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The Use of Lasers in Dentistry

A Clinical Reference Guide for the Diode 810 nm & Er:Yag

Rev. 1.0 / Oct. 2009

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Elexxion's goal as leading manufacturer of dental lasers is to provide not only best in class lasers but also the information, education and training to enable superior results with our products.

One of the challenges for many new as well as experienced laser users is to acquire and maintain the knowledge to use their laser in a way to achieved best results.

The purpose of this brochure is to be the source for practical clinical knowledge covering a wide range of soft as well as hard tissue procedures. Leaders in laser dentistry and customers from Europe, United States and Asia contributed with their extensive expertise and knowledge. The result will benefit dentists new to lasers as well as experienced user.

We would like to take the opportunity to thank all of our partners and friends in the dental community who have contributed with their expertise and feedback to the creation of this clinical reference guide.

In particular we are grateful to the support of Mike Swick, DMD, Kenneth Luk, Dr. Dr. Claus Neckel, Leif Nordval.

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Dr. Kenneth Luk

Dr. Kenneth Luk recevied his BDS degree at the University of Liverpool in 1987. He was awarded the Diploma in General Dental Practice from The Royal College of Surgeons (England) in 1994.

He was in NHS / Private practice ,as well as serving part-time in the University of Liverpool before returning to Hong Kong in 1995.
Currently, he is a part-time lecturer at the Conservative Dentistry, The University of Hong Kong. He also maintains a private practice with particular interest in multi-disciplinary aesthetic dentistry and laser dentistry. He has achieved fellowship status from the International Congress of Oral Implantologists (ICOI).

Dr. Luk has incorporated the use of laser in his practice since 2002. He is a member of the Academy of Laser Dentistry (ALD) and he has achieved Standard Proficiency in various laser wavelengths. He also serves in the International Relations Committee in the Academy.

He has made textbook contributions and is interested in developing new techniques in the use of laser in dentistry. He is a trainer and laser safety representative for a dental laser company.

Dr. Mike Swick

Dr. Michael Swick is a general dentist and has offices in Allison Park and Conneaut Lake Pennsylvania. He practices Microdentistry employing air abrasion and laser, working through a surgical operating microscope. He holds an advanced proficiency in the 980 nm and 2940 nm wavelengths and standard proficiency in CO2, Nd:Yag, 810 nm diode, 980 nm diode and Er:Yag wavelengths, through the Academy of Laser Dentistry.

He is also a certified educator and his courses are accepted for Standard Proficiency Certification through the Academy of Laser Dentistry where he is currently serving on the, board of directors, the Research and Education committee and the Scientific Sessions committee.

Additionally, he holds certification, from St. Luke's Medical Center, in the Pinero Pre-cardiac Surgery Protocol with lasers. He is a fellow in the American Society of Laser Medicine and Surgery. He also is a lectured for the bioLitec and Hoya Conbio laser companies.

Dr. Swick has presented more than one hundred continuing education and hands-on courses on dental lasers both nationally and internationally.

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Preface

Lasers are a valuable adjunct to dental treatment in terms of infection control, wound healing control, bleeding control and vibration control in hard tissue removal.

Success in clinical applications of dental lasers relys on a firm basis of laser physics.

Different laser wavelengths are absorbed in varying degrees by the major oral tissue components namely; water, hydroxyapatite, haemoglobin and melanin. From the lowest energy delivery to the highest , lasers can be used for diagnosis of caries and calculus, low level laser therapy, teeth whitening, haemostasis and coagulation, tissue decontamination, melanin depigmentation , hard and soft tissue ablation. A combination of the above procedures will make up almost all of the dental procedures in daily dental practice. The understanding of the wavelength characteristics in terms of energy delivery from the laser devise, laser tissue interactions and techniques will enable the operator to deliver the desired treatment effectively. During laser treatment, the clinician should keep in mind the laser wavelength and emission mode being used for the tissue interaction desired. It is imperative that tissue interaction is monitored and appropriate adjustments are made during the procedure.

The concept and application of laser energy for dental procedures differs greatly from the use of rotary and piezo instruments. There is hence, likely to be a slightly longer learning curve for dental lasers than other dental equipment.

I · What is a laser?

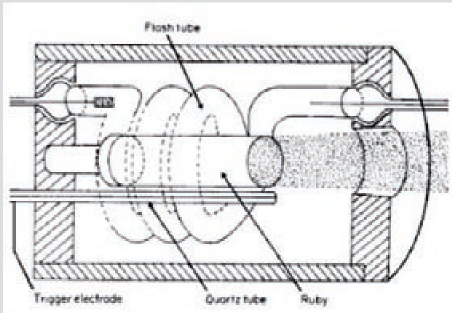
I.1 Introduction
I.2 Fundamentals of dental lasers
I.2.1 History and properties of laser
I.2.2 Basic laser components
I.2.3 Lasers used in dentistry
I.2.4 Laser parameters
I.2.5 Laser tissue interactions
I.2.6 Clinical applications with dental lasers

I.1 Introduction

In early 1960s, the first working laser was invented by Theodore Maiman who inserted a ruby rod into a photographic flashlamp. In 1964, Ralph Stern and Reidar Sognnaes used the ruby laser to vaporise enamel and dentine. In 1969 Leon Goldman used the laser clinically on enamel and dentine.

Design and built of the first working ruby laser

Dr. Theodore H. Maiman
July 11, 1927 - May 5, 2007



Initially, application of lasers for dental use was tested for hard tissue, but surface cracking and thermal damage to the enamel and dentine were reported. It is not until 1989 when the first dental laser was developed, a 3W neodymium-doped yttrium aluminium garnet (Nd:YAG) by Drs Terry and Bill Meyers.,for soft tissue use, Since that time a variety of laser wavelengths have been introduced and marketed.

Dental lasers are now being used in all fields of dental disciplines from oral surgery , restorative dentistry in caries removal and tooth preparation , cosmetic dentistry in soft tissue contouring and osseous crown lengthening to periodontology and endodontics in bacterial decontamination and associated surgical treatments. Most recently, researchers are looking into the application of lasers in implant dentistry and treatment of peri-implantitis.

This chapter provides a brief overview of the fundamentals of laser physics; laser wavelengths most commonly used in dentistry.

I.2 Fundamentals of dental lasers

I.2.1 History and properties of laser

The word laser is an acronym for Light Amplification by Stimulated Emission of Radiation.

Neil Bohr's model explained spontaneous emission as an atom which absorbs a quantum of energy and is elevated to a new energy level. The excited state decays to the lower energy state emitting the excess energy as photon, or quanta of light.

In 1916, Albert Einstein theorized that photoelectric amplification in the same amplitude of an atom already in an excited state could emit a single frequency, or stimulated emission decaying into a stable state. This time the emission will be two coherent quanta. The result of stimulated emission is that multiple photons of precisely the same wavelength are emitted in phase in a coherent manner.

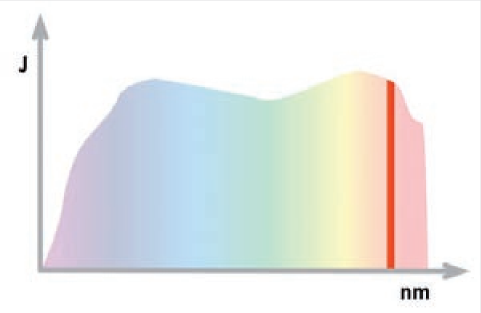
Light is a form of energy. It is comprised of photons (energy packets or wavelets) which travel in a waves. A wavlet of photons (electromagnetic wave) has four basic properties:

1. Velocity : The speed of light in a vacuum = 2.99 x 1010 cm/sec.
2. Amplitude: The total height of the wave from peak to peak (measured in millijoules)
3. Wavelength: The distance between any two corresponding points on the wave (measured generally in nanometers in dental lasers)
4 Frequency: the amount of wave cycles per second.
5. The basic mathmatical formula that relates wavelength, frequency, and the speed of light is: c= f

Unlike ordinary light, laser light is monochromatic (Fig 1) because only one wavelength is being produced rather than a spectrum of wavelengths. Laser light can also be produced in waves that are in phase showing it as characteristically organised, efficient and coherent energy. The laser light can be highly focused and directional producing a collimated beam (summarised in Fig 2).

Fig 1

Spectrum of visible light



Monochromatic light from a laser

Electromagnetic spectrum ranges from invisible ionising radiation such as gamma rays, x-rays, Ultra violet (100-400nm) ; visible light (400-750 nm) to invisible thermal radiation such as infrared (750+ nm) and radio waves. Dental wavelengths currently used ranges from 488 to 10600 nm. They are emitted from the visible spectrum in the form of nonionizing radiation ; hence not mutagenic to cellular DNA components.

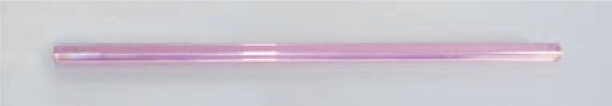
Fig 1 · Comparison between ordinary visible light and laser light

Ordinary visible light	Laser light
Multiple wavelength =	Typically one colour-**monochromatic**, specific wavelenght(s) generated
white light (Polychromatic)	Highly focusedand directional-**collimated beam**
Non-directional	**Organised , efficient**
Non-focused	**Coherent Energy**
Unorganised , incoherent	**High Intensity**
Low Intensity	**10^8-10^{16} W/cm^2**
0.1 W/cm^2	

I.2.2 Basic laser components

1. ACTIVE MEDIUM

The active medium can be gas, liquid or solid state where laser light is generated via a process called stimulated emission. The active medium used determines the laser wavelength, power and energy. The active medium typically denotes the name of the different types of lasers. For example: Carbon dioxide laser , Er:YAG laser and Nd:YAG laser.



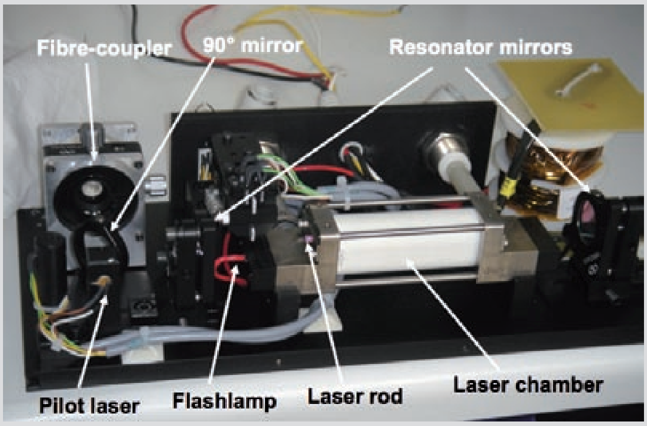
Erbium doped YAG laser rod
Erbium:YAG rod

2. PUMPING MECHANISM

External power source supplies energy continuously to excite (pump) the active medium so that stimulated emission can occur achieving a population inversion.
In the case of semiconductor diode lasers, the power source is electricity.
Laser rod of a solid-state laser or dye cell of a liquid laser is pumped with light energy, hence optical pumping. The light sources include flashlamps, arc lamps and other lasers (laser pump).

3. OPTICAL RESONATOR

The active medium is positioned within an optical subsystem called the laser resonator. The resonator consists of two mirrors separated by the active medium in between. The mirrors are aligned and parallel to each other. On each end of the optical resonator the mirror reflects the excited photons produced by the excited active medium back and forth in a direction perpendicular to the mirror surfaces. This movement of light through the active medium amplifies the power, a 'population inversion' is achieved.
One of the mirrors is partially reflective (output coupler). The non reflective surface on this mirror allows the photons to exit the resonator as a monochromatic and directional beam of energy, ie. laser.



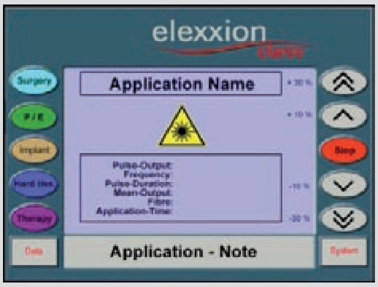
Erbium:YAG laser components

4. COOLING SYSTEM

Not all power put into the active medium is converted into laser energy. Some of the power is converted into heat which raises the temperature of the active medium. A cooling system must be employed to maintain the active medium below its maximum operating temperature.

5. CONTROL PANEL

Microcomputer or microprocessor installed for the operator to control the parameters for the output of laser energy.



User friendly control panel designs for operator

6. DELIVERY SYSTEMS

Laser energy is delivered to the target site by various delivery systems:

1.1 Fiber-optic – Generally quartz-silica flexible fiber with a quartz or sapphire tip. Transmission efficiency in the region of 80% to 90% at wavelengths between 300nm and 2400nm. Wavelengths outside this range are absorbed by quartz.

1.2 Fiber-optic – For Er:YAG lasers, the fiber system uses more rigid yet slightly flexible fiber. For example Zirconia Aluminium Fluoride or Germanium oxide

2. Hollow waveguide – A semi-rigid reflective hollow metal or plastic tube that guides the laser energy through its internal lumen

3. Articulated arm – Hollow tubes reflecting the beam with 45 degree mirrors.

Visible and near infrared lasers use flexible fiber-optic systems with bare glass fibers. Mid infrared wavelengths may be deliverd by rigid fiber glass , hollow waveguide or articulated arms. Far infrared wavelengths can be delivered by the hollow waveguide or articulated arms

I.2.3 Lasers used in dentistry

In the visible light spectrum:

1. Argon (Ar) : 488 nm Blue wavelength
2. Argon (Ar) : 514 nm Blue-green wavelength
3. Frequency doubled Neodymium-doped yttrium aluminium garnet laser ; Nd:YAG with a potassium titanyl phosphate (KTP) crystal : 532 nm Green ; commonly known as KTP laser
4. Low-level lasers: 635 nm (for therapy & photo activated disinfection), 655 nm (for caries and calculus detection) and 660 nm (Photodynamic therapy) Red wavelength

Argon lasers are less commonly used for dentistry with the emergence of smaller compact diode lasers.

In the near, middle and far infrared portion of the electromagnetic spectrum, laser light is invisible and a guiding beam is used for the operator to locate the laser beam on the target site.

NEAR INFRARED LASERS
Diode lasers emit laser wavelengths between 800 nm and 980 nm. Depending on the active medium used, different wavelengths can be produced

1. Aluminium, gallium and arsenide 800 nm - 830 nm
2. Gallium and arsenide 904 nm
3. Indium, gallium and arsenide 980 nm

Neodymium-doped yttrium aluminium garnet (Nd:YAG) emits a laser wavelength of 1064 nm

MID INFRARED LASERS
The most commonly used wavelengths in the mid infrared portion is the erbium family.

1. Erbium-chromium doped yttrium scandium gallium garnet (Er,Cr:YSGG) of 2780 nm
2. Erbium doped yttrium aluminium garnet (Er:YAG) of 2940 nm

FAR INFRARED LASERS
CO_2 lasers emits wavelengths of 9600 nm , 10600 nm and 11200 nm. 10600 nm, is most commonly used CO_2 wavelength in dentistry.

I.2.4 Laser parameters

Operators should have a clear understanding on laser parameters as well as clinical techniques when using different wavelengths of lasers (Table 1).

For example: 1W continuous wave of diode laser for 1 second has an average power of 1W. An average power of 1W from Nd:YAG laser at 100usec , 50mj per pulse & 20Hz per second delivers a peak power of 500W.

Table 1

Terminology

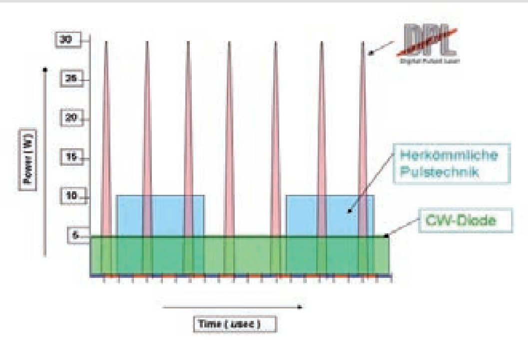
- Peak Power – Watts (Joules/sec)
- Pulse Energy – W(PP) x Time(PD) = Joules
- Average Power – PE x Hz
- Energy Density (Fuence) – J (PE) / Area
- Pulse Width/Depth – Seconds
- Frequency – Hz (Pulse Per Second)
- Duty Cycle PD/(PD + Relaxation Time) x 100 %
- Power Density – W (PP) / Area

Relaxation Time – Off time between pulses

TEMPORAL EMISSION MODES

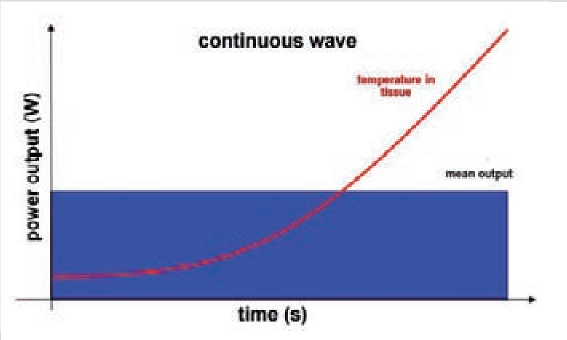
Temporal emission modes or emission modes describes the way that the laser energy proceeds with time. There are two basic modes of emission in dental lasers:

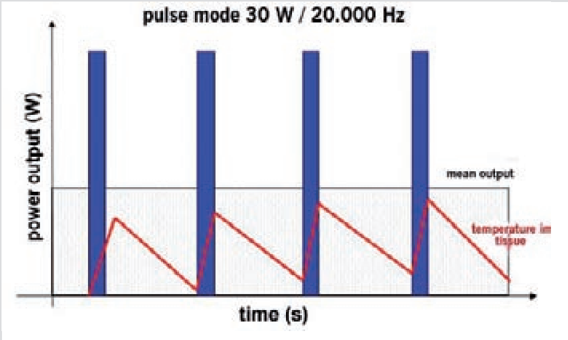
Continuous wave (cw) – CO2 , Argon and diode lasers operate in this mode. The laser energy is emitted continuously without time lapse (1sec). Lasers that emits continuous wave also have mechanical shutter to 'cut' the continuous wave allowing time for tissue to relax from the continuous energy exposure. Gated pulse mode produces pulse duration in 0.1sec to 0.01sec. The power output, pulse on time & pulse off time are variables for operator selection in almost all lasers.



Digital pulsed mode produces pulse duration from continuous wave down to 2.5 µsec (one millionth of a second). Selection modes include output power, pulse duration and frequency.

Breaking up the continuous energy emission can minimize undesirable tissue damage beyond the target site (collateral thermal damage). The accumulative rise in tissue temperature is delayed avoiding carbonisation of the tissue.



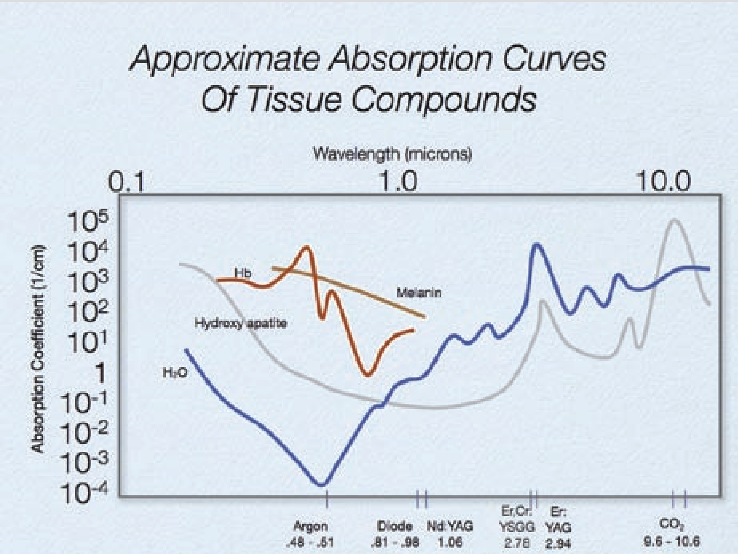


Free running pulse – Nd:YAG, Er:YAG, Er,Cr:YSGG are free running pulse
lasers. High level of laser energy (even up to 2000W) is emitted in very short pulse between 50µsec to 1000µsec. As free running pulse exhibits much shorter pulse duration and lower duty cycle (laser on time / laser on + off time X 100%) undesirable thermal damage is even lower. Care should be taken into account due to the high peak power. The average power, pulse energy, pulse duration and frequency are variables for the operator to select.

I.2.5 Laser tissue interactions

CHROMOPHORES

Various components of dental tissue exhibit different absorption characteristics in the electromagnetic spectrum. Each laser wavelength will therefore, interact with their specific chromophore(s). The chromophores in dental tissue components are water, enamel, dentine, hydroxyapatite, haemoglobin and melanin.



Approximate absorption curves of dental tissue components

In dental tissues, the target site will be a combination of water, hydroxyapatite, blood, and tissue pigments. A clear understanding of laser and target tissue interactions enables the clinician to choose the appropriate wavelength for specific procedures.

The unique optical absorption of each wavelength determines the depth of tissue penetration. In the case of the erbium and CO2 lasers, water is highly absorbed. As there are high water content in all tissue components, penetration depth by these lasers is only limited to the tissue surface. Argon, diode and Nd:YAG lasers penetrate tissues in varying depths due to their poor optical absorption properties with water. The varying depths of penetration depends on their specific chromophores and energy intensities. This property is useful for low level laser therapy. As there is no immediate visual tissue effect, care must be taken in case of excessive energy delivery which will result in deep tissue damage even a few days after treatment (similar to tissue burns).

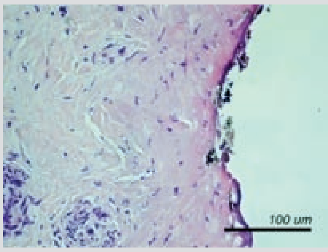
TISSUE INTERACTIONS

Laser energy is either absorbed, reflected, refracted, transmitted or scattered by the tissue. The level of tissue responses are related to the wavelength and power of the laser used.
Different levels of energy absorption produce different tissue response. The laser energy absorbed can be converted into different types of energies:

Photothermal – Heat energy is converted which results in rise in tissue temperature.

The rise in temperature ranges from:

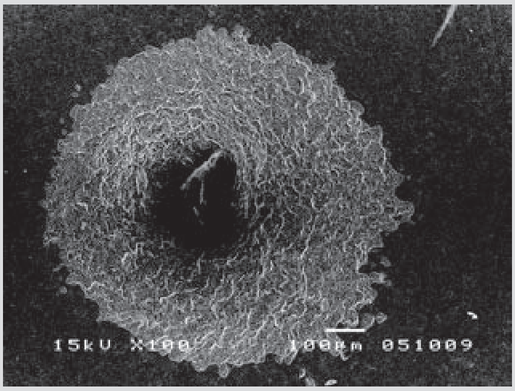
1. hyperthermia (37°C-50°C)
2. coagulation / denaturation of protein (>60°C)
3. welding (70°C-90°C)
4. vaporization (100°C-150°C)
5. carbonisation (>200°C)



Excision site ablated with diode laser

Photochemical – Chemical energy is converted where chemical bonds in the molecules are broken directly by laser.

Photoacoustic – Also known as photodisruptive where energy is converted into mechanical energy in the form of shock wave, or high pressure wave. This causes physical disruption of the target tissue.



Photoacoustic effect on dentine ablation by Er:YAG laser

Photodynamic – A kind of photochemical interaction. Photodynamic **interactions** occur when a specific light-absorbing molecule is used to mediate the interaction. A biochemically reactive form of oxygen is produce ; call singlet oxygen.

Biostimulation & biomodulation – Low power of lasers are thought to affect tissue in a cellular level such as increase in ATP production (380nm-700nm) & calcium transport mechanism. Much research are required to establish these specific effects.

I.2.6 Clinical applications with dental lasers

LOW INTENSITY LASER ENERGY APPLICATIONS

- Diagnosis: Caries and calculus
- Low level laser therapy LLLT (Low intensity laser therapy LILT)
- Photo activated decontamination
- Haemostasis and coagulation
- Teeth whitening

HIGH INTENSITY LASER ENERGY APPLICATIONS

- Bacterial decontamination
- Soft tissue ablation (cutting)
- Enamel ablation
- Dentine ablation
- Osseous ablation
- Depigmentation of melanin and other endogenous pigments

Single application or combination applications of the above provide clinical applications of lasers in ASSISTING dental procedures.

MAIN TYPE	ACTIVE MEDIUM	ABBR.	WAVELENGTH (NM)	CLINICAL APPLICATIONS	MANUFACTURES
Gas Lasers	Carbon Dioxide	Co_2	10,600	Soft tissue incision and ablation Subgingival soft tissue curettage	Deka Lumenis
Diode Lasers	Indium-Gallium-Arsenide-Phosphide (GA-Al-As)	Diode	655-810-980	Bacterial decontamination Caries and calculus detection Soft tissue incision and ablation Subgingival soft tissue curettage	Biolase Elexxion HoyaConBio KaVo Ivoclar Vivadent Siron
Solid-Sate Laser	Neodymium-doped: Yittrium-Aluminium-Garnet	Nd:YAG	1,064	Bacterial decontamination Soft tissue incision and ablation Subgingival soft tissue curettage	Deka Fotona Periolase
	Erbium-doped: Yittrium-Aluminium-Garnet	Er:YAG	2,940	Bacterial decontamination Soft tissue incision and ablation Subgingival soft tissue curettage Scaling and root debridement Hard tissue conditioning Hard tissue ablation	Deka Elexxion Fotona HoyaConBio KaVo Lumenis Syneron
	Erbium-Chromium doped: Yittrium-Selenium-Gallium-Garnet	Er,Cr:YSGG	2,780		Biolase

Current Laser Wavelengths
Commonly Used in Clinical Dentistry

Epilog by the editor

The histology presented above by Dr Neckel , Bad Neustadt, Germany, is a tribute to his vision and hard work. A majority of the dental laser industry has followed the trend that the use of lower power in continuous wave mode is less damaging than using higher power settings. However, because of his understanding of emission modes, this is definitively proven by Dr. Neckel's work to be incorrect. He initially presented his findings, "A comparative study on CW mode versus pulsed mode in AlGaAs diode lasers," at the SPIE (originally The International Society for Optical Engineering) meeting and later at the Academy of Laser Dentistry meeting in 2001.

As a matter of interest, the editor of this manual, Dr Michael Swick, Allison Park/Conneaut Lake, Pennsylvania, US, working independently from Dr Neckel, an ocean away, came to similar conclusions during the same time period,, through anecdotal clinical results and later histology. His work employed longer pulses due to the absence of a short pulse diode in the US, but was supplemented using water for cooling to reduce thermal damage. See: A Char –Free Technique for the Ceralas D15 Diode Laser, Wavelengths 2000;8(4):20 and A comparative Study of two Intraoral Laser Techniques, SPIE, Progress in Biomedical Optics and Imaging, Lasers in Dentistry IX, Vol.4, No.2 ISSN 1605-7422. pg. 11-17.

To the best of the editor's knowledge they were the only practitioners at the time to utilize diode lasers at higher power levels.

CLINICAL REFERENCE GUIDE

1 · Surgery

SURGICAL PROCEDURES WITH THE DIODE LASER ARE OFTEN BLOODLESS AND PAIN FREE. THESE ARE VERY DESIREABLE ATTRIBUTES FOR BOTH THE DENTIST AND PATIENT.

Important surgical principles and considerations:

1. Always use the correct protective eyewear. The wave length and optical density will be marked on the lens and frame. Elexxion will supply the correct eyewear.
2. Always use high speed suction or smoke evacuation.
3. Always place the tissue targeted for surgery under tension if possible.
4. The surgeon's hand speed will depend on the average power, pulse duration and pause interval used by the surgeon. Carbonization is an undesirable outcome and should be avoided. Using water irrigation for cooling can aid in reducing carbonization and lateral thermal damage
5. A reciprocal (back and forth) motion should be used for conservation of movement and increased effectiveness.
6. In most cases sutures and periodontal dressings will not be needed.
7. The fiber should always be used in light contact and at an angle of 90° due to the divergence of the energy as it exits the fiber tip. Contact with the tissue also reduces the potential for reflectance and back scatter. Attempts at non contact ablation should only be attempted by only the most experienced surgeons due to the penetration depth of all near infrared wavelengths.
8. Coagulum (denatured protein) will collect on the fiber tip; this should be removed regularly using moist gauze. Alcohol gauze should not be used as accidental combustion can occur.
9. All surgical procedures should be followed with low level therapy using the laser therapy programs and the T8 glass rod.

Choosing a Fiber

1. Fiber size is an important factor to be considered in laser surgery. Fiber size controls the power density of the beam at the fiber tip.
2. Power density is the radiant power transmitted per unit area of cross-section of a laser beam.
3. General tendencies of power density :
   a. The larger the fiber size the lower the power density the smaller the fiber size the higher the power density. Therefore a 200 µm fiber will have a higher power density than a 400 µm fiber and a 400 µm fiber will have a higher power density than a 600 µm fiber and so on.
      i. Higher power densities will vaporize more quickly than lower power densities.
      ii. Lower power densities will tend to coagulate better than higher power densities.
4. When choosing a fiber it is important to remember that the power density varies inversely with the square of the diameter of the focal spot. Thus, if the diameter if the focal spot is reduced by a factor of 2, the average power density increases by a factor of 4, and vice-versa.

GENERAL INFORMATION ABOUT HIGH POWER, DIGITALLY MICROPULSED DIODE LASERS

Comparison between a low power, pulsed diode laser and high power digitally micropulsed laser
Histological findings by Dr. Claus Neckel

Materials and methods

- **LASER BY ORALIA:**
- GaAlAs Diode Laser emitting 810 nm
- Maximum power output 20W
- CW Mode and gated pulsation of up to 10.000 Hz
- Pulse- pause ratio (PPR) of 1:1 to 1:10

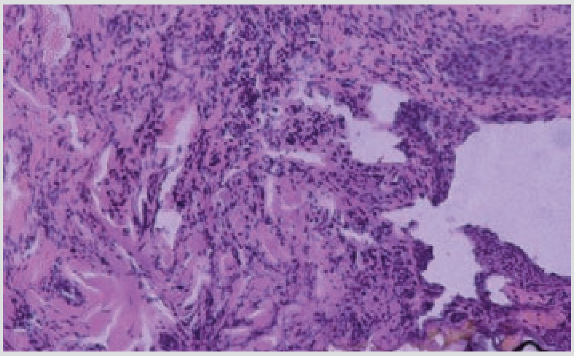
- **CLINICAL PARAMETERS FOR ORALIA:**
- Group I: 1.5 W CW- mode,100% emission cycle, 400µm fiber
- Group II: 5 W gated 50% emission cycle, 400µm fiber
- Group III: 20 W gated, 33% emission cycle, 400µm fiber
- Group IV: 20 W gated, 10% emission cycle, 400µm fiber

- **ELEXXION CLAROS:**
- GaAlAs Diode Laser emission wavelength 810 nm
- Maximum power output up to 30W
- CW Mode and pulsation up to 20.000 Hz
- Variable pulse width, digital pulse

- **CLINICAL PARAMETERS FOR ELEXXION CLAROS:**
- Group V: 30 W, Micropulsed, 18% Emission cycle, 20.000 Hz 9 µs pulse width, 400 µm;
- Group VI: 25 W, 20% emission cycle, Micropulsed, 20.000 Hz 10 µs pulse width, 400 µm

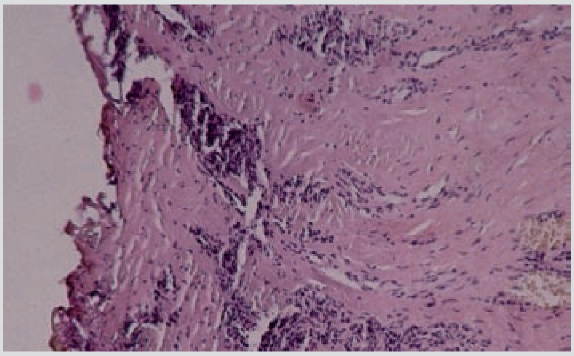
Histological findings

Group I • 1.5 W Continuous Wave Mode, Emission cycle 100%



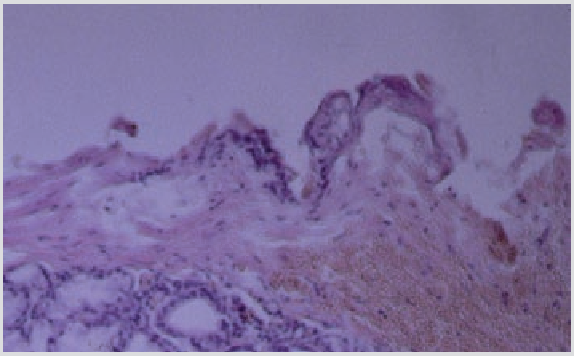
The thermal damage zone was up to 125 µm. Dehydration and protein denaturation is prominent. Charring is accompanied by deeper thermal damage.

Group II • Gated 5 W, Emission Cycle 50%, 10,000 Hz



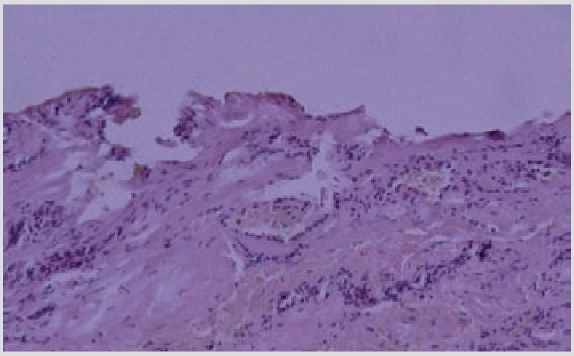
All thermal effects are more drastic than in group I. The differing extent of charring leads to an inconsistent thermal damage depth between 250 and 800 µm.

Group III • Gated, 20 W, Emission cycle 33%



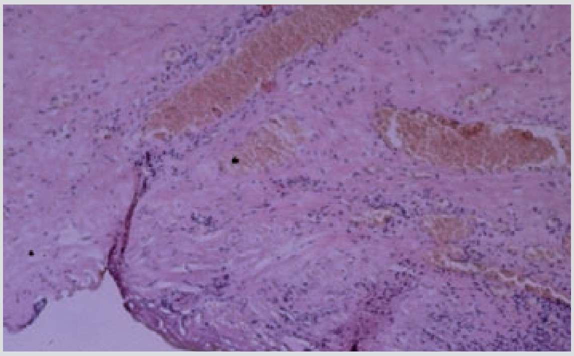
Thermal damage zone was found to be between 45 and 65 µm. The zone was rather consistent. Little charring was present.

Group IV • 20 W, Gated, Emission cycle 10%



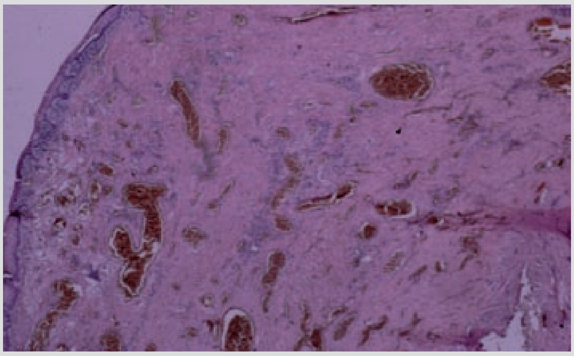
Group IV: thermal damage between 35 and 50µm. No charring was visible.

Group V • 30 W, Emission cycle 18%, 9 µs pulse width, 20.000 Hz



Elexxion claros. Thermal damage between 15 and 25 µm. No charring was visible.

Group VI • Emission cycle 20%, 10 µs pulse width, 20.000 Hz pulsed



Elexxion claros. Thermal damage between 20 and 35 µm. No charring was visible.

Please Note:

As elexxion has several laser models, for the proper parameters for the laser you are using see the appendix at the end of this manual.

SURGERY

1. Surgery General

a. Indications: This is the high performance program; the laser is working at its highest power level. This setting is to be used by only the most experienced laser surgeons.
b. Laser parameters: Surgery General Setting, 400µm or 600µm fiber.
c. Technique: Rapid fiber movement is necessary. Carefully monitor laser tissue interaction. Excessive carbonization or tissue blanching should not be present.

2. Treatment of Abscess

a. Indications: A localized periapical or periodontal abscess must be present.
b. Laser Parameters: Puncture Abscess Setting, 200µm fiber.
c. Technique: Use the surgery hand piece with a 200µm fiber and penetrate into the abscess to the maximum depth while firing the laser. After 3-4 seconds the bacteria should be killed and the abscess will resolve over the next few days. Additionally, after the puncture, you can use the laser with the softlaser program “post-extraction pain” for better healing..
d. Alternate technique: Incise and drain: Using a small amount of anesthesia Incise the abscess using the flap surgery setting and drain with a surgical suction. Irradiate the interior of the abscess with the bacterial decontamination setting.

Case courtesy of Michael D. Swick DMD, United States.

3. Apthous Ulcer Therapy

a. Indications: apthous ulceration of the cheek or tongue

b. Laser Parameters: Aphtha Setting, 400µm fiber.

c. Technique: You can treat the ulcerations with the softlaser or surgery. When using the surgical program give a small amount of anaesthesia, topical should suffice.. Use the hand piece for surgery and move in a grid with a distance of approximately 1mm over tissue. After treatment for patient comfort use the therapy laser in the program “post-extraction pain” with the glass root “T8” under contact.

4. Hemostasis

a. Indications: bleeding following any dental surgery procedure.

b. Laser Parameters: Haemostasis Setting Or Bacterial Reduction under Periodontics.

c. For cessation of bleeding, use the hand piece for surgery and the 600µm fiber activate the laser and maintain a distance of approximately 2mm until the bleeding stops. An additional technique to try would be: rinse the area of bleeding to locate the precise areas where the bleeding is occurring (bleedings points). With a 90 degree incident angle apply the laser only to the bleeding spots at 1 watt CW (bacterial reduction under Periodontics) until the bleeding stops. This technique should achieve rapid hemostasis

5. Curettage

a. Indications: Treatment of advanced periodontal disease 6-10mm.

b. Laser Parameters: Curettage setting, 400µm or 600µm fiber.

c. Starting at the gingival margin and continuing to the base of the pocket with a reciprocal sweeping motion, remove the intrasulcular epithelium. The size of the fiber will determine the width of tissue removed. Total root debridement which is facilitated by the opened pocket then follows utilizing scaling and root planning techniques with appropriate ultrasonic and hand instrumentation. Following root debridement coagulation and final bacterial reduction is accomplished by repeating the curettage motion with the bacterial reduction setting.

Case courtesy of Michael D. Swick DMD, United States.

6. Epulides

a. Indications: Epulis Fissurata all biotypes from granulomatous to giant cell, and fibrous.
b. Laser Parameters: Epulides setting, 400µm or 600µm fiber.
c. Technique: Using the surgical handpiece, tissue forceps and appropriate fiber place the tissue to be removed under tension. Activate the laser keeping the tissue under tension while cutting. Send tissue samples to the pathologist as appropriate for biopsy.

7. Irritation Fibroma

a. Indications: Fibromas of the tongue, lip, cheek, and gingiva.
b. Laser Parameters: Fibroma setting, 400µm.
c. Technique: Place the fibroma under tension with the tissue forceps, and excise the lesion aiming the fiber parallel to the cheek surface. It is not necessary to suture or to place any type of wound bandage. After excision treat the wound with low level laser therapy using the "Post-extraction pain" program with the T8 glass rod.

Case 1 • Case report from Dr. Michel Vock/Switzerland

Fibroma

cutting with 600µm fibre

4 days post OP

30 days post OP

Case 2

Fibroma Pre-OP

Excision with 600µm fibre

8. Frenectomy

a. Indications: labial and lingual Frenectomy for relief of excess muscle tension.

b. Laser Parameters: Frenectomy setting, 400µm.

c. Technique: less injectable anaesthetic or topical may be used. Sutures and surgical dressings are generally not needed. Post surgery the low level therapy program for post-extraction pain should be applied for better healing and less postoperative pain.

i. Labial frenula: Important; the mental nerve must be avoided in the mandibular bicuspid region. Place the frenum under tension by stretching the lip, Apply the laser with the fiber parallel to the alveolar ridge. Continue deepening the incision until the muscle pull is relieved.

ii. Lingual frenula: Important; a complete and thorough knowledge of the sublingual anatomy is needed prior to attempting this treatment. Delicate structures must be avoided. A hemostat may be used to anchor the frenum and facilitate treatment. The incision should parallel the floor of the mouth and the tongue.

Frenulum Pre-OP

Cutting with 600µm fibre

Cutting with 600µm fibre

Immediately after treatment

4 days later

7 days later

4 weeks later

9. Gingivectomy prior to impression or cad cam crown.

a. Indications: excess tissue needing removal prior to crown impression, cosmetic recontouring.

b. Laser Parameters: gingivectomy setting, 300, 400 or 600 µm fiber as needed.

c. Technique: remove excess tissue as determined by examination, bone evaluation and periodontal probing. A blade technique (cutting like a blade or ablation technique, erasing tissue like a pencil eraser can be used.

Case courtesy of Michael D. Swick DMD, United States.

Pre operative

Post surgery

Immediately post op

3 weeks Post operative

Case courtesy of Michael D. Swick DMD, United States.

Pre Operative

Tissue removal prior to endodontics

Rubber dam in place

Endodontics and build up completed

Further tissue removal on 2nd molar

Tissue removal 1st molar

Immediately Post operative

10. Granuloma

a. Indications: granulomatous tissue present necessitating removal.
b. Laser Parameters: Granuloma setting, 400µm fiber.
c. Technique: as seen previously with a fibroma place the granuloma under tension and excise parallel to the cheek or gingival tissue. Sutures are not needed.

11. Hemangioma

a. Indications: hemangiomas of the lip cheek or tongue as well as blue or venous lake lesions.
b. Laser Parameters: Hemangioma setting for Surgical excision, 400µm fiber.
c. Technique: Case report Dr Kenneth Luc Hong Kong.
   a. 25 year old Female patient of Chinese ancestry complained of long standing dark red patch on her power lip. Haemagioma was diagnosed previously by her medical doctor. No treatment was able to be offered to improve her condition. She has been frustrated by this aesthetic problem. The only remedy with her social life would be putting on dark coloured lipstick. This could not completely mask the area. Patient was informed of the treatment procedure and consented to this treatment protocol.
   b. Procedure: Elexxion Claros DPL (810nm) laser was set at 30W, 20000Hz and 16usec. A 600um un-initiated fiber was held at right angle to pigmented area. After administration of local anesthetics, the pigmented area was fired in constant motion (non contact mode) and cooled with air (3 in 1 syringe). The procedure took 8 seconds to complete.
   c. Result: There was immediate disappearance of pigment. Subsurface coagulation was noted. Surface ablation on the mucosal surface was minimal. 2 days post-op showed scalp formation on the area. (Patient reported tissue slothing one day post-op). 2 weeks post-op showed healing of the surface epithelium complete. There was still some dark red pigment visible. 3 months review showed virtually complete disappearance of dark red pigment on the lower lip.
   d. Conclusion: The use of digital pulsed diode laser was effective in the removal of haemangioma. Patient's aesthetics was improved. There was no need to mask the area with dark colored lipstick. She now prefers her natural lip color to using lipstick. Her self confidence and quality of life is now much improved.

Case Images

Pre-op

Immediate Post-op

2 days post-op

2 weeks post-op

ii. Case report from Dr. Kenneth Luke, Hong Kong

5 days post-Op

12. Removal of Hyperplastic tissue

a. Indications: removal of any type of hyperplastic tissue.
b. Laser parameters: Hyperplasia program, 400 or 600µm fiber.
c. Technique: anesthesia as needed, depending on the type of hyperplasia the tissue can be removed under tension of a tissue forceps with a cutting motion with a simple incision or by erasing in a grid type motion at a 90° angle. Sutures or wound dressings will not be needed.

13. Bacterial Reduction

a. Indications: any surface area needing reduction of bacteria.
b. Laser parameters: bacterial reduction program, 200 or 300µm fiber.
c. Technique: irradiate the area to be decontaminated at an incident angle of 90°. Move the fiber in a grid across the entire area for 5-10 seconds taking care not to overheat the structure.

14. Flap surgery

a. Indications: any area requiring a bloodless flap where compromised vascularity is not an issue, for example a split thickness flap for a connective tissue graft is not an area where the laser should be used.
b. Laser parameters: flap surgery program.
c. Technique: the initial incision should be made with the 200µm fiber for the first 2mm. The remaining depth can then be cut with the 300µm fiber, if desired, for more control and coagulation. Prior to suturing the flap should be refreshed with a blade if primary intention healing is desired.

15. Excisional biopsy

a. Indications: any tissue requiring removal that is indicated for a pathology report.

b. Parameters: Biopsy program, 300 or 400µm fiber.

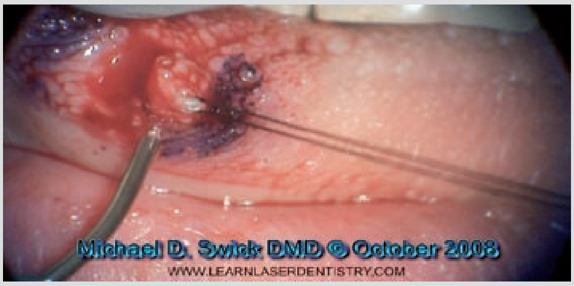
c. Technique: using a tissue forceps or a suture on the tissue to be excised, place the tissue under tension and remove tissue using water for cooling to limit the damage to the tissue sample. Tissue carbonization and blanching are to be voided. Sutures and wound bandages are not needed.

Case courtesy of Michael D. Swick DMD, United States.

Punch biopsy

Punch completed

Suture capture of sample



Laser removal

Sample removed and placed in biopsy bottle

laser coagulation

Coagulation continued

Final site coagulated

16. Retention cyst

a. Indications: any retained cystic tissue.
b. Parameters: Cyst Program, 300 or 400µm fiber.
c. Technique: Access the cyst and with a combination of laser energy and mechanical curettage remove the cyst keeping it intact if possible.

17. Exposure of Impacted Teeth

a. Indications; removal of impacted teeth or exposure for orthodontic purposes.
b. Parameters: exposure program, 300 or 400µm fiber.
c. Technique; using the laser in a blade type motion, access the impacted tooth and expose either for removal or placement of an orthodontic appliance.

Case courtesy of Michael D. Swick DMD, United States.

Molar to be exposed for orthodontics

Incision

Tissue removal

Completed exposure without bleeding

18. Edentulous ridge

a. Indications: removal of excess tissue for preprosthetic surgery.
b. Parameters: edentulous ridge program and 300 or 400µm fiber.
c. Technique: Using tissue forceps place the tissue under tension and remove as needed.

19. Seeping hemorrhage

a. Indications: areas of persistent bleeding.

b. Parameters: Seeping hemorrhage program, 600µm fiber.

c. Technique: Irradiate the area of bleeding at a distance of 2mm from the tissue until a scab-like formation occurs stopping the bleeding

   i. Alternate technique: rinse the area in question and locating the bleeding points. Touching the fiber to the bleeding points fire the laser until the bleeding stops. Repeat rinsing and firing the laser until all of the bleeding points have been treated.

Case courtesy of Michael D. Swick DMD, United States.

Molar to be exposed for orthodontics

Incision

Tissue removal

Completed exposure without bleeding

20. Sulcus preparation

a. Indications: preparing the sulcus for impressions for crowns or for cad cam images for crowns.

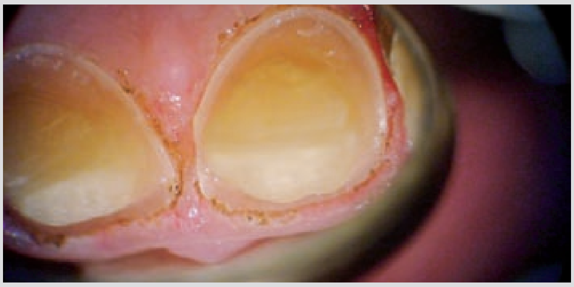
b. Parameters: sulcus preparation program or a suitable program of lower average power such as implant exposure if the power is more than the operator desires. Keep in mind that sulcus preparation is a precision procedure rather than a speed procedure so lower power may be indicated. Use a 200 or 300µm fiber for anterior teeth or a 400 or 600µm fiber for posterior teeth.

c. Technique: Moving the fiber parallel to the tooth surface accurately remove the intrasulcular epithelium clearing the margins for the impression or cad cam image, without removing gingival height.

Case courtesy of Michael D. Swick DMD, United States.



Second case 4 unit anterior bridge




Sulcus preparation complete


Impresson taken


Final insertion of bridge

21. Verrucae

a. Indications: Removal of all Verrucae, wart like and papillomatous lesions.
b. Parameters: Verrucae program and a 300 or 400µm fiber.
c. Technique: Similar to fibroma removal place tension on the lesion with tissue forceps and excise. A deeper incision may be necessary for these lesions.

Case courtesy of Michael D. Swick DMD, United States.

Verrucae placed under tension with tissue forceps

Laser incision

Lesion excised

Coagulation of any remaining parts of the lesion

Treatment complete

22. Vestibuloplasty

a. Indications: Ill fitting dentures due to high muscle attachments.
b. Parameters: Vestibuloplasty setting and a 400 or 600µm fiber.
c. Technique: Pull the lip and or cheek away to place tension on the tissue relieve the muscle attachments down to the periosteum working parallel to the alveolar ridge. Do not put excessive energy into the bone. Relieve the muscles o the depth of the vestibule. Sutures are generally not needed. Reline the denture with a tissue conditioner or temporary soft reline material and instruct the patient to wear the denture continuously removing only to rinse.

Case courtesy of Michael D. Swick DMD, United States.

23. Root end rescetion

a. Indications: Failed endodontic treatment needing endodontic surgery (apicoectomy/apicesectomy).
b. Parameters: root end resection program and 300 or 400µm fiber.
c. Technique: After exposure of the lesion, granulation tissue can be removed using a combination of the laser and surgical curettes. After resection of the root apex the area can be decontaminated using the "retrograde bacterial reduction" program in the Endodontics section of the laser programs.

2 · Periodontology

The diode wavelengths have desireable charac teristics for peridontsal therapy because of an excellent bacterial decontamination rate of 99.6%

1. Pocket treatment

a. Indications: periodontally generated pain
b. Parameters: Pocket treatment program under periodontology, T8 glsss rod.
c. Technique irradiate the painful area for several minutes or until the pain is resolved.

2. Gingivectomy

a. Indications: excessive gingiva, sufficient attached tissue and biologic width is needed.
b. Parameters: 400 or 600µm fiber.
c. Technique: Angle the fiber at a 45° angle to the tooth long axis, follow the anatomic border of the gingiva and excise the desired amount of tissue. A 90° angle may be used if the practitioner later thins the margin and creats a bevel with a pencil eraser type motion,

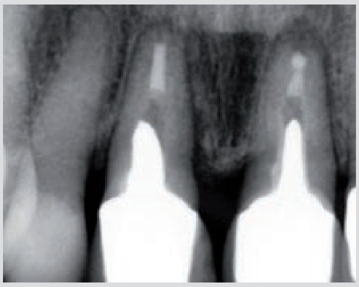
Case courtesy of Michael D. Swick DMD, United States.

3. Internal bevel incisiona

a. Indications: swollen gingiva, excessive pocket depth that will not resolve with conservative treatiment.
b. Parameters: 300, 400, or 600µm fiber. Internal gingivectomy program.
c. Technique: with a rapid motion make an internal bevel incision and femove the intersulcular epithelium and well as lowering the gingival margin to the desired height.

4. **Bacterial reduction**
a. Indications: mild to advanced periodontal disease accompanied by bleeding and or bone loss.
b. Parameters: 300 or 400µm fiber. Bacterial reduction program.
c. Technique: Several techniques are documented that work well for this procedure. The main idea is to cover the entire area of the pocket with laser radiation the will kill the bacteria. Some practitioners start at the top of the pocket and move apically in a circumferential motion to an area 1mm short of the pocket depth, some move from the base of the pocket ot the gingival crest while others work vertically with and up and down motion. All seem to work as long as all of the area is covered. Total time in the pocket is 15 to 30 seconds.

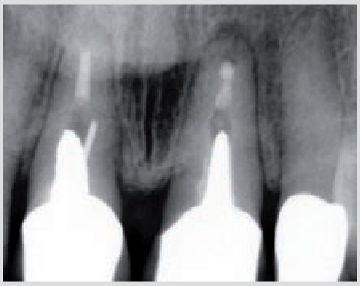
Case Images



X-Ray, first day

Pocket depth 6mm

"Bacterial reduction in pocket", 300µm, 90° hand piece



X-Ray 3 month post

5. **Decontaminate membranes**
a. Indications: any surface which is in need of bacteial decontamination.
b. Parameters: 600 µm fiber decontaminate membranes program.
c. Technique: Using an overlapping motion irradiate the surface to be decontaminated from a distance of 3mm for 2 minutes, taking care not to overheat the surface. Tissue being decontaminated should not co-agulate (turn white).

6. Open curettage

a. Indictions: Pocket depth in excess of 7 mm where access and visualization of calculus for removal is necessasary.

b. Parameters: A 300,400 or 600µm fiber can be utilized depending on the amount of access that is desired by the practitioner. The larger the fiber the greater the access.

c. Technique: starting at the gingival margin move circumfrentially around the tooth gradually deepening the incision until the base of the pocket is reached. A small thin elevator can then be used to aid in visualizing the calculus as needed for removal.

Case courtesy of Michael D. Swick DMD, United States.

7. Pocket reduction

a. Indications: excessive pocket depth or a need to remodel the gingival architecture to a more favorable state where the attached gingiva is sufficient for removal, ie.the hard palate.

b. Parameters: 400µm fiber should be used to remove the gingiva utilizind the pocket reduction program.

c. Technique: the tissue removal can be accomplished positioning the fiber parallel to the tooth surface with a pencil eraser type motion of perpendicular to the surface with a blade type incision.

3 · Endodontics

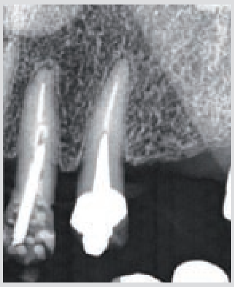
Diode lasers provide excellent bacterial reduction in endodontic canals. The laser offers much better reduction than other means. Investigation of the dentinal tublii shows bacterial contamination up to 1,100µm in depth. Chemical decontamination produces activity up to only 100µm. Diode lasers will produce complete decontamination up to 1,000µm.

1. Bacterial decontamination in the canal

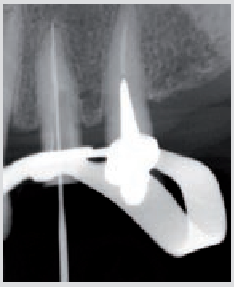
a. Indications: all endodontic canals particularly infected canals and canals being retreated.
b. Parameters: 200µm fiber and bacterial reduction program.
c. Technique: open the canal to a minimum of ISO 30, dry the canal following normal chemical methods with a paper point. Mark the canal length on the fiber 1 mm short of the apex. Place the fiber at that length, fire the laser while slowly removing it rotating it as you back out. Limit the time to 15 seconds per canal.

Case report from Dr. Leif Nordvall/Unident

Endo treatment at tooth 22



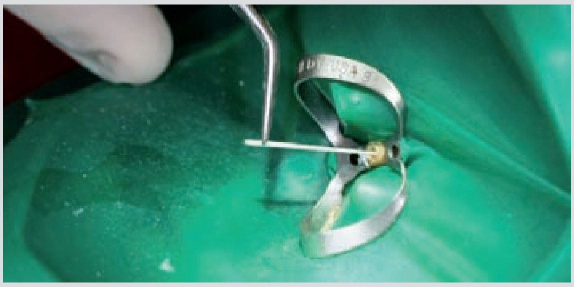
X-Ray



Opening canal minimum ISO 30 length with X-Ray

Controlling of the canal

Conditioning the surface with Er:YAG



Dry the canal with paper tip

Measuring length of canal and marking at 200 µm fibre

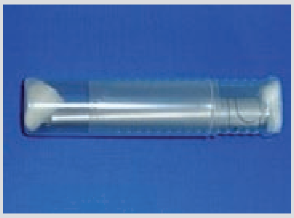
Go with fibre until you fell the apex, pull back 1mm press foot-step and move in circulating motion out of canal

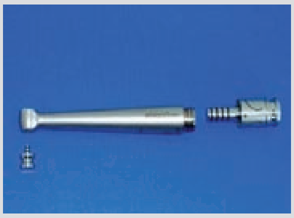
4 · Hard tissue

The upper class of laser dentistry is the Er:YAG laser. It is the reason why our patients and dentists have the dream of the painless, vibration free and minimal invasively treatment. The Er:YAG is the best marketing instrument a dentist could have!

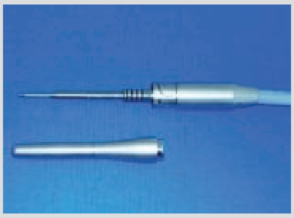
! Important user instruction !

• Installation: take hand piece out of the box and remove the two protection caps at the ends.

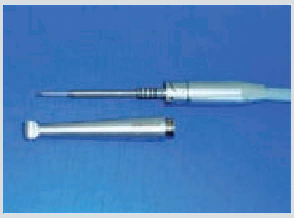


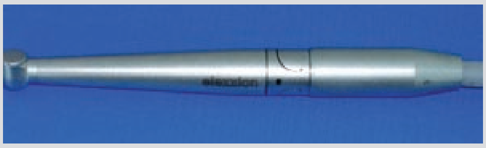


• Remove protection cap from the fibre end at the laser device.

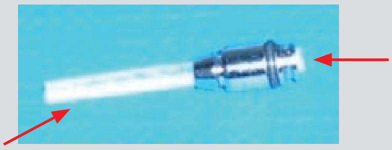


• Stick the hand piece very carefully on the hand piece connector at the laser device

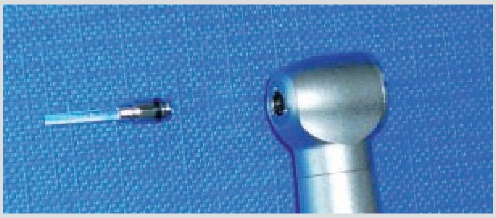




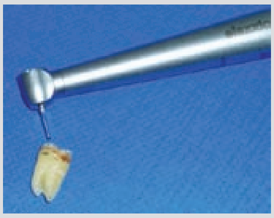
• Clean the sapphire tip at both ends with alcohol and a softly tissue

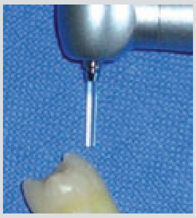


- Put the sapphire tip in the hand piece, till you can hear a click

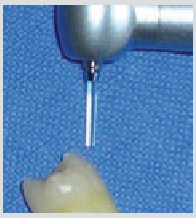


- Work with the sapphire tip approximately in a distance of 1 - 2mm to the surface





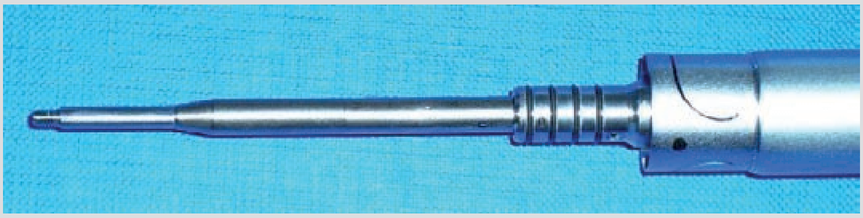
- Insure that there is enough water on the surface from the water spray. (when you get black patches on the surface, you have not enough water)
- Keep the sapphire tip still moving, do not stay on place
- Keep the sapphire tip in an angle of 30 - 45° degrees to the surface



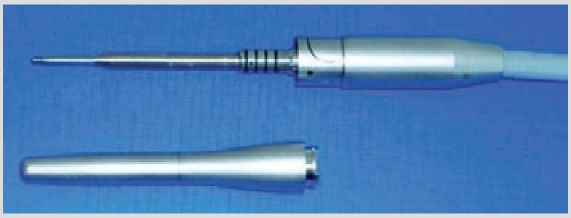
- When you want to change the tip, press please at first stop in the program, now you can hear the air for ca. 10 sec. When the air stops, you can change the tip now. Take care, that the tip is not damaged and that it's clean.

- Autoclave procedure: remove carefully the hand piece from the fibre end. Protect the fibre end with the protection cap. Now close the hand piece with the two protection caps. Put the hand piece in a plastic bag and lay it into the autoclave at 136°C.

• Take care that the fibre end is always dry when you put the hand piece on it.



• The fibre end must be always closed with the protection cap or hand piece.



• Sapphire tips are consumer goods or – materials.
• Check the tip regular all 2 - 3 minutes and clean it in the front with alcohol

DIFFERENT TIPS

Generally: the smaller the tip diameter is, the higher is the power density on the surface!
400µm tip: smallest one for excavations and opening fissures
800µm tip: dentin and enamel preparation, apectomie, bone prep, conditioning
1200µm tip: dentin and enamel preparation, apectomie, bone prep, conditioning
Paro tip: removement of calculus

Bleaching

A treatment which gets much more famous to every year in aesthetic dentistry is bleaching.

First step is to clean up the customize. Apply the light or water curing gingival protector at the marginal gingiva and the 35% coloured (red or blue) hydro oxygen on the teeth surface, 1 - 2mm thickness.

Now wait please 3 - 5 minutes, until the bleaching gel will start to oxidize.

Choose the program “Bleaching” under “Hard tissue” and use T8 glass root. Move in a distance of approximately 1mm over the gel, in a time of 15 seconds for two teeth.

Let the gel further 3 minutes on the surface, now wash it up please. When the result is ok, is no further treatment necessary, when not, please same procedure again.

Case report from Dr. Köstlinger/Germany

Colour B4/A3

after bleaching B2/A2, one treatment

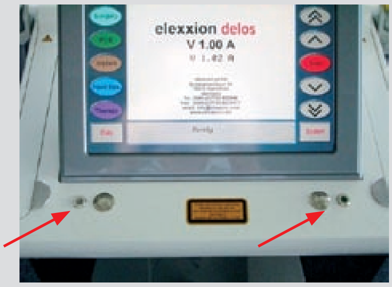
Combined perio program

Is the combined program where you can remove the tartar in the first step, second step is the bacterial reduction in pocket.

After activating the program in the menu under hard tissue/combined perio program, you can choose the single treatment steps over the buttons on the footstep.

Green button is for diode and blue for the Er:YAG, the LED under the display is showing you which side is activated.

Case Images



Hard tissue ablation low, med & high

Indications are excavation and etching/conditioning with **low** settings and 400µm/800µm or 1200µm tipp.

Dentin preparation and pulp near dentin preparation with 800µm or 1200µm tipp have to be done with the **med** settings.

For enamel preparation you have to choose the program with high settings. Please use 800µm or 1200µm tipp, avoid the using of the 400µm tipp with these settings.

Case Images

Preparation with med settings and 800µm tipp

After preparation and conditioning

The result

5 · Softlaser/Therapy

The therapy laser (LLLT – low level laser therapy) is a good instrument for a pain reduction, better wound healing and a biostimulation.

Please work always under contact with the T8 (T – therapy, 8 – diameter 8mm). Between the single treatments, there should be a time of 12 hours.

Aphtha

The second possibility to treat aphtha is the treatment with the softlaser. Under the chapter of surgery we had the other way of aphtha treatment, the surgical way. This program is a softlaser program which could reduce the pain without anaesthesia.

Choose the program "Aphtha", use the T8 glass root ("T" for Therapy, "8" for diameter 8mm), go under contact on the aphtha, press the footstep, time is limited, laser stops the program automatically.

Case report from Leif Nordvall/Unident Sweden

First day in the morning

second day in the evening, after 3 treatments

CASE REPORT
Patient with an aphta case, treatment with the softlaser in the program „Aphta". Aphta was one day old and hurted much.

Patient gets three treatments, at the first day in the evening, at the second day in the morning and in the evening.

Patient felt after every treatment a relief.

In the evening of the second day the patient felt nearly no pain and aphtha was nearly healed.

Decubital ulcer

Case Images

Herpes labialis

Choose under "Therapy" the program "Herpes Labialis". Use the T8 glass root for the therapy. Treat the herpes labialis for the fixed time in the program, when treatment is finished, laser stops automatically.

Case report from Dr. G. Bach/university Freiburg

First day in the morning

second day in the evening, after 3 treatments

Suppress gag reflex

Please us T8 glass root and the acupuncture points LG25 and HG 27.

Case Images

6 · Specials

Depigmentation

Use the normal hand piece for this indication with the 600µm fibre. A small anaesthesia could be sensefull, choose the program “Surgery general” and move fast in a distance approximately 1mm over gingival. After treatment you have to wait two or three days to control the result. When result is not OK, treat it again.

Case report from Dr. Kenneth Luke/Hong Kong

Pre - OP

1 week post - OP

Pre - OP

3 week post - OP

eLAP, elexxion Laser Assisted Protocol

The aim of eLAP is to offer a complete therapy protocol which you can only with laser technology. It is not necessary to use conventional steps during this therapy. Further you will have much more success wit this kind of therapy, less rezidives and a higher patient compliance. The therapy success will be more than 90%. Developed is this program especially for the combined laser delos.

eLAP
elexxion Laser Assisted Protocol
periodontics

1. Meeting dentist
- Medical examination
- PSI (Parodontaler Screening Index)
- Short information over the reasons and the therapy
- KV / Termin für PZR

2.Meeting dh/dentist
- PZR/professional tooth cleaning
- PAR Status
- RÖ/x-ray
- Diagnosis (dentist)

3. Meeting dh/dentist
- Full Mouth Disinfection with CHX 0,2%, starting one day before the therapy, 3 times a day for 1 minute pure, till 14 days after the treatment

4. Meeting dentist/dh
- One visit therapy – Full Mouth Disinfection
- If necessary „supress gag reflex“ LLLT, T8, 60mW, 1800Hz für 70 sec., KG24 and LG25.
- Er:YAG, PARO-Tip, „removement of concretions low“, 50mJ, 10Hz and 200µs, from apical to coronal
- eLAP Laser,
- 400µm Faser, Paro-hand piece with settings 30 Watt, 10µs and 3702Hz or
- 300µm Faser, Paro-hand piece with settings 30 Watt, 10µs and 3600Hz for 20 sec/tooth (5sec/Site)
- Er:YAG, PARO-Tip, „removement of concretions low“, 50mJ, 10Hz und 200µs, from apical to coronal
- eLAP Laser,
- 400µm Faser, Paro-hand piece, 30 Watt, 10µs and 3702Hz or
- 300µm Faser, Paro-hand piece, 30 Watt, 10µs and 3600Hz for 20 sec /tooth (5sec/Site)
- We want to have the bleeding
- For removement of the inflammed tissue in the pocket „internal gingivectomy“with, 25Watt, 15.000Hz und 10µs
- Softlaser with LLLT 75 mW, 8000Hz and 9µs for 2 Minutes/Quadrant for better wound healing.
- Sealing of the pockets with coagulation. Program: Hemostasis, 30Watt, 20.000Hz, 10µs, 600µm fiber

5. Meeting dentist/dh at the next day for controlling of the healing
- „healing of wounds“ LLLT 75 mW, 8000Hz und 9µs für 2 Minutes/Quadrant
- Recall in 3-4 months

Case Images

Thursday 10.00 o´clock
- before eLAP TT 4,9 mm
- BOP generell > 90 %
- PSI 4

Friday 11.30 o´clock

after eLAP TT 2,6 mm, BOP < 5 %, PSI 0 – 1

Case report from Dr. Daruis Moghtader, Oppenheim

First visit, Friday afternoon,

Scaling, normally with Er:YAG, in this case only with ultrasonic scaler

Sealing of the pocket by coagulation for ca. 3 days and softlaser therapy for reducing “post extraction pain”

7 · Studies, Abstracts, Cases

Low level lasers in dentistry

Jan Tunér DDS, Grängesberg, Sweden
Per Hugo Christensen, DDS, Copenhagen, Denmark

A wide range of different lasers are used in modern dentistry. The Erbium:YAG laser has a potential of replacing the drill in selected situations; the carbon dioxide laser is a valuable tool in oral surgery; the Argon laser is used in minor surgery and composite curing; the Nd:YAG is used in pocket debridement, tissue retraction and more. This is just to mention a few of the possibilities of the dental laser.

The major drawback so far has been the high cost compared to the conventional therapies and the fast development in the field. The high cost of the investment may not have paid off until the next generation of lasers is on the market. So far the majority of the dentists using lasers are mainly the entrepreneurs and the enthusiasts.

All the above listed lasers are using, or have the possibility of using high powers, ranging from fractions of a watt to 25 watts or more.

Interest from media and patients has been considerable during the last decade, party because of a general interest in "high-tech" and partly because of the eternal dream about an escape from the discomfort experienced in the dental chair.

This article will summarize the physics, science and clinic of a quite different type of dental lasers - the low level laser.

LOW LEVEL LASERS

While the lasers already mentioned can be labeled "High level lasers", there is a less known type of lasers called "Low level lasers". These lasers are generally smaller, less expensive and operate in the milliwatt range, 1-500 milliwatts. The therapy performed with such lasers is often called "Low Level Laser Therapy" (LLLT) or just "laser therapy" and the lasers are called "therapeutic lasers". Several other names have been given to these lasers, such as "soft laser" and "low intensity level laser" whereas the therapy has been referred to as "biostimulation" and "biomodulation". The latter term is more appropriate, since the therapy can not only stimulate, but also suppress biological processes [1].

Therapeutic lasers generally operate in the visible and the infrared spectrum, 600-900 nm wavelength. However, other wavelengths such as the Nd:YAG at 1064 nm and even the carbon dioxide laser at 10600 nm have been successfully used in laser therapy.

The **energy** used is indicated in Joule (J), which is the number of milliwatts x the number of seconds of irradiation. Thus, 50 mW x 60 seconds produces an energy of 3000 millijoules, equals 3 J. Suitable therapeutic energies range from 1-10 J per point. The dose is expressed in J/cm2. To calculate the **dose**, the irradiated area must be known. 1 J over an area of 1 cm2 = 1 J/cm2. 1 J over an area of 0.1 cm2 = 10 J/cm2. There is generally no heat sensation or tissue heating involved in this therapy.

THE HISTORY

The first laser was demonstrated in 1960. It was a ruby laser, 694 nm wavelength. Interest in the medical implications of laser light was high and already in 1967 [2] some of the first reports appeared on the effects of very low doses of ruby light on biological tissues. In animal studies it was observed that experimental wounds healed better if irradiated and that even the shaved fur of the experimental animals reappeared faster in the irradiated areas. There appeared to be a biological window for the dose. If too low, there was no effect, if too high there was a suppressive effect. Not much later the Helium-Neon laser was introduced in research and the results were similar. Later on diode lasers were introduced and they provided the same results, although some wavelengths appeared to be better for certain indications. In particular, the introduction of infrared lasers improved the optical penetration of the light, reaching deeper lying tissues.

The first commercially available lasers in the early 80ies were extremely low powered, below 1 mW, in spite of the fact that the first scientific reports used 25 mW. This partly explains the initial controversy about LLLT. With the rapid development of laser diodes, the powers of therapeutic lasers have changed dramatically and diode lasers today are typically in the range of 50-500 mW. Increased power has not only shortened the treatment time but also improved the therapeutic results.

RISKS AND SIDE EFFECTS

The only physical risk in laser therapy is the risk of an eye damage. While never reported to have occurred, the risk of an eye damage must be considered, especially when using an invisible and collimated (parallel) beam. Suitable protective goggles should be worn by the patient for extra oral therapy in the face.

Since the therapeutic lasers are well above the ionizing spectrum there is no risk of cancerous changes. Suspected malignancies should of course not be treated by anyone but the specialist.

Among the side effects (rarely) observed are:

- temporary increase of pain in chronic pain conditions. It has been suggested that this is a sign of a transfer of the chronic condition into an acute situation.
- tiredness after the treatment. This is probably a result of the pain relief where the pain previously has prevented a normal relaxation pattern
- redness and a feeling of warmness in the area which is irradiated a result of a increases micro circulation

THE SCIENCE

There are more than 2500 scientific studies in the field of laser therapy, among them more than 100 positive double blind studies [3]. In dentistry alone, the number of studies are some 325, from 82 institutions in 37 countries [4]. The quality of these studies vary but it is interesting to note that more than 90% of the studies report on positive effects of laser therapy.

In total, 30 different dental indications have been reported in the literature. The very variety of indications has been used as an argument against the probability of laser therapy. However, it rather shows the input on general biological systems, such as the immune system, SOD activity, ATP production, cell membrane permeability, release of transmitter substances etc.

Laser therapy science is a complicated matter where a combined knowledge about laser physics, medicine, clinical procedures and scientific rules is essential [5]. Many studies, positive and negative, lack relevant reporting parameters and make a proper evaluation difficult. The existing literature is a sufficient foundation for successful clinical therapy but more research is still needed to find out the optimal parameters.

In two recent US meta analyses [6], [7] there was a high overall significance for wound healing, tissue regeneration and pain.

TREATMENT

Treatment is often carried out through local irradiation of the site of injury/pain, but it can also be performed on distal points such as regional lymph nodes, ganglia and cervical nerve roots corresponding to the dermatome in question. Pain release can often be achieved in one or two sessions (especially if the reason for the pain still is in a acute stage) whereas many conditions have to be treated during several sessions. When calculating the dosage, parameters such as pigmentation of the skin, condition of the tissue, acute/chronic stage, depth beneath skin/ mucosa, transparence of overlying tissue must be considered.

NEW POSSIBILITIES

The therapeutic lasers offer improved possibilities in the treatment of pain, wound healing, inflammation and oedema. However, they also offer the dentist a possibility to treat indications previously not within the capability of the general dentist. In the following some examples will be given, each with a selected reference
Dentinal hypersensitivity

With the advent of desensitizing agents, the prevalence of treatment-resistant dentinal hypersensitivity has diminished considerably. On the other hand, the placement of composites and inlays has brought a new reason for the very same. Gershman [8] has shown that dentinal hypersensitivity can be successfully treated with LLLT. Mild pulpitis requires higher doses than the common dentinal hypersensitivity, and repeated treatments. Frequently a sensitive tooth neck can be treated with only one treatment.

HERPES SIMPLEX

Oral herpes (HSV1) is a common feature in the dental operatory. Instead of being a contraindication for dental treatment during the acute period, an onset of HSV1 can be a good reason for a visit to the dentist. As with any treatment of HSV1 a treatment in the early prodromal stage is most successful. The pain will be reduced immediately and the blisters will disappear within a few days. Repeated treatment, whenever a blister appears will lower the incidence of recurrence. Unlike Acyclovir tablets, there are no side effects [9]. It has been shown [10] that laser therapy can even be used in the latent period between the attacks to lower the incidence of recurrence.

MUCOSITIS

Patients undergoing radiotherapy [11] and/or chemo radiotherapy [12] suffer gravely from the mucositis induced by the therapy. Nutrition is troublesome and therapy regimen may have to be suboptimal for this reason. LLLT can be used not only to treat the mucositis but even to reduce it by mucosal irradiation prior to radiotherapy/ chemotherapy.

PAIN

The most frequent complaint among patients is of course pain. LLLT can reduce or eliminate pain of various origins]6]. Postoperative discomfort after surgery can be substantially reduced by irradiating the operated area postoperatively before the anaesthesia wears off.

PARESTHESIA

After oral surgery paresthesias may occur as a result of the surgery, in particular in the mandibular region. LLLT has been used to eliminate or reduce such complications [13].

SINUITIS

While many cases of sinuitis are “dental”, a great number of patients arrive in the dental office with sinuitis of a viral or bacterial background. LLLT will in most cases lead to a fast reduction of the symptoms [14], making the scheduled treatment easier.

TMD

Problems in the temporo-mandibular joint region are quite suitable for LLLT. For arthritic cases the treatment is concentrated to the joint area, in myogenic cases the muscular insertions and trigger points are treated. Laser therapy should always be used in combination with conventional treatment but will improve the outcome of the treatment [15].

TINNITUS/VERTIGO

It has been shown [16] that patients suffering from Ménière's disease (tinnitus/vertigo) have a significantly increased prevalence of problems in the masticatory, neck and trapezius muscles plus problems in the cervical spine, particularly in the transverse processes of the atlas and the axis. Relaxation of the tension in these muscles plus occlusal stabilisation procedures (occlusal adjustment, bite splint) will reduce or eliminate the symptoms of tinnitus and vertigo in this group of patients. Laser therapy can successfully be used to promote muscular relaxation and pain relief in these cases.

TRIGEMINAL NEURALGIA

Apart from being extremely debilitating, trigeminal neuralgia can sometimes make dental treatment impossible. While no miracle cure, dentists can offer a great deal of comfort to these patients, and with a non-invasive method [17].

ZOSTER

Zoster in the trigeminal nerve should be treated in its early phase. The zoster attack in itself is bad enough, but not too infrequently a postherpetic neuralgia will persist for years or even lifelasting. Laser therapy is a cost-effective, non-invasive method without side effects [18].

OTHER INDICATIONS

29 different dental indications are described in the literature, some of them being aphtae, bone regeneration, dentitio dificilis and decubitus.

ACUPUNCTURE

If a dentist is trained in acupuncture, the low level laser will be a very convenient way of replacing the needles in many instances, for corporal or auricular acupuncture. Needles are not too popular with the patients, so the laser will be appreciated. Even for a dentist not practicing acupuncture, there are some well defined acupuncture points which can be used, for instance to reduce nausea [19].

NO PANACEA

The clinical results described above may seem impressive, even to the degree of doubts. However, laser therapy is no panacea and should only be used within the limits of its own merits. Correct diagnosis, proper treatment technique and treatment intervals plus sufficient dosage are all essential to obtain good results.

NON-BIOMODULATING LLLT

A large number of in vitro studies have reported on the enhanced killing of bacteria using various dyes in combination with low level lasers. The most frequently used dye has been toluidine blue (TBO) and some of the microorganisms studied are streptococcus mutans (20) and staphylococcus aureus (21). The bactericidal effect of TBO is enhanced by low level laser light and the clinical implications of this combination in cariology and periodontology are indeed promising. Low level laser has also been shown to enhance the release of fluoride from lacquers (22) and resin cements (23).

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Low level laser therapy of tinnitus - a case for the dentist?

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ABSTRACT

Tinnitus is a debilitating condition with an increasing incidence, especially among the young generation, due to intensive sound levels at concerts and in headsets. It is, however, not solely a problem of the modern world. The condition is described in papyrus documents dating back 600 BC. Some famous historic persons have suffered from tinnitus, such as Martin Luther, Jean-Jaques Rousseau and Ludwig van Beethoven. It is estimated that roughly one person in ten is affected by tinnitus of some degree. The origin of tinnitus is controversial. It is claimed that tinnitus is located in the inner ear but also that it actually is situated in the brain cortex, as evidenced by PET-scanning. It is reasonable to believe that the condition can have several origins and that one of these then is of interest to the dentist. Low level lasers have been claimed to have a therapeutic effect on tinnitus and vertigo. In these cases the irradiation has been directed towards the cochlea. Low level laser therapy (LLLT) is also reported to be useful in the treatment of temporo-mandibular disorders (TMD). Furthermore, some patients are cured from their tinnitus when a proper TMD therapy has been performed. It now also appears that low level lasers can be used to advantage in the treatment of TMD-related tinnitus, and without actually irradiating the inner ear.

LOW LEVEL LASERS

Since the beginning of the 80's low level lasers have become increasingly popular as an additional treatment possibility in many professions, such as chiropractors, naprapaths and physiotherapists but not so much in traditional medicine and dentistry. In spite of more that 100 positive double blind studies there remains a skeptical attitude. In dentistry alone, more than 90% of the published studies show positive results. It is true that several studies have failed to show any result, but it is not uncommon for such studies to contain serious flaw [1]. And it is not to be expected that any dosage or any wavelength of low level laser will produce a biological response.

Low level lasers are generally in the visible - near visible range of the spectrum. The most common types are HeNe (633 nm), InGaAlP (630-685 nm), GaAlAs (780-870 nm) and GaAs (904 nm). Power output in the beginning ranged from 1-10 mW. With the advent of less expensive diodes the power has increased considerably and GaAlAs lasers are now available with power of even 1 000 mW (1 Watt). Increased dosage and power density have proven to be important and the clinical results have consequently been improved. Suitable dosage varies depending on the condition and the depth of the target tissue, but generally 4-20 J/cm2 are applied. Red laser light is optimal for superficial conditions such as mucosa and skin whereas infrared is better for pain and deeper lying conditions because of its superior penetration.

Biological responses of cells to laser irradiation are suggested [2] to occur due to physical and/or chemical changes in photo acceptor molecules, components of the respiratory chain like cytochrome c oxidize and NADH-dehydrogenize. Hypotheses about primary mechanisms at the interface of laser irradiation and tissue are redox properties alterations, NO release, super oxide anion reactions, singlet oxygen production and local transient heating of chromophores. Further, secondary processes are triggered where the mechanisms are performed "in the dark". Thus, distant effects can be obtained far from the irradiated area. The redox-regulation mechanism may explain the positive effect of tissues characterized by acidosis and hypoxia.

LOW LEVEL LASER OF TINNITUS - THE LITERATURE

Low level laser therapy (LLLT) has been suggested as a possible therapy for tinnitus. Several studies have used Ginkgo biloba infusions in combination with LLLT, the former being a widespread but not well documented therapy for tinnitus. The numbers of studies are few and they will be briefly described in the following.

Witt [3] is one of the pioneers in this field, but to the knowledge of the author his results have not been published in any peer-review journal. Witt combines infusion of Gingko biloba (Egb 761, 17.5 mg dry extract per 5 ml amouple)) and laser. This may be a favorable combination but an evaluation of the contribution of the laser is not possible. More than 500 patients have been treated since 1989 and Witt claims that more than 60% of the patients have reached a considerable or total relief. The laser used is a combination of HeNe 12 mW/GaAs 5 x 10 mW. Treatment technique not stated.

Swoboda [4] did not find any significant effect of Gingo/laser. However, the ginkgo infusion used was at a homeopathic level (D3 = 1:1000 dilution), acc. to Witt.

Partheniadis-Stumpf [5] also failed to find any effect from the combined ginkgo (6 ml Tebonin) infusion and laser. However, the laser was applied at a distance of one cm above the mastoid. The non-contact mode reduces penetration considerably and the mastoid is not ideal for reaching the inner ear.

Plath [6] treated 40 tinnitus patients with 50 mg Ginkgo biloba. 20 patients received sham laser irradiation, 20 real laser. A HeNe 12 mW/GaAs 5 x 15 mW GaAs laser was used, irradiation procedure approximately the same as for Partheniadis-Stumpf. In this study, 50% of the patients reported a reduction of the tinnitus of more than 10 dB, compared with 5% in the control group, in both self-assessment and audiometric findings.

A similar study has been performed by von Wedel [7]. 155 patients were treated with Ginkgo infusion (5 ml Syxyl D3) and laser. The outcome was negative. No information about the type of laser, treatment technique or dosage is given, making an evaluation impossible.

Shiomi [8] has investigated the effect of infrared laser applied directly into the meatus acusticus, 21 J, once a week for 10 weeks. The result of this non-controlled study is as follows: 26% of the patients reported improved duration, 58% reduced loudness and 55% reported a general reduction in annoyance.

The same author [9] has also examined the effect of light on the cochlea, using guinea pigs. Direct laser irradiation was administered to the cochlea through the round window and the amplitude of CAP was reduced to 53-83% immediately after the onset of irradiation. The amplitude then returned to the original level. The results of this investigation suggest that LLLT might lessen tinnitus by suppressing the abnormal excitation of the 8th nerve or the organ of Corti.

More or less the same parameters were used in a controlled study by Mirtz [10] but in this case there was no significant effect.

Wilden [11] [12] has applied a different method where the dose has been increased considerably. A set consisting of one HeNe laser and three powerful GaAlAs lasers is used, covering a large area over and around the ear, in the non-contact mode. Doses between 3.000 and 5.000 J are given each session. Laser is applied as a monotherapy. More than 800 patients have been treated with this concept and positive effects are reported, even for vertigo. Recent injuries in “the disco generation” are more easily treated than long-term chronic conditions. In a separate study [13] Wilden reports improvment of the hearing capacity of these patients, as evaluated by audiometry.

Beyer [14] has performed a very exact ex-vivo laser penetration study. Based on these findings it was possible to calculate the energy needed to obtain a dose of 4 J/cm2 in the cochlea itself. 30 patients were treated five times within 2 weeks. One group was irradiated with 635 nm diode laser, the other with 830 nm diode laser. By self-assessment around 40% of the patients reported a slight to significant attenuation of the tinnitus loudness of the irradiated ear. This study has been followed by a double blind study.

Prochazka [15] has evaluated the effect of combined Egb 761 Ginkgo infusion and laser in a double blind study. 37 patients were divided into three groups. One group had Egb 761 only, one Egb761 and placebo laser, one Egb761 and real laser, 830 nm. The results in the three groups were as follows: no effect 29/26/19, less than 50% relief 44/48/29, more than 50% relief 18/26/36, no more tinnitus 9/0/26. Irradiation was performed over the mastoid and over the meatus acusticus, twice a week, 8-10 sessions, total 175 J.

Rogowski [16] divided a group of 32 tinnitus patients into one group receiving LLLT and one receiving a placebo procedure. Dose, wavelength and treatment technique not stated in the available English abstract. The effect was evaluated through VAS. Within the patient group transiently evoked otoacoustic emissions (TEOAE) were measured before, during and after therapy. No significant difference between laser and placebo was found in annoyance or loudness of the tinnitus and in changes of TEOAE amplitude. These results indicate that there is no relationship between the effect of low-power laser and changes in cochlear micromechanics.

A few other indications in otorhinolaryngology have been treated with low level lasers, even with intravenous irradiation. [17-20]

It is obvious that the available literature on laser therapy of tinnitus is scares and ambiguous. Some studies have used a combination of Ginkgo and laser, others laser as monotherapy. Differences in wavelengths, pulsing, dosage and treatment technique makes a firm evaluation impossible. However, the positive results reported in some studies do merit attention and further research. Recent clinical experience also suggests that the doses necessary for successful outcome of the therapy have to be increased considerably. Tinnitus is a grave condition, sometimes leading to suicide. It is also an increasing problem and the existing treatment modalities offered to tinnitus patients are not very effective. Young persons suffering from acoustic chocks (concerts, discos) can be more successfully treated with laser therapy. Understandably enough, a long standing condition in elderly persons is a severe condition taking 10-20 sessions to influence.

LASER THERAPY OF TMD

The following is an account of some studies published in the field of low level laser therapy for TMD.

Hansson [21] studied the effects of GaAs laser on arthritis of the temporo-mandibular joint. The author stresses that lasers are not an alternative to conventional treatment, but that it seems possible to reduce healing periods and more quickly reduce inflammation.

Bezuur and Hansson [22] treated a group of 27 patients suffering from long-term problems related to TMD with a GaAs laser. The treatment was administered over the joint on five consecutive days. 80% of the 15 patients with arthrogenous pain experienced total pain relief. The maximum jaw-opening ability increased during the treatment period, and continued to increase during the year that the group was monitored. The group suffering from myogenic problems also improved, both in terms of pain and jaw-opening ability. The effect here was, however, much lower. As the muscles were not treated, it is assumed that this group also had undiagnosed arthritis. The reduction of joint sounds may possibly have been due to an increase of metabolism in articular cell structures, e.g. an activation of the synovial membrane, producing more synovial fluid.

Eckerdal [23] reports on the clinical experience of a 5-year non-controlled study of perioral neurapathias. The treated diagnoses were trigeminal neuralgia, atypical facial pain, paresthesias, and TMD pain. Of these diagnoses, the TMD pain group was the most successful one. At the end of treatment, 73% of the patients (N = 40) had a good response, at six months still 73%, and at one year 70%. 10 J/cm2 was applied to the joint over 4-8 sessions.

In a study comprising 75 cases, Bradley [24] found LLLT effective as a monotherapy when treating acute joint pain (less than eight weeks duration). In more chronic cases, without bone changes on X-ray, LLLT was used as an adjunct to splints and the like. In osteoarthritic cases, LLLT can be almost as useful as intra-articular steroids.

Bradley [25] used GaAs laser acupuncture when treating a small group of patients suffering from TMJ pain dysfunction syndrome who had not responded to treatment with a bite splint or psychotropic medicine. Needle acupuncture was used in a comparative group. Both types of acupuncture can be studied with thermography. Biostimulation was observed to yield vascular effects which locally resemble the vascular effects achieved with needle acupuncture, although it takes more time for laser stimulation to take effect. Both forms of acupuncture were more effective on known acupuncture points than on randomly chosen points. St 6 was used throughout as a “known acupuncture point”.

Kim [26] divided a group of 36 patients with maxillary joint problems into three therapy groups. The patients were treated with bite splints, GaAlAs laser treatment, or laser acupuncture. The treatment results were compared after two and four weeks with a check on status before treatment. The following conclusions were drawn: The patients’ subjective discomfort was reduced in both the bite splint and laser treatment groups. The improvement in the laser group was much greater than in the bite splint group. Clinically observable symptoms showed a significant reduction in all groups, but the group treated with laser light responded faster to treatment than the other groups. EMG activity gradually decreased in all the groups - and without any great difference between groups. Laser treatment had more beneficial effects than bite splints, while laser acupuncture produced the poorest results.

Lopez [27] treated a group of 168 patients with problems related to TMD with a combination of bite splints and HeNe laser. An obvious improvement could be observed in 52 of the patients after a single treatment. After ten treatments, 90% of the patients had improved. No further improvement was brought about in the other 10% by administering further treatments. The laser treatment was given directly over the maxillary joint - 6 mW for five minutes (1.8 J). The extent of healing was inspected using a tomographic X-ray before treatment and after six months. At that point, healing had advanced to a stage usually seen after 12 to 18 months when only a bite splint is used. In a group of 88 patients with pains in the jaw muscles, pain was alleviated for up to six hours, but without lasting results. The author concluded that HeNe lasers are effective as a complementary method to bite splints when treating arthrosis and arthritis, but that this wavelength is not optimal for myogenic pain.

Hatano [28] used a GaAlAs laser to study the effect on palpation pain in 15 patients with TMD. A 30 mW laser was used for 3 minutes (5.4 J) in the area of one temporo-mandibular joint. The other side served as control. Palpation score was estimated directly after irradiation and at 20, 40, and 60 minutes after irradiation. There was a significant decrease in palpation pain with better values at 20, 40, and 60 minutes than directly after irradiation.

Bertolucci [29] compared two groups of patients (16+16) receiving physical therapy for mandibular dysfunction. One group received sham irradiation, the other GaAs during three weeks. The results were as follows (treatment group/placebo group): change in pain 40.25/1.56; change in vertical opening 1.35/-0.05; change in left and right deviation 3.78/0.62.

Interleukin-1b in the synovial fluid is associated with TMD pain [30]. In a study by Shimizu [31], GaAlAs laser light influenced the production of this substance.
Ivanov [32] treated 109 patients with temporomandibular joint arthritis and arthrosis with an HeNe laser (12 mJ/cm2, 3-7 treatments). 89% of the patients reported clinical improvement.
In a double blind study by Sattayut [33], the higher doses (20 J per point, 300 mW) were clearly more effective than 4 J and 60 mW . In this study GaAlAs was used as monotherapy. Following a period of 2-4 weeks after therapy (3 sessions in one week) there was an average of 52% reduction of pain as assessed by SSI pain questionaire.

CMD, TMD, LLLT AND TINNITUS

It has been know for decades that patients with temporo-mandibular joint dysfunction (TMD) and crano-mandibular disorders (CMD) also may have tinnitus problems, and that there is a connection between the two.

In a book by Myrhaug [34], the author underlines the fact that there are two muscles in the inner ear which are innervated by two facial nerves. M. tensor tympani is innervated by n. trigeminus and m. stapedius is innervated by n. facialis. Intensive action in the masticatory muscles could therefore influence these two small muscles as well and thereby cause the tinnitus sensation.

Bjorne [35] compared a group of 31 patients suffering from Ménière's disease with a control group, matched for sex and age. The patients in the Ménière group had statistically significant more signs of crano-mandibular disorders, such as tenderness to palpation upon the masticatory muscles, of the temporo-mandibular joint, upper part of the trapezius in the area of the atlas, the axis and the third cervical vertebra.

In a second study by Bjorne [36] 24 of the 31 patients from the previous study were compared with 24 control subjects regarding the frequency of signs and symptoms of cervical spine disorders. Symptoms of cervical spine disorders as head and neck/shoulder pain, and signs as limitations in side-bending and rotation movements were more frequent in the patient group as well as tenderness to palpation of the neck muscles. 39% of the Ménière patients could influence their tinnitus, both sound level and pitch, by protrusion or lateral movement of the mandible or by clenching their teeth. 75% of the patients could trigger their attacks of vertigo by extension, flexion or side-rotation of the head and neck.

A correlation between tinnitus and tension of the lateral pterygoid muscle has also been found [37]. Further correlation between signs and symptoms of TMD and tinnitus is indicated in studies by Rubenstein [38] and Ciancaglini [39].

Wong [40] reports that the styloid process and its attachments are often the center of TMD problems and that no less than 11 symptoms have been observed in connection with soft tissue lesions in this region, one of them being tinnitus. The muscular symptoms are suitable for low level laser therapy acc. to the authors.

DISCUSSION

There is reason to beleive that a subgroup of the tinnitus (and vertigo) patients actually have a primary crano-temporo-mandibular dysfunction problem and that the tinnitus sensation is a secondary phenomenon. A greater awareness of this possibility and a closer cooperation between otorhinologists and dentists would probably reduce the problems of the patients in this subgroup. The size of this group is unknown, since the CMD relation is seldom diagnosed, nor treated. The correlation between Mènière's disease and CMD seems to be more frequent than the correlation between an isolated tinnitus problem and CMD.

Some of these patients in the mentioned subgroup can change the intensity or pitch of their tinnitus by clenching or opening their mouth wide, and in some cases even by changing the position of their head. Irradiating a muscle involved in the creation of the tinnitus phenomenon can alter the carachter of the tinnitus. This offers a possibility of an initial diagnosis of the type of tinnitus. It is not unusal for the tinnitus sensation to disappear temporarily after laser irradiation. Repeated irradiation can keep the patient free of tinnitus and also make the patient more aware of the hypertension in the muscles.

CMD/TMD is a very common condition and the suggested treatment modalities are multifold. Occulsal splints and elimination of occlusal interferences are standard procedures but the scientific documentation of these, and other treatment modalities are still poor, although the clinical experience seems to verify their effectiveness.

The concept of treating tinnitus and vertigo patients through occlusal stablisation is not new but so far not very much explored. Adding low level laser irradiation to this therapy is even less explored and there is very little research. The objective of this article is not to give precise recommendations about treatment procedures but rather to put the light on the possibility for the dentist to improve the quality of life of many vertigo and tinnitus patients and that the dentist could play an important role in this treatment. Further research is warranted.

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In vitro attachment of osteoblasts on contaminated rough titanium surfaces treated by Er:YAG laser

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Microbial contamination of implant surfaces inhibits formation of new osseous tissues. Biocompatibility of sand-blasted large grid (SLA) surface, after previous in vitro cocultivation with Porphyromonas gingivalis and concomitant Er:YAG laser irradiation of microorganisms, was tested by attachment of newly cultured osteoblasts. A total of 36 customized titanium cubes with SLA surface were placed into human osteoblast culture for 14 days. After removal of 1 control cube, 35 other cubes were contaminated with precultured P. gingivalis (ATCC33277) and incubated in broth medium for 1 week. Ablation was carried out on 32 cubes. Each side was treated for 23.5 s with a pulsed, water-cooled laser beam. After irradiation, cubes were again placed into fresh osteoblast culture for 2 weeks. One randomly selected single side per cube was analyzed by scanning electron microscope in 22 cubes. On other 10 cubes, vitality of attached cells was tested with ethidiumbromide staining by fluorescence microscopy. Three negative controls revealed constantly adherent P. gingivalis, and no osteoblasts were detectable after P. gingivalis contamination on the surfaces. Laser-treated specimens showed newly attached osteoblasts, extending over 50-80% of the surface. Positive control cube (without bacterial contamination) showed over 80% cell coverage of the surface. Vitality of widely stretched osteoblasts was confirmed by FITC staining. Our results indicate that Er:YAG laser was effective in removing P. gingivalis and cell compounds, offering an acceptable surface for new osteoblast attachment. (c) 2006 Wiley Periodicals, Inc. J Biomed Mater Res, 2006.

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Use of Er:YAG laser to improve osseointegration of titanium alloy implants – a comparison of bone healing

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PURPOSE: The objective of this study was to compare the osseointegration of implants in rats in sites prepared with an Er:YAG laser with osseointegration in sites prepared using a conventional drill by assessing the percentage of bone-implant contact (BIC). MATERIALS AND METHODS: Osteotomies were prepared with an Er:YAG laser in the tibiae of 18 rats (the test group) and drill-prepared with a 1.3-mm-wide surgical implant drill at 1,000 rpm with simultaneous saline irrigation in the tibiae of another 18 rats (the control group). Acid-etched titanium alloy implants (2 x 8 mm) were placed in the tibiae, engaging the opposite cortical plate. The Er:YAG laser was used with a regular handpiece and water irrigation (spot size, 2 mm; energy per pulse, 500 to 1,000 mJ; pulse duration, 400 ms; and energy density, 32 J/cm2). Nine animals from each group were sacrificed after 3 weeks of unloaded healing; the remainder were sacrificed after 3 months. The tissues were fixed and prepared for histologic and histomorphometric evaluation. RESULTS: Statistical analysis showed significant differences between the 2 groups at both 3 weeks and 3 months. After 3 weeks of unloaded healing, the mean BICs (+/- SD) were 59.48% (+/- 21.89%) for the laser group and 12.85% (+/- 11.13%) for the control group. Following 3 months of unloaded healing, the mean BICs (+/- SD) were 73.54% (+/- 11.53%) for the laser group and 32.6% (+/- 6.39%) for the control group. DISCUSSION: Preparation of the implant sites with the Er:YAG laser did not damage the interface; the healing patterns presented were excellent. CONCLUSIONS: Based on the results of this study, it may be concluded that the Er:YAG laser may be used clinically for implant site preparation with good osseointegration results and bone healing and with a significantly higher percentage of BIC compared to those achieved with conventional methods.

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Acceptance and efficiency of Er:YAG laser for cavity preparation in children

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Objective: To evaluate the clinical efficiency and patient acceptance during cavity preparation in children, a direct comparison was made between Er:YAG laser preparation and conventional mechanical preparation of caries using a split-mouth design. Background Data: The Er:YAG laser system was developed for cutting dental hard tissue and has been approved as a useful alternative method for cavity preparation. Methods: Children with previously unrestored and matched carious cavities in non-pulpally involved anterior teeth were selected, and the sequential order of treatment was randomized. In total, 40 children from 4 to 12 years old took part in the study. Two teeth each in the 40 patients were prepared without anesthesia and restored with a light-cured compomer following application of a bonding agent. The time spent on cavity preparation and the behavior of the patients during cavity preparation were recorded; finally, a modified face scale was used for pain assessment. In addition, the children were asked to indicate whether they found the laser or the mechanical approach more uncomfortable, and their preferred treatment when undergoing future caries therapy. Results: The analysis of pain indicated that 82.5% of children felt no pain at all with the laser preparation, and they also showed much more body and head movement with the conventional mechanical preparation. Although the Er:YAG laser took about 2.35 times longer to prepare the same type of cavity, 92% of the children said that they would prefer laser preparation for further caries therapy. Conclusion: Cavity preparation with the Er:YAG laser would seem to be an option for fearful children, since it produces less pain and has acceptable efficiency compared to the conventional mechanical preparation.

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Clinical application of Er:YAG laser for cavity preparation in children

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OBJECTIVE: The purpose of this study was to determine the clinical usefulness of Er:YAG laser for cavity preparation in children. BACKGROUND DATA: The conventional methods for cavity preparation instill fear and discomfort in paediatric patients. The Er:YAG laser is a new tool developed for cavity preparation; however, there are few reports of its clinical application. MATERIALS AND METHODS: A clinical evaluation using an Er:YAG laser was carried out using 32 subjects (with 16 deciduous and 19 permanent teeth) with ages ranging from 2 to 12 years. All cavities were restored with light-cured composite resin following the application of bonding agent, but without acid etching or primer conditioning. RESULTS: During laser treatment, the paediatric patients were very cooperative and hardly complained of any pain, and no tooth showed undesirable effects during the 3-year period of observation. CONCLUSION: It can be concluded from the results of this study that an Er:YAG laser would be a useful alternative method for cavity preparation for composite resin restoration in children.

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Comparison of marginal micro leakage of flowable composite restorations in primary molar prepared by high speed carbide bur, Er:YAG laser and air abrasion

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PURPOSE: The purpose of this study was to assess in vitro the influence of 3 cavity preparation devices (carbide bur, Er:YAG laser, and air abrasion) on the micro leakage of flowable composite restorations in primary teeth. METHODS: Fifteen primary second molars were selected, and Class V cavities were prepared on the buccal/lingual surfaces, being assigned to 3 groups (n= 10). Group 1 (control) was prepared using a high-speed hand piece and was acid etched. Group 2 was prepared and treated with a Er:YAG laser (400mJ/4Hz and 80mJ/4Hz, respectively) and was acid etched. Group 3 was prepared and treated with an air abrasion system and was acid etched. Cavities were restored and stored for 7 days. Restorations were polished, thermo cycled, immersed in 0.2% rhodamine B, sectioned, and analyzed for leakage. RESULTS: Er:YAG laser-prepared cavities showed the highest degree of infiltration. The performance of the air abrasion device was comparable to that of the high-speed hand piece. CONCLUSION: It may be concluded that the method of cavity preparation affected the micro leakage of Class V cavities restored with flowable composite in primary teeth.

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Er:YAG laser application in caries therapy. Evaluation of patient perception and acceptance

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OBJECTIVES: In previous studies it has been demonstrated that the Er:YAG laser can be used to prepare cavities efficiently and without thermal damage to the adjacent dental hard and soft tissues. To investigate the patients' response to Er:YAG laser preparation of teeth, a prospective clinical study was performed in five dental hospitals. METHODS: To evaluate patients' perception and response to cavity preparation a direct comparison was made between conventional mechanical preparation and Er:YAG laser preparation of caries in dental hard tissues. Half of the preparations were completed by the laser alone with standardized parameters, with the other half being mechanically prepared. The sequential order of treatment was randomized, and clinical parameters such as depth and location of the cavities were carefully balanced. A three-score evaluation scheme of patient responses was used: comfortable, uncomfortable, very uncomfortable. In addition the patients were asked to decide which was the more uncomfortable form of treatment and the preferred treatment for future caries therapy. RESULTS: The study included 103 patients with 206 preparations distributed amongst 194 teeth. All teeth gave vital responses (ice test) before and after both types of treatment. The laser treatment was found to be more comfortable than the mechanical treatment, with high statistical significance. During treatment, the need for local anaesthesia was 11% for mechanical preparation compared to 6% during laser application. It was found that 80% of the patients rated the conventional preparation as more uncomfortable than the laser treatment and 82% of the patients indicated that they would prefer the Er:YAG laser preparation for further caries treatment. CONCLUSIONS: The application of the Er:YAG laser system is a more comfortable alternative or adjunctive method to conventional mechanical cavity preparation.

PMID: 9793286 [PubMed - indexed for MEDLINE]

8 · Appendix

Claros nano

FIG.	PROGRAM NAME	PULSE OUTPUT [W]	PULSE FREQUENCY [HZ]	PULSE DURATION [MS]	REMARK	MEAN OUTPUT [W]
	Endodontics					
E1	Canal Decontamination	4.0	20k	17	Bacterial Reduction, 300 µm, cover as many areas as possible while moving	1.33
E2	Pulp capping	5.0	12k	17	Capping of pulp, 300µm fiber	1.00
E3	Expose Implant	15.0	8k	17	Implant exposition, 400µm fiber	2.01
E4 - E9	Temp. Free programming	1.0	CW	CW	*Attention – decontamination of root canal: max. 1.5W (mean) / 15 sec per tooth*	1.00
	Surgical Procedures					
S1	Troughing for crowns	15.0	5k	17	Crown and Bridge, 300/400 µm	1.28
S2	Gingivectomy	15.0	9k	17	300/400/600 µm	1.50
S3	Frenectomy	15.0	12k	17	400/600 µm, tauten tissue, loosen parallel to alveolar ridge, no sutures	3.00
S4	Fibroma Removal	15.0	10k	17	400/600 µm, tauten tissue with surgical forceps	2.55
S5	High Performance Excisions	15.0	20k	17	High performance program, 400/600 µm	5.10
S5 - S9	Temp. Free programming	1.0	CW	CW	*Output power depends on specific application. Always start with low power and increase if necessary.*	1.00

Claros nano

FIG.	PROGRAM NAME	PULSE OUTPUT [W]	PULSE FREQUENCY [HZ]	PULSE DURATION [MS]	REMARK	MEAN OUTPUT [W]
	**Periodontics**					
P1	Sulcular Debridement	15.0	2.5k	17	Bacterial Reduction, 300 µm, cover as many areas as possible while moving	0.62
P2	Sulcular Debridement high	15.0	6k	17	Capping of pulp, 300µm fiber	1.50
P3	Coagulation	1.0	CW	CW	Coagulation of tissue, 300/400 µm	1.00
P4	Bacterial Reduction	1.0	CW	CW	Bacterial Reduction, 200 µm, fiber as far toward apex as possible, circular up and down	1.00
P5 - P9	Temp. Free programming	1.0	CW	CW	*Attention – decontamination of pocket: max. 1.5W / 15 sec per tooth*	1.00
	**Free Programming**					
	Free Programming	1.0	CW	CW	Output power depends on specific application. Always start with low power and increase if necessary.	1.00

All 36 Programs are programmable inside following parameter-sets:

Continuous mode: 0.01 - 7.0W (mean)
Pulse mode: 0.5 – 15.0W (pulse), 0.1-20.0 kHz, min. 17µs, 0.01 -5.1W (mean)

Program settings in Endodontics, Periodontics and Surgical Procedures will be reset to factory settings when entering the Stand-By Mode!

Claros

NO.	PROGRAM NAME	PULSE OUTPUT [W]	PULSE FREQUENCY [HZ]	PULSE DURATION [MS]	THERAPY	APP. TIME [S]	REMARK	MEAN OUTPUT [W]
	Surgery							
C 1	Surgery, general	50	20.000	15	-	-	High performance: Move fiber 400/600 relatively rapidly	15,00
C 2	Puncture abscess	10	20.000	20	L 6	-	200 µm, punct. max. penetration into the abscess	4,00
C 3	Aphtha	30	10.000	10	L 6	-	600 µm, move in a grid at a distance of approx. 1 mm	3,00
C 4	Hemostasis	50	12.000	10	-	-	600 µm, maintain distance of approx. 2 mm	6,00
C 5	Curettage	25	15.000	10	-	-	400/600 µm, remove granulation tissue	3,75
C 6	Epulides	30	13.330	10	L 6	-	400 µm, gigantocel-lularis, granulomatous, fibromatous, tauten tissue	4,00
C 7	Fibroma	40	12.500	10	L 6	-	400/600 µm, tauten tis-sue with surgical forceps	5,00
C 8	Frenectomy	50	12.000	10	L 6	-	600 µm, tauten tissue, loosen parallel to alveo-lar ridge, no sutures	6,00
C 9	Gingivectomy before impression	25	15.000	10	L 6	-	200/400/600 µm, increasing from anterior tooth to posterior molars	3,75
C10	Granuloma	40	12.500	10	L 6	-	400 µm, tauten tissue with surgical forceps	5,00
C11	Hemangioma	25	15.000	10	L 6	-	300/400 µm, remove in circular shape, no su-tures depending on size	3,75
C12	Hyperplasia	50	12.000	10	L 6	-	600 µm, move in a grid at a distance of approx. 1 mm	6,00
C13	Expose implant	15	15.000	10	L 6	-	600 µm, from center of screw outward, impression can be taken immediately	2,25
C14	Decontaminate implant	1,0	CW	CW	-	15	200/300 µm, Cover as many areas as possible while moving	1,00
C15	General bacteria reduction	1,0	CW	CW	-	15	200/300 µm, Cover as many areas as possible while moving	1,00

Claros

NO.	PROGRAM NAME	PULSE OUTPUT [W]	PULSE FREQUENCY [HZ]	PULSE DURATION [MS]	THERAPY	APP. TIME [S]	REMARK	MEAN OUTPUT [W]
	Surgery							
C16	Flap surgery	25	15.000	10	L 6	-	300 µm, surgical field remains visible and free of bleeding	3,75
C17	Periimplantitis, surgical	25	15.000	10	I 3	-	400/600 µm, for removing the granulation tissue, please have hygienist suction	3,75
C18	Specimen biopsy	30	13.330	10	L 6	-	400 µm, tauten tissue, wedge excision	4,00
C19	Retention cyst	30	13.330	10	L 6	-	300 µm, remove cyst, keeping as intact as possible	4,00
C20	Expose impacted teeth	25	15.000	10	L 6	-	400 µm, brackets adhere well because wound area is dry	3,75
C21	Edentulous ridge	50	12.000	10	L 6	-	600 µm, tauten tissue with surgical forceps	6,00
C22	Seeping hemor-rhage	50	12.000	10	L 6	-	600 µm, Distance approx 2 mm, formation of scab	6,00
C23	Sulcus preparation	30	13.330	10	L 6	-	300 µm, for anterior teeth, 400/600 µm for the molars	4,00
C24	Verrucae	25	15.000	10	L 6	-	300/400 µm, tauten tis-sue with surgical forceps	3,75
C25	Vestibuloplasty	25	15.000	10	L 6	-	400/600 µm, pull lip or cheek away and tauten tissue	3,75
C26	Root end resection	25	15.000	10	E 3	-	300/400 µm, excise granulation tissue, decontaminate at 200 µm	3,75

Claros

NO.	PROGRAM NAME	PULSE OUTPUT [W]	PULSE FREQUENCY [HZ]	PULSE DURATION [MS]	THERAPY	APP. TIME [S]	REMARK	MEAN OUTPUT [W]
	Implantology							
I 1	Frenectomy	50	12.000	10	L 6	-	600 µm, tighten tissue, loosen parallel to alveolar ridge, no sutures	6,00
I 2	Gingivectomy before impression	25	15.000	10	L 6	-	300/400/600 µm, increasing from anterior tooth to posterior molars	3,75
I 3	Decontaminate implant	1,0	CW	CW	-	15	200/300 µm, Cover as many areas as possible while moving	1,00
I 4	Expose implant	15	15.000	10	L 6	-	600 µm, from center of screw outward, impression can be taken immediately	2,25
I 5	Flap surgery	25	15.000	10	L 6	-	200 µm, surgical field remains visible and free of bleeding	3,75
I 6	Periimplantitis, surgical	25	15.000	10	I 3	-	400/600 µm for removing the granulation tissue, please have hygienist suction	3,75
I 7	Vestibuloplasty	25	15.000	10	L 6	-	400/600 µm, pull lip or cheek away and tauten tissue	3,75
	Periodontology							
P1	Pocket treatment	1,5	1.500	444	L6	-	T8 glass rod, right next to pockets, pain will subside	1,00
P 2	Gingivectomy, external	50	12.000	10	L 6	-	600 µm, tauten tissue if possible	6,00
P 3	Gingivectomy, internal	25	15.000	10	L 6	-	300/400/600 µm	3,75
P 4	Hyperplasia	50	12.000	10	L 6	-	600 µm, move in a grid at a distance of approx. 1 mm	6,00
P 5	Bacterial reduction in pockets	1,0	CW	CW	-	15	300 µm, cover as many areas as possible while moving	1,00
P 6	Remove concretions	-	-	-	-	-	We will be happy to advise you on the best attachments	-
P 7	Decontaminate membranes	1,0	CW	CW	-	15	300 µm	1,00
P 8	Open curettage	25	15.000	10	-	-	300/400/600 µm	3,75
P 9	Pocket reduction	25	15.000	10	L 6	-	300/400 µm	3,75

Claros

NO.	PROGRAM NAME	PULSE OUTPUT [W]	PULSE FREQUENCY [HZ]	PULSE DURATION [MS]	THERAPY	APP. TIME [S]	REMARK	MEAN OUTPUT [W]
	Endodontology							
E 2	Bacterial reduction in canal	1,5	CW	CW	-	15	200 µm, fiber as far toward apex as possible, circular up and down	1,50
E 3	Retrograde bacterial reduction	1,5	CW	CW	-	15	200 µm, try to reach all of the areas	1,50
E 4	Pulp capping	5	10.000	20	-	-	T4 immediate hemostasis, inhibits inflammation, promotes dentine formation	1,00
E 5	Sulcus preparation	30	13.330	10	L 6	-	200 µm, anterior teeth, increasing to 600 µm for posterior molars	4,00
	Hard tissue							
H 1	Bleaching	1,5	CW	CW	-	15	T8 Glss rod; always go over 2 teeth right over the gel	1,50
H 2	Decontamination of membranes	1,0	CW	CW	-	15	600 µm, if possible with contact	1,00
H 3	Implant decontamination	1,0	CW	CW	-	15	300/400 µm, if possible with contact	1,00
H 4	Cavity decontamination	1,0	CW	CW	-	15	600 µm, if possible with contact	1,00
H 5	Cavity preparation	-	-	-	-	-	We will be happy to advise you on the best attachments	-
H 6	Remove concretions	-	-	-	-	-	We will be happy to advise you on the best attachments	-
H 7	Hypersensitive teeth	1,5	CW	CW	-	15	T8 glass rod, Elmex fluid, if possible go over entire tooth	1,50
H 8	Tooth surface irradiation	1,5	CW	CW	-	15	600 µm, if possible with contact	1,50
H 9	Tooth stump sensitivity	1,5	100	3000	-	10	Use T8 glass rod, irradiate prior to seating the crown	0,45

Claros

NO.	PROGRAM NAME	PULSE OUTPUT [W]	PULSE FREQUENCY [HZ]	PULSE DURATION [MS]	REMARK	MEAN OUTPUT [W]
	Therapy					
L 1	Abscess matures develops fully	70	7000	100	T8, in a circular motion around the abscess, pain subsides, 2-4 treatments	3,5
L 2	Allergies to metals	20	3000	180	T8 go over entire area, allergy will subside after 3 treatments	1,8
L 3	Aphtha	60	1800	80	T4, go over directly if possible, aphtha will break down after 2 - 3 treatments	2,4
L 4	Decubital ulcer	70	3500	60	T4/T8, directly onto pressure point, pain will subside immediately	2,1
L 5	Pericoronitis	80	7000	90	T8, Inflammation will subside rapidly, 2-3 treatments	3,6
L 6	Post-extraction pain	60	8800	100	T4, into wound immediately after extraction, more rapid healing of wound	3
L 7	Gingivitis	60	2500	70	T4, Go over, seam, bleeding and pain will subside after 2-3 treatments	2,1
L 8	Granuloma	70	10000	80	T4, go over as close as possible, rapid heal-ing, 1-2 treatments	2,8
L 9	Hematoma	40	3500	90	T4, go over close, accelerated resorption, 1-2 treatments	1,8
L10	Herpes labialis	40	4000	90	T4, dry vesicles, tautness will subside after 2-3 treatments	1,8
L11	TMJ complaints	100	10000	60	T8, Pain will subside, but will not eliminate cause, 2 treatments	3
L12	Lockjaw	100	10000	60	T4, irradiate each side, hold directly on the joint	3
L13	Maxillary ostititis	90	8000	30	T8, post-extraction pain, irradiate entire surgery area, 2 treatments	1,35
L14	Smooth scars	100	8500	90	T8, depending on age of scar, 10-15 treat-ments	4,5
L15	Neuralgiform pain	60	7000	120	T4, place on suspected pain spot, usually provides immediate relief	3,6
L16	Edema	60	4000	120	T4, Tension subsides immediately, rapid resorption, 2-3 treatments	3,6
L17	Periodontosis, initial	80	10000	120	T4, irradiate diseased gingiva, 2-3 treat-ments	4,8
L18	Periodontitis, initial	60	6200	120	T4, irradiate as close to apex as possible	3,6
L19	Pulp capping	25	1500	90	T4, place directly on open spot, inhibits inflammation	1,125
L20	Pulpitis, initial	20	1000	80	T4, directly on the free pulp horn, touch the pulp	0,8
L21	General pain	50	9000	120	T4, hold as close as possible to center of pain	3

Claros

NO.	PROGRAM NAME	PULSE OUTPUT [W]	PULSE FREQUENCY [HZ]	PULSE DURATION [MS]	REMARK	MEAN OUTPUT [W]
	Therapy					
L22	Acid trauma	70	10000	120	T4, Irradiate gingiva bilaterally, complete alleviation of pain	4,2
L23	Abrasion trauma	70	10000	120	T4, hemostasis after 2 min, immediate improvement	4,2
L24	Sinusitis	20	9000	60	T4, prevents outbreak if applied early enough	0,6
L25	Stomatitis	20	2200	90	T4, rapid alleviation of inflammation, 5 treatments	0,9
L26	Healing of wounds	75	8000	120	T4, ATP process accelerated approximately 4-fold	4,5
L27	Suppress gag reflex	60	1800	70	T4, irradiate KG24 and LG25 directly, helps for approx. 20 min.	2,1
L28	Root end resection - wound treatment	30	3500	120	T4, place directly in apex region, avoids edema	1,8

Duros / Delos

NO.	PROGRAM NAME	PULSE OUTPUT [W]	PULSE FREQUENCY [HZ]	PULSE DURATION [MS]	THERAPY	APP. TIME [S]	REMARK	MEAN OUTPUT [W]
	Surgery							
C 1	Surgery, general	50	20.000	15	-	-	High performance: Move fiber 400/600 relatively rapidly	15,00
C 2	Puncture abscess	10	20.000	20	L 6	-	200 µm, punct. max. penetration into the abscess	4,00
C 3	Aphtha	30	10.000	10	L 6	-	600 µm, move in a grid at a distance of approx. 1 mm	3,00
C 4	Hemostasis	50	12.000	10	-	-	600 µm, maintain distance of approx. 2 mm	6,00
C 5	Curettage	25	15.000	10	-	-	400/600 µm, remove granulation tissue	3,75
C 6	Epulides	30	13.330	10	L 6	-	400 µm, gigantocel-lularis, granulomatous, fibromatous, tauten tissue	4,00
C 7	Fibroma	40	12.500	10	L 6	-	400/600 µm, tauten tis-sue with surgical forceps	5,00
C 8	Frenectomy	50	12.000	10	L 6	-	600 µm, tauten tissue, loosen parallel to alveo-lar ridge, no sutures	6,00
C 9	Gingivectomy before impression	25	15.000	10	L 6	-	200/400/600 µm, increasing from anterior tooth to posterior molars	3,75
C10	Granuloma	40	12.500	10	L 6	-	400 µm, tauten tissue with surgical forceps	5,00
C11	Hemangioma	25	15.000	10	L 6	-	300/400 µm, remove in circular shape, no su-tures depending on size	3,75
C12	Hyperplasia	50	12.000	10	L 6	-	600 µm, move in a grid at a distance of approx. 1 mm	6,00
C13	Expose implant	15	15.000	10	L 6	-	600 µm, from center of screw outward, impression can be taken immediately	2,25
C14	Decontaminate implant	1,0	CW	CW	-	15	200/300 µm, Cover as many areas as possible while moving	1,00
C15	General bacteria reduction	1,0	CW	CW	-	15	200/300 µm, Cover as many areas as possible while moving	1,00

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NO.	PROGRAM NAME	PULSE OUTPUT [W]	PULSE FREQUENCY [HZ]	PULSE DURATION [MS]	THERAPY	APP. TIME [S]	REMARK	MEAN OUTPUT [W]
	Surgery							
C16	Flap surgery	25	15.000	10	L 6	-	300 µm, surgical field remains visible and free of bleeding	3,75
C17	Periimplantitis, surgical	25	15.000	10	I 3	-	400/600 µm, for removing the granulation tissue, please have hygienist suction	3,75
C18	Specimen biopsy	30	13.330	10	L 6	-	400 µm, tauten tissue, wedge excision	4,00
C19	Retention cyst	30	13.330	10	L 6	-	300 µm, remove cyst, keeping as intact as possible	4,00
C20	Expose impacted teeth	25	15.000	10	L 6	-	400 µm, brackets adhere well because wound area is dry	3,75
C21	Edentulous ridge	50	12.000	10	L 6	-	600 µm, tauten tissue with surgical forceps	6,00
C22	Seeping hemorrhage	50	12.000	10	L 6	-	600 µm, Distance approx 2 mm, formation of scab	6,00
C23	Sulcus preparation	30	13.330	10	L 6	-	300 µm, for anterior teeth, 400/600 µm for the molars	4,00
C24	Verrucae	25	15.000	10	L 6	-	300/400 µm, tauten tissue with surgical forceps	3,75
C25	Vestibuloplasty	25	15.000	10	L 6	-	400/600 µm, pull lip or cheek away and tauten tissue	3,75
C26	Root end resection	25	15.000	10	E 3	-	300/400 µm, excise granulation tissue, decontaminate at 200 µm	3,75

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NO.	PROGRAM NAME	PULSE OUTPUT [W]	PULSE FREQUENCY [HZ]	PULSE DURATION [MS]	THERAPY	APP. TIME [S]	REMARK	MEAN OUTPUT [W]
	Implantology							
I 1	Frenectomy	50	12.000	10	L 6	-	600µm,tighten tissue, loosen parallel to alveolar ridge,no sutures	6,00
I 2	Gingivectomy before impression	25	15.000	10	L 6	-	300/400/600 µm, increasing from anterior tooth to posterior molars	3,75
I 3	Decontaminate implant	1,0	CW	CW	-	15	200/300 µm, Cover as many areas as possible while moving	1,00
I 4	Expose implant	15	15.000	10	L 6	-	600 µm, from center of screw outward, impression can be taken immediately	2,25
I 5	Flap surgery	25	15.000	10	L 6	-	200 µm, surgical field remains visible and free of bleeding	3,75
I 6	Periimplantitis, surgical	25	15.000	10	I 3	-	400/600 µm for removing the granulation tissue, please have hygienist suction	3,75
I 7	Vestibuloplasty	25	15.000	10	L 6	-	400/600 µm, pull lip or cheek away and tauten tissue	3,75
I 8	Combination Periimplantitis	-	-	-	-	-	1. Biofilm Reduction 2. Periimplantitis, surgical	-
	Periodontology							
P1	Pocket treatment	1,5	1.500	444	L6	-	T8 glass rod, right next to pockets, pain will subside	1,00
P 2	Gingivectomy, external	50	12.000	10	L 6	-	600 µm, tauten tissue if possible	6,00
P 3	Gingivectomy, internal	25	15.000	10	L 6	-	300/400/600 µm	3,75
P 4	Hyperplasia	50	12.000	10	L 6	-	600 µm, move in a grid at a distance of approx. 1 mm	6,00
P 5	Bacterial reduction in pockets	1,0	CW	CW	-	15	300 µm, cover as many areas as possible while moving	1,00
P 6	Decontaminate membranes	1,0	CW	CW	-	15	300 µm	1,00
P 7	Open curettage	25	15.000	10	-	-	300/400/600 µm	3,75
P 8	Pocket reduction	25	15.000	10	L 6	-	300/400 µm	3,75

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NO.	PROGRAM NAME	PULSE OUTPUT [W]	PULSE FREQUENCY [HZ]	PULSE DURATION [MS]	THERAPY	APP. TIME [S]	REMARK	MEAN OUTPUT [W]
	Endodontology							
E 2	Bacterial reduction in canal	1,5	CW	CW	-	15	200 µm, fiber as far toward apex as possible, circular up and down	1,50
E 3	Retrograde bacterial reduction	1,5	CW	CW	-	15	200 µm, try to reach all of the areas	1,50
E 4	Pulp capping	5	10.000	20	-	-	T4 immediate hemos-tasis, inhibits inflamma-tion, promotes dentine formation	1,00
E 5	Sulcus preparation	30	13.330	10	L 6	-	200 µm, anterior teeth, increasing to 600 µm for posterior molars	4,00
	Hard tissue							
H 1	Biofilm Reduction	100 mJ	10	300	-	60	1200 µm - irradiation of large areas under perma-nent movement	1,00
H 2	Cavity-Preparation,	100 mJ	20	50	-	-	Low pulse energy, 800 µm	2,00
H 3	Cavity-Prepara-tion, Dentin	250 mJ	20	200	-	-	Medium pulse energy, 800 µm	5,00
H 4	Cavity-Preparation, Enamel	400 mJ	20	300	-	-	High pulse energy, 800 µm	8,00
H 5	Caries Excavation, near pulp	100 mJ	15	200	-	-	Low pulse energy, 400 µm	1,50
H 6	Caries Excavation, Dentin	150 mJ	20	200	-	-	Medium pulse energy 800 µm	3,00
H 7	Caries Excavation, Enamel	250 mJ	20	200	-	-	High pulse energy, 800 µm	5,00
H 8	Concrement removal, closed pocket	50 mJ	10	200	-	-	Paro Tip	0,50
H 9	Concrement removal, open pocket, standard	75 mJ	15	200	-	-	Paro Tip Caution! Only open pocket!	1,08
H 10	Concrement removal, open pocket, strong	100 mJ	15	300	-	-	Paro Tip Caution! Only open pocket!	1,50
H11	Open fissure, enamel	400 mJ	20	300	-	-	Preparation in Enamel, 800µm	0,50
H12	Root End Surgery, Bone	250 mJ	20	200	-	-	Ablation of bone tissue, 800 µm	5,00
H13	Crown extens., Bone removal	250 mJ	20	200	-	-	Ablation of bone tissue 800 µm	5,00

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NO.	PROGRAM NAME	PULSE OUTPUT [W]	PULSE FREQUENCY [HZ]	PULSE DURATION [MS]	THERAPY	APP. TIME [S]	REMARK	MEAN OUTPUT [W]
	Hard tissue							
H14	Bone ablation	250 mJ	20	200	-	-	Ablation of bone tissue 800 µm	5,00
H15	Root End Resection	250 mJ	20	200	-	-	Removal of root end, 800 µm	5,00
H16	Veneer removal	250 mJ	20	200	-	-	Caution! Veneer can be damaged800 µm	5,00
H17	Empty spray water lines	-	-	-	-	-	Removal of water bottle. Press footswitch until spray lines are empty.	0,00
H18	Retained tooth - hard tissue	250 mJ	20	200			Ablation of hard tissue, 800µm	5,00
H19	Displaced tooth – hard tissue	250 mJ	20	200			Ablation of hard tissue,800 µm	5,00
H20	Adhesive tech., Bracket/Retainer	100 mJ	20	100			Preparation of tooth surface, 1200µm	2,00
H21	Conditioning, Dentin	100 mJ	10	150			800µm	1,00
H22	Conditioning, Enamel	150 mJ	10	150			800µm	1,50
H23	Combi. program fissure-sealing	-	-	-	-	-	1.Cavity Preparation, near pulp 2.Cavity decontamination	
H24	Combi. Perio program	-	-	-	-	-	1. Concrem. removal,closed pocket 2. Bacterial reduction in pockets	
H25	Odontoplastic/ Directveneer	100 mJ	20	100			Tooth surface preparation 1200µm	2,00
H26	Hypersensitive teeth	1,5 W	CW	CW	-	15	T8 glass rod, Elmex fluid, if possible go over entire tooth	1,50
H27	Tooth surface ir-radiation	1,5 W	CW	CW	-	15	600 µm, if possible with contact	1,50
H28	Tooth stump sensitivity	1,5 W	100	3000	-	10	Use T8 glass rod, irradiate prior to seating the crown	0,45
H29	Bleaching	1,5 W	CW	CW	-	15	T8 Glass rod; always go over 2 teeth right over the gel	1,50
H30	Dekontamination von Membranen	1,0 W	CW	CW	-	15	600 µm, if possible with contact	1,00
H31	Implantat- Dekon-taminationen	1,0 W	CW	CW	-	15	300/400 µm, if possible with contact	1,00
H32	Cavity decontami-nation	1,0 W	CW	CW	-	15	600 µm, if possible with contact	1,00

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NO.	PROGRAM NAME	PULSE OUTPUT [W]	PULSE FREQUENCY [HZ]	PULSE DURATION [MS]	REMARK	MEAN OUTPUT [W]
	Therapy					
L 1	Abscess matures develops fully	70	7000	100	T8, in a circular motion around the abscess, pain subsides, 2-4 treatments	3,5
L 2	Allergies to metals	20	3000	180	T8 go over entire area, allergy will subside after 3 treatments	1,8
L 3	Aphtha	60	1800	80	T4, go over directly if possible, aphtha will break down after 2 - 3 treatments	2,4
L 4	Decubital ulcer	70	3500	60	T4/T8, directly onto pressure point, pain will subside immediately	2,1
L 5	Pericoronitis	80	7000	90	T8, Inflammation will subside rapidly, 2-3 treatments	3,6
L 6	Post-extraction pain	60	8800	100	T4, into wound immediately after extraction, more rapid healing of wound	3
L 7	Gingivitis	60	2500	70	T4, Go over, seam, bleeding and pain will subside after 2-3 treatments	2,1
L 8	Granuloma	70	10000	80	T4, go over as close as possible, rapid healing, 1-2 treatments	2,8
L 9	Hematoma	40	3500	90	T4, go over close, accelerated resorption, 1-2 treatments	1,8
L10	Herpes labialis	40	4000	90	T4, dry vesicles, tautness will subside after 2-3 treatments	1,8
L11	TMJ complaints	100	10000	60	T8, Pain will subside, but will not eliminate cause, 2 treatments	3
L12	Lockjaw	100	10000	60	T4, irradiate each side, hold directly on the joint	3
L13	Maxillary ostititis	90	8000	30	T8, post-extraction pain, irradiate entire surgery area, 2 treatments	1,35
L14	Smooth scars	100	8500	90	T8, depending on age of scar, 10-15 treatments	4,5
L15	Neuralgiform pain	60	7000	120	T4, place on suspected pain spot, usually provides immediate relief	3,6
L16	Edema	60	4000	120	T4, Tension subsides immediately, rapid resorption, 2-3 treatments	3,6
L17	Periodontosis, initial	80	10000	120	T4, irradiate diseased gingiva, 2-3 treatments	4,8
L18	Periodontitis, initial	60	6200	120	T4, irradiate as close to apex as possible	3,6
L19	Pulp capping	25	1500	90	T4, place directly on open spot, inhibits inflammation	1,125
L20	Pulpitis, initial	20	1000	80	T4, directly on the free pulp horn, touch the pulp	0,8
L21	General pain	50	9000	120	T4, hold as close as possible to center of pain	3

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NO.	PROGRAM NAME	PULSE OUTPUT [W]	PULSE FREQUENCY [HZ]	PULSE DURATION [MS]	REMARK	MEAN OUTPUT [W]
	Therapy					
L22	Acid trauma	70	10000	120	T4, Irradiate gingiva bilaterally, complete alleviation of pain	4,2
L23	Abrasion trauma	70	10000	120	T4, hemostasis after 2 min, immediate improvement	4,2
L24	Sinusitis	20	9000	60	T4, prevents outbreak if applied early enough	0,6
L25	Stomatitis	20	2200	90	T4, rapid alleviation of inflammation, 5 treatments	0,9
L26	Healing of wounds	75	8000	120	T4, ATP process accelerated approximately 4-fold	4,5
L27	Suppress gag reflex	60	1800	70	T4, irradiate KG24 and LG25 directly, helps for approx. 20 min.	2,1
L28	Root end resection - wound treatment	30	3500	120	T4, place directly in apex region, avoids edema	1,8

Notes

powered by technology

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