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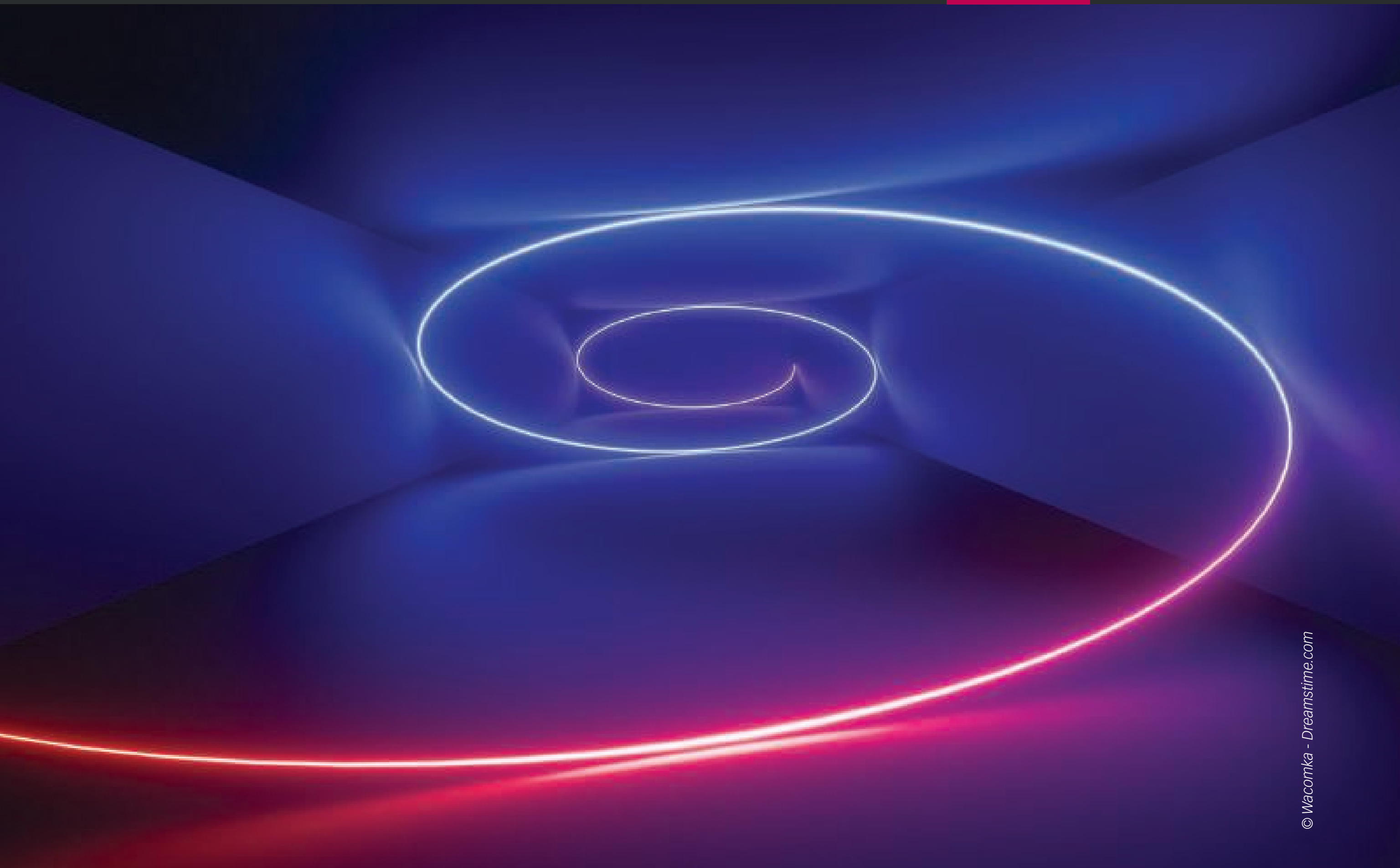
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# Lasers in dentistry: Applications and incorporation into the dental practice

A peer-reviewed article written by Gregori M. Kurtzman, DDS


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# Lasers in dentistry: Applications and incorporation into the dental practice


## ABSTRACT

Lasers have become a common device in the dental practice with multiple uses during treatment. These include periodontal soft tissue pocket treatments, gingivectomies and tissue recontouring, osseous crown lengthening, decay removal with restoration preparation, and endodontic canal disinfection. Additionally, lasers provide stimulation for enhanced healing as well as treatment of lesions such as oral herpes and aphthous ulcers. The various lasers available in dentistry have their specific uses, and understanding the types of lasers determines how they may be successfully used and for what applications they are suited. This course will review the different types of lasers being utilized in dentistry and how they may be used during treatment. It will also discuss the effects lasers have on the tissue at which the energy is directed.


## EDUCATIONAL OBJECTIVES

At the conclusion of this educational activity, participants will be able to:

1. Describe the different types of dental lasers available
2. Understand laser energy and its effects on hard and soft tissues
3. Identify what treatments lasers are suited to perform and which laser type to use

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## INTRODUCTION

Lasers have become common in the dental practice, with applications for hard and soft tissues. However, not all lasers affect human tissue in the same way. This is due to the wavelength produced by the laser and which tissue is affected by different wavelengths.

The wavelengths emitted by lasers fall into different areas of the light spectrum, measured in nanometers (nm) (figure 1). Light energy that falls under 750 nm (ultraviolet 140-400 nm and visible 400-700 nm) is not applicable for dental treatment. Lasers emitting over 700 nm, classified as infrared, are in the invisible thermal spectrum. Dental lasers operate above 800 nm and are categorized by their wavelengths as follow:

- diodes (810 nm, 980 nm, and 1,064 nm)
- Nd:YAG (1,064 nm)
- Er,Cr:YSGG (2,780 nm)
- Er:YAG (2,940 nm)
- $CO_2$ (9,300 nm and 10,600 nm)

In addition, lasers require a medium to create the wavelength energy. This medium can be in the form of a gas, liquid, solid, or semiconductor.

Laser effectiveness is based on the ability of the wavelength to be absorbed into the material being treated (figure 2). Because gingival tissues absorb wavelengths at the 810-1,064 nm range (an affinity for hemoglobin and melanin), the diode lasers are used for soft tissue applications. Nd:YAG, Er,Cr:YSGG, Er:YAG, and $CO_2$ lasers are suited for use in hard tissue treatment as their wavelength (>1,064 nm) has an affinity for hydroxyapatite and water. Energy from a laser can have four different interactions on the target tissue, and these interactions will depend on the optical properties of that tissue.

## LASER TISSUE EFFECTS

### Reflection

Reflection is the first interaction that can occur, with the beam redirecting itself off of the surface, while having no effect on the target tissue. The reflected light could maintain its collimation in a narrow beam or become more scattered (diffuse). Reflection can be dangerous because the energy can be directed at an unintentional target, such as the eyes. This is a major safety concern for laser operation and eye protection is recommended for the practitioner, dental assistant/hygienist, and the patient being treated. As lasers use different wavelengths, the eye protection used must be appropriate to block the particular wavelength of the laser being used to be effective in preventing eye (retina) damage. There is no universal eye protection available that is recommended for use with all laser wavelengths.[1,2]

### Transmission

A secondary effect is transmission of the laser energy directly through the tissue with no effect on the target tissue, and this effect is also highly dependent on the wavelength of laser light being used. Water is relatively transparent to lasers, whereas tissue fluids readily absorb erbium and carbon dioxide at the outer surface, so there is very little energy transmitted to adjacent tissues.

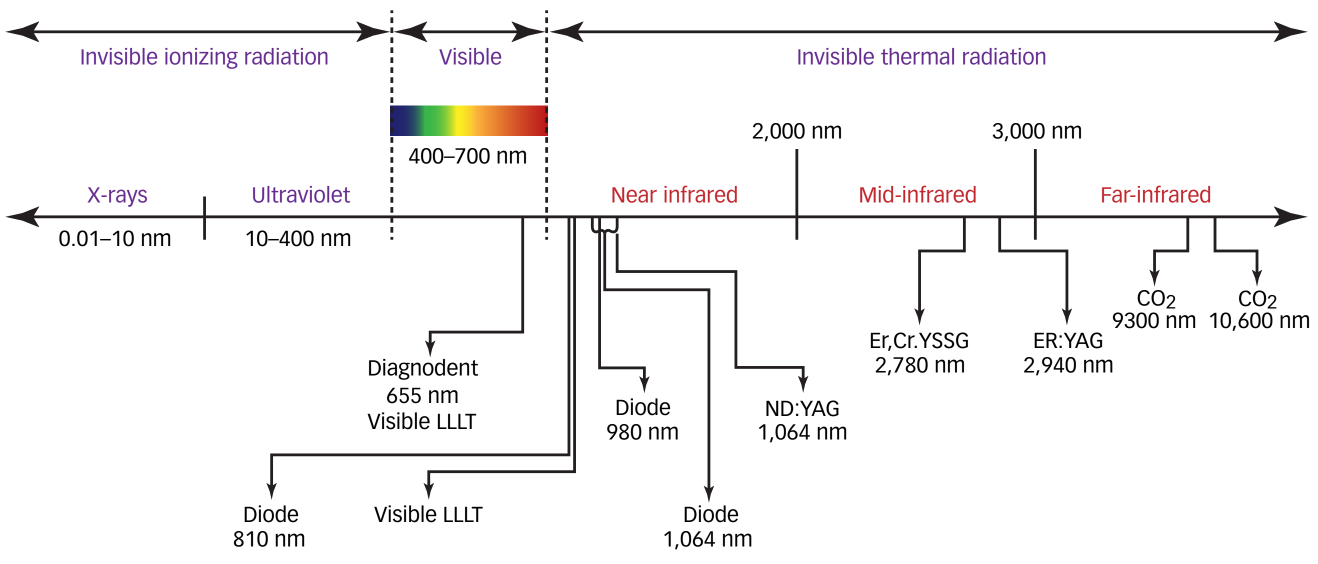
### Scattering

The third effect is scattering of the laser light, which may decrease the intended energy, limit effects on the intended target tissue, and possibly produce no useful biological effect. Scattering of the laser beam may cause heat transfer to tissue adjacent to the surgical site, potentially leading to unwanted damage.

### Absorption

The fourth effect is absorption of the laser energy by the intended target tissue. The amount of energy that is absorbed by the target tissue depends on the tissue characteristics, such as water content, pigmentation, laser wavelength, and its emission mode. The primary beneficial goal of laser energy is absorption of the laser energy by the intended biological tissue.

**FIGURE 1:** Wavelengths on the electromagnetic spectrum



## USES OF DENTAL LASERS

Several photobiological effects are possible when using a dental laser. Photothermal effects occur when the energy is transformed into heat. Surgical incisions and excisions with accompanying hemostasis are one of the many results of photothermal effects utilized in treatment. Lasers can exert a photochemical effect, where the laser energy stimulates a chemical reaction, such as curing composite resins. This can also break chemical bonds in photosensitive compounds that, when exposed to laser energy, can produce a singlet oxygen radical that aids in disinfection of periodontal pockets and endodontic canals.

Another effect involves certain biological pigments that fluoresce when absorbing laser light. This fluorescence can be used for caries detection and is the principle used with the DIAGNOdent (Kavo, Charlotte, NC) caries detection system. Lasers can be used in a nonsurgical mode for biostimulation of more rapid wound healing, pain relief, increased collagen growth, and a general anti-inflammatory effect, referred to as low level laser therapy (LLLT).

Finally, pulse energy of the laser on hard tissue (tooth structure or bone) can produce a shock wave, which could then explode or pulverize the tissue on a microscopic level, creating an abraded crater to be used for tooth preparation or osseous crown lengthening. This is an example of the photoacoustic effect that can be achieved with laser types other than a diode.

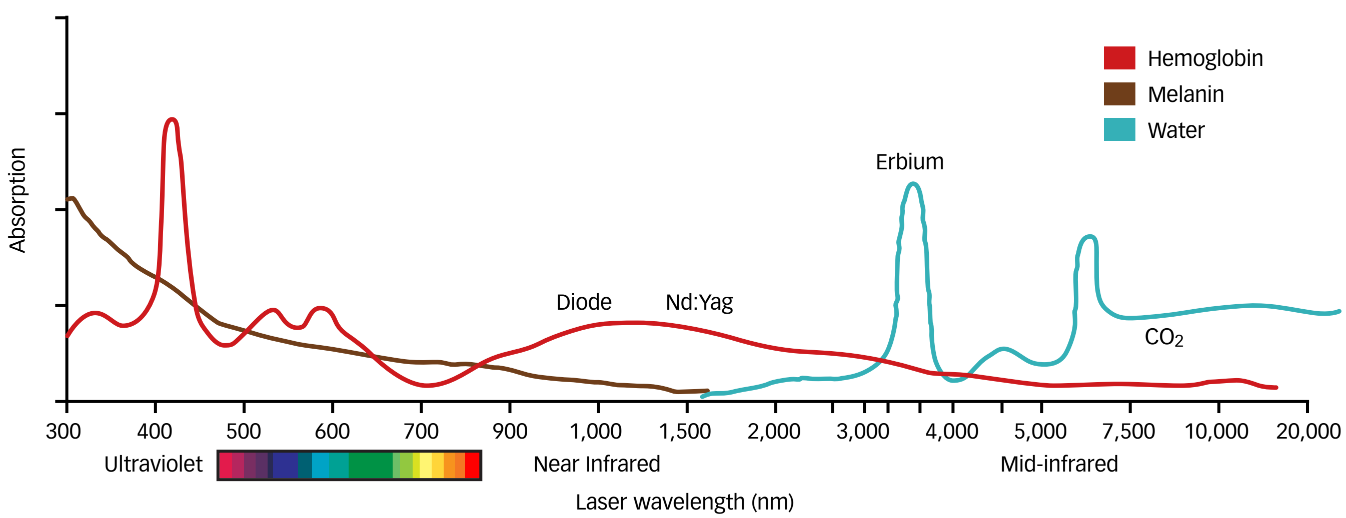
## LASERS AND TISSUE TEMPERATURE

Thermal effects of laser energy on tissue primarily involve the water content of the tissue. When the target tissue containing water is elevated to a temperature of 100 degrees C, vaporization of the water within the tissue occurs, a process called ablation.[3] As soft tissue is composed of a very high percentage of water, excision of soft tissue commences at this temperature. When temperatures are below 100 degrees C and above 60 degrees C, the proteins in the tissue begin to denature without any vaporization of the underlying tissue, allowing coagulation of any bleeding that may occur.[4] If the tissue temperature can be controlled, the biologically healthy portion will remain intact and adjacent healthy tissue will not be negatively affected. Conversely, when tissue temperature is raised to approximately 200 degrees C, the tissue is dehydrated and then burned, with carbon being the end product. This process is referred to as carbonization. Unfortunately, carbon is a high absorber of all wavelengths, so it becomes a heat sink as the lasing continues, with resulting heat conduction causing collateral thermal trauma to the adjacent tissues that will prolong healing and increase postoperative sensitivity.[5]

The degree of these various effects is dependent on the transmission of the laser energy. Transmission is affected by both the wavelength of the laser (energy output) and how long the energy is concentrated on the tissue (depth of beam). The depth of beam is dependent on how long the beam is held on the tissue and how far the tip is held from the target tissue plus the energy output (wattage) of the laser. To minimize depth, the tip should be kept moving over the area being treated and not held in a single spot. Decreasing wattage, using the lowest level that will accomplish the task intended, and increasing power output until the desired effect occurs will minimize collateral effects that are not desired.

The mode of laser emission plays an important part in the rise in tissue temperature. Light energy being emitted by the laser is classified as continuous, gated-pulse, or free-running pulse. A continuous wave is emission at a single power level for as long as the device is being activated. A gated-pulse mode has periodic alteration of the laser energy as the device cycles between on and off with a few milliseconds between the two phases. Free-running pulse mode has a large peak laser energy emitted for an extremely short time span followed by a long off period before recycling and repeating. Pulsing output as controlled by the laser (gated-pulse or free-running pulse) ensures that the target tissue has some time to cool before the next amount of laser energy is emitted. Thin or fragile soft tissue should be treated in a pulsed mode so that the amount and rate of tissue removal is slower, but the potential of irreversible thermal damage to the target and adjacent tissue is minimized. A gentle air stream from the air/water syringe or an air current from the high volume suction also aids in keeping the area cooler. When

**FIGURE 2:** Laser energy absorption based on components of what is being cut with the laser



treating thick, dense, fibrous soft tissue, more energy is required for removal, and a continuous emission mode will provide a more rapid tissue removal while maintaining a safe speed of excision.

## CLINICAL LASER APPLICATIONS

Lasers have various clinical applications in the dental practice. Depending on the type of laser, specific uses are indicated. The primary action of a diode laser is absorption in chromophores to which it is attracted: melanin, hemoglobin, water. Thus, diodes have soft tissue applications but no effect on hard tissue. The other lasers mentioned have applications that include hard tissue applications.

## SOFT TISSUE REMOVAL AND ALTERATION

Modification of the gingiva to gain ideal margin position to achieve width-to-length ratios that achieve or approach the golden proportion can greatly improve the overall case esthetics. Gingivectomy has been traditionally performed with scalpel blades, special burs/diamonds in high-speed handpieces, or electrosurgery units. But electrosurgery has been demonstrated to result in potential tissue shrinkage, affecting the esthetic results as healing occurs. Lasers such as the diode or Er:YAG, Nd:YAG, or Er,Cr:YSGG have much less depth of penetration; thus, tissue shrinkage does not occur and there is less postoperative sensitivity and better tissue healing. Lasers yield a nonbleeding edge, allowing impression taking without being hampered by oozing tissue margins. This also applies to improved troughing for crown and bridge impressions (figure 3).

Several studies have shown the effectiveness of Er:YAG, Nd:YAG, and Er,Cr:YSGG lasers for both hard and soft tissue ablation and for their bactericidal effects with less or no pain under clinical applications, due to their high absorbability in water and hydroxyapatite.[6] Diode lasers reduce postoperative bleeding and pain of patients needing cosmetic smile lift surgeries.[7] Patients treated with a laser displayed significantly lower discomfort compared with a scalpel. The laser can be a safe and effective alternative to traditional crown lengthening performed with a scalpel, and it produces fewer postoperative issues.[8,9] A diode or Er:YAG laser is an effective and safe method for removing overgrown gingival tissue without potential for medical complications, and it is a more comfortable procedure than when treated by a scalpel or electrosurgery.[10]

## ENDODONTICS

The canal system within teeth is a complex array of accessory and lateral canals, fins, and other anatomical areas that are inaccessible with endodontic files (figure 4). Endodontic success is dependent on disinfection and debridement of the canal system. Obturation, or sealing of the canal system, is dependent on how well the canal anatomy is cleaned of pulpal tissue and residual bacteria. Irrigation has been long accepted as a key part of treatment to achieve those goals.

Complete clearing of residual bacteria, especially in the apical portion of the canal system, has been difficult to achieve with traditional instrumentation and irrigation methods, even when using sodium hypochlorite (NaOCl) irrigation solutions (figure 5). Studies have demonstrated that addition

**FIGURE 3:** Diode laser being utilized to trough around a prepared tooth to improve margin capture by the impression

of laser activated irrigation greatly enhances not only the efficiency of the recommended irrigation solutions (NaOCL and EDTA), but also improves disinfection of the canal system (figure 6). This can be done with a diode laser or with Er:YAG, Er,CR:YSGG, or Nd:YAG lasers, although the two groups of lasers achieve results differently.

## LASER ENHANCED IRRIGATION

Application of the diode laser with endodontic irrigation is a good adjunct to conventional endodontic treatment when used in combination with NaOCl and other irrigants.[11] Disinfection strategies using diode laser-activated irrigation and photoactivated disinfection yield promising results and have been reported to eliminate *Enterococcus faecalis* within the canal system.[12,13] *E faecalis* is a common microflora in saliva that has been associated with endodontic failure.

**FIGURE 4:** Anatomy of the canal system demonstrating accessory canals, fins, and lateral canals that are not accessible with endodontic files as shown in cleared teeth

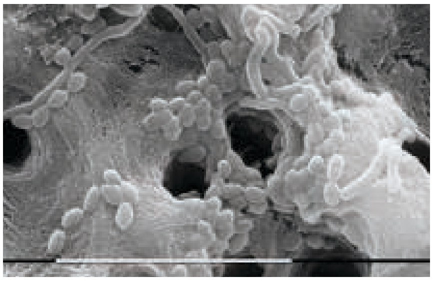


**FIGURE 5:** SEM showing bacteria and pulpal debris in the apical third that was not able to be removed fully using standard irrigation protocol (Courtesy Prof. Georgi Tomov, Plodiv, Bulgaria)

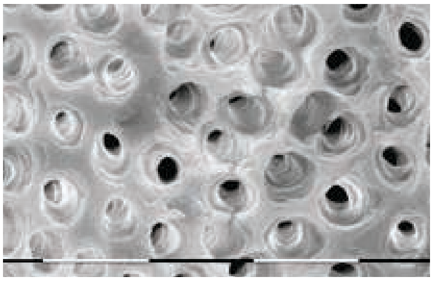


**FIGURE 6:** SEM showing complete removal of bacteria and pulpal tissue in the apical third after irrigation using laser irrigation protocol (Courtesy Prof. Georgi Tomov, Plodiv, Bulgaria)

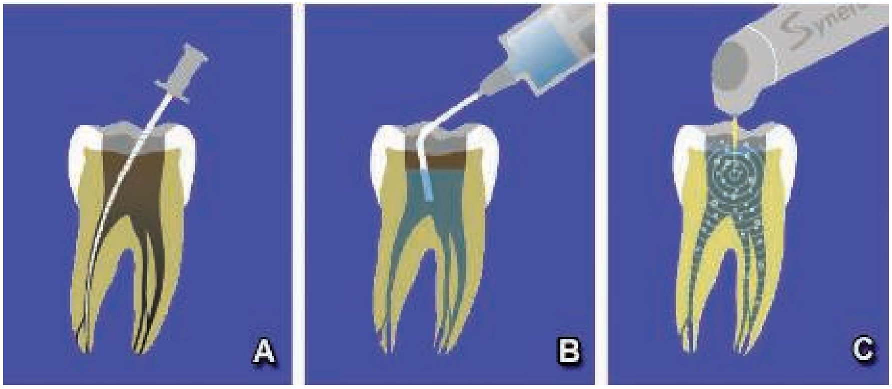



**FIGURE 7:** Laser-activated endodontic irrigation: Establishment of glide path with hand files (A), canal and chamber filled with NaOCl (B), and placement of the laser tip into the irrigant in the chamber and activation of the Er:YAG laser (Illustrations courtesy of Dr. Parvan Voynov, Plodiv, Bulgaria)

When it establishes in the canal system, it is difficult to remove using traditional irrigation methods.[14]

The diode laser has two effects when activated in the irrigation solution within the canal system. The energy from the diode heats the irrigation solution, thereby improving the efficiency of the irrigant to exert its actions on the pulpal tissue and bacteria (NaOCl) or chelate the dentin (EDTA) within the root system. Diode lasers induced only modest temperature changes on the external root surface at the settings used, and they are safe for the periodontal tissues surrounding the tooth.[15] Following instrumentation to a size 25 file (rotary or hand file), laser-enhanced irrigation is started, with the fiber of the diode extended to 2-3 mm from working length and activated. In multicanal teeth, the process is repeated in each of the canals. Photodynamic therapy (PDT), with the laser energy transmitted by the diode laser through the irrigation solution, has been shown to decrease the bacterial count within the canal system.[16] The photodynamic effect appears to disrupt the biofilm by acting on both the bacterial cells and on the extracellular matrix extending to the outer surface of the root.[17] Although the light energy from the diode laser extends out to the periodontal ligament, it has been demonstrated that the method that is safe for periodontal tissues can also be used for endodontic purposes.[18]

The Er:YAG, Nd:YAG, and Er,Cr:YSGG lasers have also proven to improve endodontic clinical results by activating the irrigation solutions in the canal system.[19] Antibacterial effects were reported to be the best with combination of irrigant and laser.[20] The higher wavelength of the Er:YAG compared to the Nd:YAG or diode was more effective in smear layer removal, hence better at bacterial elimination within the canal system.[21] These create hydrodynamic pressure following cavitation bubble expansion and collapse when the irrigation solution is activated in the chamber. A heat pulse is generated by laser radiation delivered via a sapphire tip into an absorbing liquid (irrigant), resulting in tensile stress and cavitation being induced in front of the tip at a distance. Bubble expansion and collapse cause the surrounding fluid to flow at a speed of up to 12 m/s traveling throughout the canal system.[22-24] This causes rapid displacement of intracanal fluid to drive irrigants into the canal anatomy.

Access into the pulpal chamber may be performed with the Er:YAG, Nd:YAG, or Er,Cr:YSGG laser, which provides decontamination and removal of bacterial debris and pulpal tissue to yield a cleaner chamber ( figure 7A). Laser-assisted canal irrigation requires canal preparation to an apical preparation ISO 25/30 with a taper of 0.04 or 0.06. NaOCl is utilized within the chamber and canals during instrumentation both as a pulpal tissue dissolvent and to lubricate the files within the canal ( figure 7B).

**FIGURE 8:** Accessory anatomy evident in the apical that has been filled with sealer and is accessible due to use of an Er:YAG laser (Photo courtesy of Dr. David Guex, Lyon, France)

**FIGURE 9:** Laser implant uncovery with a diode laser demonstrating lack of hemorrhage at the cut edge

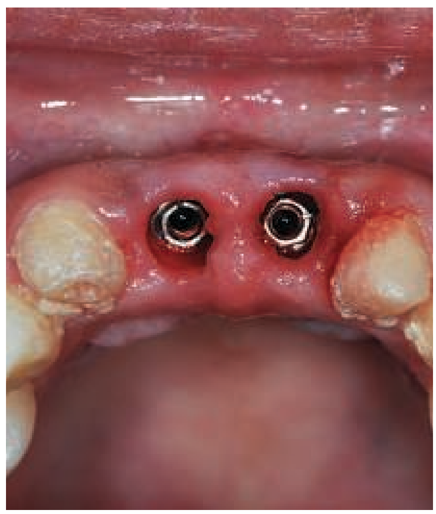


**FIGURE 10:** Implant uncovery and healing screw removal to allow the restorative phase to begin, demonstrating no tissue hemorrhage or charring

**FIGURE 11:** Gingival abscess associated with a restored dental implant

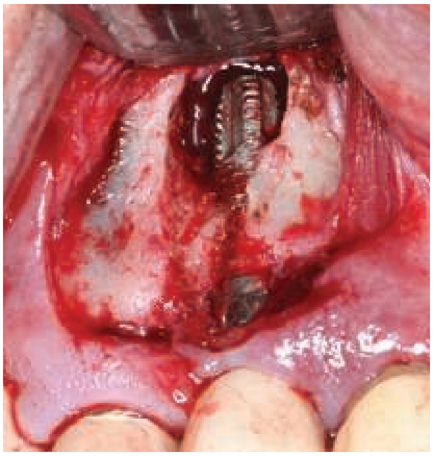


**FIGURE 12:** Exposed implant threads as a result of peri-implantitis following flapping of the area and laser degranulation and decontamination of the exposed threads prior to graft placement

**FIGURE 13:** Osseous graft has been placed to cover the laser treated exposed implant threads

Photo-activation of the irrigant within the canal system using the laser with a 0.4/17 or 0.6/17 mm tip assists in removal of the debris created by the files. The tip of the laser is placed into the chamber and the solution activated with the laser at 40 mJ at 10 Hz with an average power of only 0.5 W for 20 seconds (figure 7C). It is unnecessary to place the laser tip into the canal, as activation of the solution within the chamber transmits down the irrigant in the canals to the apical aspect of the roots. Laser activation may also be performed with 17% EDTA solution alternated with NaOCl, giving the benefit of EDTA chelation effect to open canal anatomy so that the next round of NaOCl can reach more pulpal tissue (figures 5, 6).[25] Obturation is then accomplished using the practitioner's preferred method and materials, allowing obturation of anatomy inaccessible by instrumentation with files (figure 8).

**FIGURE 14:** CBCT scan at 5 years post laser-treated peri-implantitis demonstrating maintenance of grafted bone over the exposed threads

## IMPLANT UNCOVERY AND SOFT TISSUE MODIFICATION

Clinically, diode lasers are becoming increasingly utilized in dental practices and provide sufficient power to modify soft tissue in and around the dental implant for uncovery or alteration of the gingival margin to improve the esthetics. These operate within the temperature range that has been recommended, negating negative effects observed with other uncovery methods (electrosurgery) to the soft and hard tissue around the implant.[26] Coagulation, an added benefit, is controlled, allowing impressions to be taken at the time of uncovery without fear of blood interfering with the accuracy of the gingival aspect of the impression (figures 9, 10). Because tissue cutting with the diode does not affect deep cellular layers of the gingiva, tissue shrinkage is not a concern and gingival healing does not need to complete before impressions can be taken, unlike with an electrosurgery unit.[27] Additionally, use of electrosurgery around implants may lead to deintegration of the implant due to current conduction through the implant, which has not been reported with laser usage. Other laser types may also be utilized for implant uncovery or soft tissue modification but are not as efficient as a diode laser due to the affinity for the tissue being managed and the particular laser's wavelength.[28]

## PERI-IMPLANTITIS TREATMENT

The prevalence of peri-implant complications is frequent enough that treatment needs to be accomplished to prevent loss of the implant. As with periodontitis associated with natural teeth, periodontal disease can affect implants. This may range

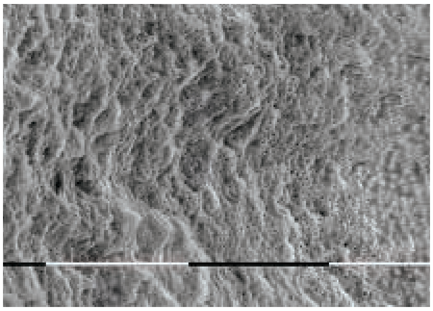


**FIGURE 15:** Dentint surface following caries removal with an Er:YAG laser demonstrating a lack of smear layer (Courtesy of Prof. Georgi Tomov, Plovdiv University-Bulgaria)

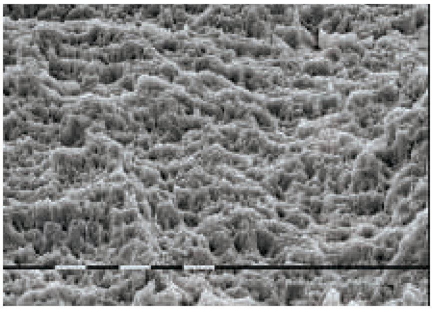


**FIGURE 16:** Enamel surface following treatment with an Er:YAG laser showing an enhanced bondable surface with a uniform roughened surface (Courtesy of Prof. Georgi Tomov, Plovdiv University-Bulgaria)

**FIGURE 17:** Carious tooth structure on a deciduous molar with soft tissue invasion into the missing tooth structure (Courtesy of Makoto Kamiya, DDS, Matsumoto City, Japan)

**FIGURE 18:** Soft tissue and caries removed with a hard tissue laser without anesthetic, ready to accept a direct resin restoration (Courtesy of Makoto Kamiya, DDS, Matsumoto City, Japan)

from gingival inflammation in the absence of bone loss to significant bone loss when the disease process is not identified early in the process or a "watch and wait" attitude is taken that leads to significant bone loss and then mobility of the fixture.

Treatment involves mechanical debridement of the exposed threads on the implant to remove any granulation tissue present. Success relates to debriding and sterilizing all exposed threads, with success diminishing as more surface area is left untreated (figure 9). Lasers have several benefits related to peri-implantitis treatment including easier access to limited access areas without the need to remove as much bone as may be required when only surgical instruments are utilized. Additionally, the laser has the ability to sterilize the implant's contaminated surface, eliminating any bacteria that caused the disease or prevented healing following treatment. An added benefit of the laser in these procedures is biostimulation of the mesenchymal stem cells in the surrounding bone and soft tissue, important for regenerative therapy and tissue engineering to provide better healing.[29] The laser is a good adjunct in the treatment of peri-implantitis, improving the clinical results observed with more traditional methods (figures 11-14). Studies have documented use of the diode and Er:YAG lasers in peri-implantitis treatment.[30,31]

## DECAY REMOVAL AND TOOTH PREPARATION

Hard tissue lasers such as the Er:YAG, Nd:YAG, and Er,Cr:YSGG are utilized for caries removal, frequently without the need for local anesthesia. These lasers are used in a noncontact mode and desensitize the odontoblastic processes in the dentin, completely eliminating both the vibration and sound of the dental drill. Laser preparation has no bur vibration; hence, there is no microfracturing of the surrounding enamel. Unlike the smear layer left by rotary burs on the treated dentin surface, the laser ablates both dentin and enamel without leaving a carbonized surface behind (figure 15).

Enamel and dentin have different water contents; thus, the energy used to ablate (remove) dentin with its higher water content is different from that of enamel. Typically, 25 Hz is optimal for enamel and 30 Hz for dentin.[32] Additionally, lasers have a bactericidal effect on dentin, leaving a sterile surface for the bonded restoration, which decreases pulpal flare-ups that can cause tooth sensitivity and the possible need for endodontic treatment. Treatment of the enamel margins with a hard tissue laser yields a surface with an enhanced bonding surface (no need for acid etching). This removes the prismatic substance around the rods (figure 16). Increased retention has been found when demineralized enamel was prepared with a laser compared to acid etching.[32] Hard tissue lasers are effective for ablation of tooth structure, creating an irregular and microretentive morphological pattern without hard tissue damage (figures 17, 18).[34]

## LOW LEVEL LASER THERAPY (LLLT)

Low level laser therapy (LLLT), also referred to as phototherapy or photobiomodulation, uses light energy from lasers to elicit biological and cellular responses within the body. Photons of light from the laser work to stimulate the release of energy at the cellular level. In the dental arena, LLLT is documented in literature to promote wound healing by reducing postoperative inflammation, edema, and pain.[35-37]

Histologically, LLLT has been reported to potentially promote cell-level osseointegration of titanium implants.[38] It has been suggested that a single session of irradiation with LLLT was beneficial to improve bone-implant interface strength, contributing to the osseointegration process.[39] Utilizing a laser (LLLT) on pre-osteoblasts suggests that this may be a useful tool for improved bone regeneration therapy, stimulating cells responsible for bone development.[40] In patients with chronic periodontitis, a combination of a single application of photodynamic therapy with a diode laser provided additional benefit to scaling and root planing in terms of clinical parameters six months following the intervention.[41]

Aphthous ulcers, commonly referred to as canker sores, are the most common ulcerative lesions of the oral mucosa. These are usually painful and are associated with redness and occasional bleeding from the affected area. The aims of treatment are to reduce pain and healing time. Complete resolution of the ulcers was reported 33% of the time compared to those lesions not treated with LLLT. LLLT is an effective treatment in relieving pain and reducing the healing time of aphthous ulcers.[42] It has also been shown to be effective in treating other lesions such as those caused by herpes, decreasing immediate pain and speeding healing.[43,44]

## CONCLUSION

Lasers have become standard equipment in the dental practice and are a good tool for enhanced treatment in many areas. As outlined, tissue response is enhanced with an improvement in soft tissue healing, better hemorrhage control during treatment, and the ability to prepare teeth without the use of local anesthetic. All laser types have their pros and cons, and the choice of which laser to use depends on the treatment to be be performed.

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## QUESTIONS

**1. Dental lasers operate above which wavelength?**

A. 650 nm
B. 800 nm
C. 1,000 nm
D. 1,200 nm

**2. Diodes do not operate in which wavelength?**

A. 810 nm
B. 980 nm
C. 1,064 nm
D. 1,640 nm

**3. Gingival tissues absorb wavelengths in the range of:**

A. 750-900 nm
B. 810-1,640 nm
C. 810-1,064 nm
D. 980-1,260 nm

**4. Which laser has no effect on hard tissue?**

A. Diode
B. Er:YAG
C. Nd:YAG
D. Er,Cr:YSGG

**5. Lasers that are suited for use in hard tissue treatment and have an affinity for hydroxyapatite and water have a wavelength greater than:**

A. 810 nm
B. 980 nm
C. 1,064 nm
D. 9,300 nm

**6. Which property of a laser may cause eye damage?**

A. Reflection
B. Transmission
C. Scatter
D. Absorption

**7. What do lasers require to create wavelength energy?**

A. Handpiece
B. A bulb
C. A vacuum
D. A medium

**8. For laser eye protection to be effective, the glasses must:**

A. Match the laser's wavelength
B. Have a thick enough lens
C. Have an orange tinted lens
D. Have a polarized lens

**9. Hard and soft tissues do what to the laser energy?**

A. Alter it
B. Transform it
C. Absorb it
D. Convert it

**10. Scattering of laser energy may:**

A. Limit heating of the tissue
B. Transfer heat to adjacent tissue
C. Chemically alter the tissue
D. Biologically alter the tissue

**11. The amount of energy absorbed by the target tissue depends on:**

A. Tissue characteristics, such as water content and pigmentation
B. Laser wavelength
C. Emission mode
D. All of the above

**12. Photothermal refers to:**

A. Energy is transformed into heat
B. Heat is transformed into light
C. Light causes cooling
D. Energy causes cooling

**13. When cutting hard tissue with the laser, the energy:**

A. Melts the hard tissue
B. Creates a shock wave in the hard tissue
C. Vibrates the hard tissue
D. Vaporizes the hard tissue

**14. Which laser does not have photoacoustic effects?**

A. Diode
B. Er:YAG
C. Nd:YAG
D. Er,Cr:YSGG


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## QUESTIONS

**15. Thermal effects of laser energy on tissue primarily involve:**

A. Reflection potential
B. Pigmentation
C. Calcium content
D. Water content

**16. Excision of soft tissue commences at what temperature?**

A. 100 degrees C
B. 120 degrees C
C. 140 degree C
D. 160 degrees C

**17. When vaporization of the water within the tissue occurs, the process is called:**

A. Dehydration
B. Coagulation
C. Carbonization
D. Ablation

**18. When carbonization occurs in the tissue, there is:**

A. A decrease in heat transfer
B. An increase in heat transfer
C. A decrease in postoperative sensitivity
D. A decrease in postoperative inflammation

**19. The depth of the laser beam is dependent on:**

A. How long the beam is held on the tissue
B. How far the tip is held from the target tissue
C. Energy output (wattage)
D. All of the above

**20. Using the lowest level wattage that will accomplish the task intended will:**

A. Minimize collateral effects
B. Decrease postoperative pain
C. Increase collateral effects
D. Stabilize the tissue

**21. Thin or fragile soft tissue should be treated with:**

A. Continuous wave
B. Pulsed wave
C. High wattage with rapid motion
D. Low wattage with slow motion

**22. When comparing tissue cellular effects between electrosurgery and a laser, we find that:**

A. There is similar tissue shrinkage with both modalities
B. There is similar tissue penetration with both modalities
C. Electrosurgery has less depth of penetration and thus less tissue shrinkage
D. Lasers have less depth of penetration and thus less tissue shrinkage

**23. Complete clearing of residual bacteria in the apical portion of the canal system:**

A. Is enhanced with use of laser activated irrigation
B. Requires mechanical instrumentation to the radiographic apex
C. Is achieved with NaOCl and endodontic files
D. Is not required as the obturation will seal those areas

**24. Which bacteria has been associated with endodontic failure?**

A. *Streptococcus mutans*
B. *Fusobacterium nucleatum*
C. *Enterococcus faecalis*
D. *Yersinia pestis*

**25. Which irrigant is recommended for use, alternated with NaOCl?**

A. Saline
B. EDTA
C. CHX
D. Anesthetic

**26. What is not safe to use on soft tissue around an implant?**

A. Electrosurgery
B. Diode laser
C. Er:YAG laser
D. Er,Cr:YSGG

**27. When using a hard tissue laser on tooth structure, which settings are typically optimal?**

A. 35 Hz for enamel and 40 Hz for dentin
B. 30 Hz for enamel and 25 Hz for dentin
C. 20 Hz for enamel and 40 Hz for dentin
D. 25 Hz for enamel and 30 Hz for dentin

**28. With laser phototherapy, which of the following does not happen?**

A. Elicits biological and cellular responses
B. No effect on pain
C. Reduces inflammation
D. Improves healing

**29. Usage of LLLT on viral lesions provides which immediate effect?**

A. Destruction of the virus
B. Removal of the affected soft tissue
C. Pain reduction
D. Increases host immune response to the virus

**30. LLLT treatment of oral herpes provided complete resolution of what percentage of lesions compared to those not treated with LLLT?**

A. 20%
B. 33%
C. 50%
D. Same as nontreated lesions, with less pain

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ANSWER SHEET

# Lasers in dentistry: Applications and incorporation into the dental practice

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## EDUCATIONAL OBJECTIVES

1. Describe the different types of dental lasers available
2. Understand laser energy and its effects on hard and soft tissues
3. Identify what treatments lasers are suited to perform and which laser type to use

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