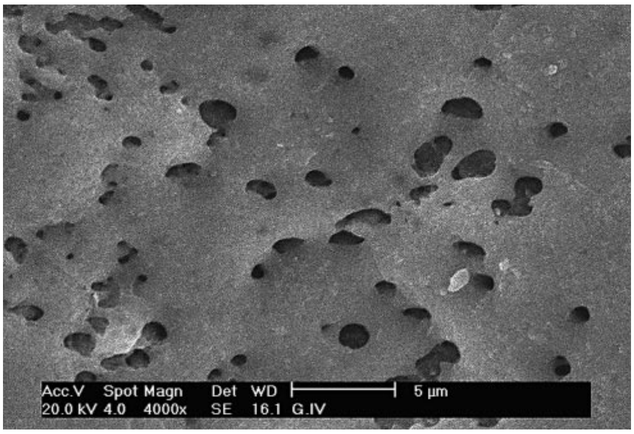
Ablation of dental hard tissue

• **Er:YAG laser, 2.94 µm:** The absorption spectrum (Figure 19) demonstrates that the Er:YAG laser and the 9.6 µm CO_2 laser are highly absorbed by the components of the enamel and dentin (water content and minerals). The light energy absorbed by the components of the tooth is transformed into thermal energy. The thermal action heats up the water amongst the mineral crystals causing micro explosions and disrupting the hard tissue. However, the emission of the irradiation must be pulsed, with a short thermal relaxation time and a short pulse duration so that harmful thermal are minimized. The thermal relaxation time is the time that the remaining energy, which is not absorbed when removing the hard dental tissue during ablation, takes to spread in the layer beneath the ablated tissue. During the micro explosion ablation processes mediated by the water, if the pulse duration and the thermal relaxation time are low, the deposited heat will only depend on the energy density (49).

Several *in vitro* studies evaluating the ablation process with the Er:YAG laser demonstrated the ability to remove hard dental tissue. Hibst and Keller (27) and Keller and Hibst (30) were the pioneers to report the use of irradiation with the pulsed Er:YAG laser on enamel and dentin for cavity preparation without







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22 | 23

Fig. 20. Apical root resection with the 9.6 µm TEA CO_2 laser (Opus 96-Opus Dent) with 5 W; 20 Hz; 250 mJ, no contact, beam irradiation with 1.6 mm diameter of circular configuration, energy density of 352.73 J/cm².

Fig. 21. Dentine cut surface treatment with the 9.6 µm TEA CO_2 laser with 3 W; 20 Hz; 150 mJ, no contact, beam irradiation with 2.0 mm diameter of circular configuration, energy density of 211.64 J/cm².

Fig. 22–23. Morphological changes of dentine surface after apicectomy and cut surface treatment with the 9.6 µm TEA CO_2 laser. Less permeable cut surface after the CO_2 laser irradiation when compared with the control group (Gouw-Soares (19)).

causing thermal damage to the adjacent tissues, since this wavelength is highly absorbed by the water component of the dental tissues. The absorbed energy induces a rapid rise in temperature and pressure, and the heated material is removed by a micro explosion process. Although the amount of water contained in the hard dental tissue is relatively low, it seems that enough absorption occurs to start the ablation process, and only a little incident energy remains in the tissue to cause thermal injury.

Further studies were developed using this wavelength to cut the apical root in apicoectomy (21, 32, 33, 46). All of them have demonstrated by SEM examination that the resection surface presented a slightly irregular clean surface, no smear layer, with dentinal tubules exposed. Those aspects evidenced by photomicrography were similar to the ones found in in vitro studies of the Er:YAG laser irradiation on dentine surface in cavity preparations as well as on root canal dentine (27, 30, 60, 61). The Er:YAG laser irradiation to perform the apicoectomy in vitro in conjunction with the dentine surface treatment with the Nd:YAG laser produced the melting and recrystallization in discontinued areas resulting in a less permeable surface to methylene blue dye when compared with the samples irradiated only with the erbium laser (23). Following the same protocol, the Er:YAG laser was also used in clinical procedures of apicoectomy in conjuction with the Nd:YAG laser and the As-Ga-Al low intensity laser in a 3-year clinical and radiographic follow-up (22). This association was made in an attempt to obtain a less permeable apical surface since previous studies with the 1064 nm Nd:YAG laser demonstrated its capacity to promote vitrified dentinal areas by fusion, dentin resolidification and partial sealing of the dentinal tubules with a decrease of the surface permeability without thermal damage (34, 53).

• **9.6 µm TEA Carbon Dioxide (CO_2) laser:** In the field of apical surgery Miserendino et al. (41), in 1988 were the first to use clinically the continuous wave 10.6 µm CO_2 laser to promote hemostasis, apicectomy and bacterial reduction. They observed thermal effects with the carbonization of the dental hard tissues using the continuous emission laser with a very high power (10 W), during 20 seconds. Using the same wavelength, other experimental studies showed the disadvantages of the 10.6 µm continuous CO_2 laser in apical surgeries due to the thermal effect on the dentinal surface (15, 32). The CO_2 laser was the first one to be used experimentally for the ablation of dental hard tissue by Stern and Sognnaes (56), however nowadays, it is well known that the continuous wave does not remove dental tissue properly as the temperature rise causes thermal damage to surrounding tissue. For this reason, the 10.6 µm CO_2 laser emitted in a continuous wave should be restricted to soft tissue use.

The main CO_2 laser emission is 10.6 µm, however, the CO_2 laser has the possibility to emit several wavelengths in a pulsed mode with the modification of some factors in the active medium such as the relative concentration of the facilitator gases of Helium, Nitrogen and carbon dioxide (59).

Recent studies demonstrated that CO_2 laser irradiation in pulsed mode and with wavelengths from 9.3 to 10.6 µm, more specifically the 9.3 and 9.6 µm pulsed TEA CO_2 laser (transversely excited atmospheric pressure) presents the capacity to remove dental hard tissue by the ablation process in general followed by fusion, since this wavelength is highly absorbed by the water components and specially the hydroxyapatite of the dental tissues due to the predominant resonant absorption for the phosphate ion of the hydroxyapatite crystals at around 9.6 µm. The infrared transmission spectrum of hydroxyapatite shows lowest transmission at wavelengths near 9–11 µm with the lowest transmission of energy at 9.6 µm meaning that this one is highly absorbed by the inorganic content of the hard dental tissues (9, 10, 12, 13, 14). For this reason the use of these wavelengths, mainly the 9.6 µm TEA, CO_2 laser, presents a great potential to remove dental hard tissue in cavity preparations (49, 67), as well as in apicoectomy (19, 54). Furthermore, according to Featherstone (9), in cavities prepared with this wavelength the residual energy may be sufficient to provide inhibition of subsequent caries after the placement of composite resin restoration.

Numerous researchers have demonstrated the use of a 9.6 µm CO_2 laser with pulsed emission to irradiate dentine and enamel samples in cavity preparations and apicoectomies, without causing carbonization of the hard tissues (12, 13, 14, 19, 44, 54, 67). The best results seem to be obtained when the tissue is cooled with water spray during the irradiation, as with other laser systems with the purpose of dental hard tissue ablation without thermal damages.

Conclusion

The use of laser irradiation for endodontic applications has increased in recent times due to the development of different wavelengths and related laser parameters for interaction with the target tissues, together with advances in laser technology and suitable delivery systems. Correct protocols are mandatory to avoid thermal damage to surrounding tissues and to reach the treatment objective with the improvement of the success rate.

Die Anwendung von Lasern in der Endodontie

Am dentalen Hartgewebe haben Laser bereits heute Eingang in die klinische Praxis gefunden. Durch andere Wellenlängen, sowie neue Methoden oder Applikationssysteme kommen weitere Anwendungen hinzu. In der endodontischen Therapie werden Laser sowohl bei niedrigen Leistungen (low intensity laser therapy, LILT) als auch im Hochleistungs-Bereich (high intensity laser treatment, HILT) als Adjuvans eingesetzt, um die Erfolgsrate zu erhöhen. Im vorliegenden Artikel werden die in vitro Studien und klinischen Prozeduren zusammengefasst.

Die LILT hat analgetische, anti-inflammatorische und biomodulierende Effekte auf das bestrahlte Weichgewebe, wodurch Wundheilungsprozess und post-operativer Verlauf verbessert werden. Am Weichgewebe können ähnliche Wirkungen auch durch eine defokussierte Bestrahlung bei hoher Leistung hervorgerufen werden. Am dentalen Hartgewebe, wie dem Wurzelkanal-Dentin oder der Dentin-Schnittfläche nach einer Wurzelspitzenresektion (Apikotomie), können durch eine Laserbestrahlung bei hoher Leistung verschiedene Effekte erzielt werden. Diese sind abhängig von der Wellenlänge und umfassen strukturelle Veränderungen, wie das Aufschmelzen und Rekristallisieren von Dentin, die Entfernung der Schmierschicht nach mechanischer Wurzelkanalaufbereitung, das Freilegen von Dentin-Kanälchen und den Hartgewebe-Abtrag, z. B. im Rahmen einer Apikotomie. Weiterhin lassen sich Bakterien abtöten, sei es in der Chirurgie oder insbesondere auch in kontaminierten Wurzelkanälen. Letzteres wird als besonders vorteilhaft gegenüber den konventionellen Methoden der Wurzelkanal-Desinfektion angesehen.

Schlüsselwörter
Laser, Endodontie, Bakterien, Nd:YAG-Laser, Er:YAG-Laser, Ho:YAG-Laser, 9.6 µm CO_2-Laser, Apikotomie

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