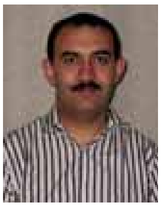

Munther Sulieman

An Overview of the Use of Lasers in General Dental Practice: 2. Laser Wavelengths, Soft and Hard Tissue Clinical Applications

Abstract: The profession now benefits from many different laser wavelengths that enable their use in nearly every dental specialty. This article will cover these wavelengths and their uses for soft and hard tissue procedures.

Clinical Relevance: There are many laser wavelengths available but their use within dentistry is quite tissue specific. It is hoped the reader will be able to decide which wavelength is best for a particular procedure.

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In 1990 the first laser, the dLase 300 (American Dental Lasers, Corpus Christi, TX 78405, USA), designed for dental use, was introduced to the profession. It was a Nd:YAG (Neodymium: Yttrium Aluminum Garnet) laser which promised a lot but delivered very little. It was to revolutionize dentistry, with headlines in the dental press signalling the end of the dental drill, but it operated at a wavelength poorly absorbed by hard tissue and produced little or no effect on it.

Since the introduction of the first dental laser, the profession has benefited from the addition of many different laser wavelengths that enable their use in nearly every dental specialty. This article will cover these wavelengths and their uses for soft and hard tissue procedures. Table 1 shows the laser wavelengths available to dentistry.

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Hard tissue interactions

The optical properties of dental hard tissues in terms of their absorption, transmission, reflection and scattering of various laser wavelengths dictates the effect the laser wavelength will produce on the tissue.[1,2] The absorption and transmission of laser light on human teeth is mainly dependent on the wavelength of the laser light.[3] Generally, laser wavelengths emitted in the UV range of the spectrum are well absorbed, while those emitted in the mid-infrared show quite a range of different absorption capabilities for water and hydroxyapatite (HA) found in hard tissues.

Photothermal and thermomechanical interactions of laser light and hard tissues have been investigated widely[4] for many different wavelengths possibly useful in dentistry. These include:

- Erbium: Yttrium Aluminium Garnet (YAG, 2940 nm);
- Erbium chromium: Yttrium Scandium Gallium Garnet (YSGG, 2790 nm);
- Neodymium: YAG (1064 nm);
- CO_2 (10600 nm); and
- Excimer (193 nm and 308 nm) lasers.

Undesirable thermal effects to the surrounding area of irradiated tissue can cause zones of carbonization, necrosis and thermally induced cracks, especially in enamel where the content of water is low compared to that in dentine.

Erbium: YAG (2940 nm)/Erbium chromium:YSGG (2790 nm) wavelengths have the highest absorption in water and have a very high affinity for hydroxyapatite (HA), though the Erbium is 20% better absorbed than Erbium chromium. These wavelengths have similar properties, hence will be discussed together. Water molecules within the various components of dental tissues absorb these wavelengths. These water molecules are heated and steam pressure builds up before they are vaporized. This explosive expansion takes

Laser Wavelengths (nm)	Absorption	Dental Use
Argon (488 nm and 514 nm)	Red pigment/ Camphoroquinone	Soft tissue (excellent haemostatic ability)/ Curing composite/Power bleaching
Diode* (810–830 nm and 980 nm)	Pigment	Soft tissue including periodontal and endodontic procedures (reasonable haemostatic ability)/Power bleaching
Nd:YAG* (1064 nm)	Pigment	Soft tissue including periodontal and endodontic procedures (reasonable haemostatic ability)
Er,Cr:YSGG (2790 nm)	Water	Hard tissue/limited soft tissue procedures (poor haemostatic ability)
Er:YAG (2940 nm)	Water (highest absorption)	Hard Tissue/limited soft tissue procedures (poor haemostatic ability)
Carbon Dioxide (10600 nm)	Water	Soft tissue (excellent haemostatic ability)
* Other wavelengths within this media type are available.		

Table 1. Laser wavelengths available to dentistry, their use and absorption.

with it the surrounding hydroxyapatite (HA). The process takes place in thin layers on the tissue surface creating holes or craters where the HA has been vaporized. This thermo-mechanical effect is very efficient and all the laser energy is used to heat up and vaporize the water; there is very little if any energy left over to cause a heating effect on the tooth. Nonetheless, a water/air spray is used for cooling with the laser system. The application of an air/water spray has been found to provide adequate protection to the pulp equivalent to that of the common dental drill.[5,6] The use of the water/air spray with this laser wavelength has a number of functions:

- It has a cooling effect on the dental pulp;
- It helps wash away debris from the removal of old filling materials;
- It assists the lasing process by lubricating and keeping the area moist, preventing drying especially in enamel;
- The water spray absorbs laser energy and then makes the lasing process more efficient by vaporizing or exploding on the surface thereby taking any loosely adherent HA crystals away with it.

Nd: YAG at 1064 nm is poorly absorbed by both water and HA, making it very poor at hard tissue removal. Moreover, its high absorption by pigmented tissue means that, even at low power densities, it diffuses deeply through enamel and dentine finally to heat up the pulp with zones of debris and carbonization in the surrounding area of dentine.

Continuous wave CO_2 lasers cause structural changes and damage in hard tissues with zones of carbonization, necrosis and microcracks. However, when used in pulsed mode, and there is reduction of heat diffusion to the surrounding area, the damage zones of carbonization and necrosis are greatly reduced. In fact, CO_2 at a wavelength of 9300 nm is undergoing research and shows properties and hard tissue cutting ability similar to, if not better than, Erbium:YAG lasers.

Different wavelengths of excimer lasers have been researched for cutting hard tissue. The 193 nm ArF excimer showed great promise without pathological hard tissue changes to the area irradiated and no zones of damage to the surrounding area. This is probably owing to high absorbency of this wavelength in a very small area of tissue producing a thermal microexplosive effect and leading to mechanical destruction of the surrounding hard tissue. The process occurs in a very small area and is very efficient, leaving very little redundant energy to cause thermal injuries. Unfortunately, this wavelength shows very low effectiveness compared to conventional burs in cutting hard tissues.

The use of lasers in dentistry

The use of lasers in dental practice has steadily increased since their introduction in 1990 and has been gaining great momentum in the past few years with the development of even more highly efficient, less expensive devices. Lasers can now be used alongside conventional techniques to simplify certain procedures or to save time in others. Lasers can also be used as a replacement for conventional techniques and have enabled the clinician to carry out techniques that would not be possible using conventional methods. Finally, lasers have a very important beneficial role in practice marketing, this being especially relevant in today's competitive environment. Table 2 shows a summary of clinical uses with various laser wavelengths currently available.

Soft tissue lasers

The main beneficial effect of laser energy is absorption of the light by the target tissue and the transfer of this laser energy, thus causing a tissue interaction or photobiological effect. Absorption and specific tissue components were discussed in the first article of this series. Soft tissue lasers produce their effect by being highly absorbed by the water content, as in the case of the CO_2 laser, or the degree of pigmentation present in the tissue, as

CLINICAL APPLICATIONS	Er:YAG/Er,Cr:YSGG	CO_2	Diode	Nd:YAG	Argon
Soft Tissue					
Pre-impression troughing		****	****	****	****
Gingevectomy/gingivoplasty	*	****	***	***	****
Frenectomy		****	****	***	****
Operculectomy		****	***	***	***
Crown lengthening	*	****	***	***	***
Biopsy		****	***	***	***
Exposing unerupted teeth or decay	*	****	****	****	****
Implant exposure		**	****	**	***
Tuberosity reduction		****	*	*	*
Periodontal/endodontic disinfection	**	***	****	****	****
Incision/excision procedures		****	***	***	****
Treatment of leukoplakia		****	*	*	*
Hard Tissue					
Caries removal	****				
Cavity preparation	****				
Enamel etching/Preventive resin restorations	****				
Apicectomy	****				
Root amputations/ hemi sections and surgical extractions	****				
Tooth whitening			****		****
* Limited use ** Good *** Better **** Excellent for the chosen procedure.					

Table 2. Clinical applications with currently available dental laser wavelengths.

with Argon, Diode and Nd:YAG lasers. This means that the CO_2 laser energy is absorbed very efficiently by tissue fluids and has little penetration beyond the surface.[7] On the other hand, water is comparatively transparent to the emission of the Nd:YAG laser, which accounts for its tendency to penetrate deeper into tissue.

The CO_2 laser (10600 nm) has been used in general medicine for soft tissue surgery for approximately 40 years[8] and can be considered the gold standard in soft tissue surgery for the following reasons:

- A very rapid though shallow penetration of the tissue (0.1 mm).
- A very good haemostatic ability coagulating vessels of up to 0.5 mm in diameter as it cuts and up to 2 mm in diameter when used in de-focused mode.

With the CO_2 laser, wavelength cells are ablated layer by layer with the vaporization of the soft tissue's water content. (Ablation is another term for the vaporization or painting away of cells layer by layer.)

The power setting, the handpiece used as well as the speed of movement, can control this interaction and therefore the effect across the tissue. Higher powers set using the control panel means greater vaporization of the tissues.

There are many different types of handpieces used, depending on the application: focused handpieces focus the laser energy and are primarily used in a non-contact manner for cutting soft tissues in place of a scalpel; collimated or non-focused handpieces vaporize and do not incise tissue away. The dwell time on a tissue determines the power density; moving quickly across a tissue will mean lower power and the degree of cutting/ vaporization will be less, while remaining on the same spot will cut deeper and deeper into the tissue.

The use of this laser has many advantages in periodontology, including reduction of periodontal probing depths using an epithelial exclusion technique and enhancing guided tissue regeneration, as well as surgical periodontal procedures.

Carbon dioxide lasers have the following advantages compared to conventional surgical procedures using a scalpel:

- Reduced mechanical trauma;
- Minimal post-operative swelling and scarring;
- Minimal post-operative pain;
- A relatively dry bloodless surgical field.[9]

However, all lasers produce a small zone of coagulated tissue layer along the walls of the incision and produce a small degree of vaporization with surrounding thermal necrosis.[7]

The Argon laser is fibre-optically delivered in continuous wave and gated pulsed modes, with two emission wavelengths both of which are visible to the human eye. The 488 nm (blue colour) emission is the wavelength needed to activate camphoroquinone, the most commonly used photo-initiator that causes polymerization of the resin in composite materials. The Argon laser used in non-contact mode for this purpose results in a much shorter curing time compared to conventional dental lights, with the advantage of having more complete cure of the material. In addition to this, the Argon laser is used to accelerate power bleaching by being absorbed by dyes within the bleaching gel and causing a slight heating effect of the gel which promotes the breakdown of more reactive oxygenating perhydroxyl free radicals.

The 514 nm (blue green) wavelength has its peak absorption in red pigment. Therefore, tissues containing haemoglobin and melanin will readily interact with this laser. It is a very useful surgical laser with excellent haemostatic capabilities. Used in contact with the tissue, treatment of acute inflammatory periodontal disease and highly vascularized lesions, such as a haemangioma, would be ideally suited to the Argon laser.[10]

Diodes (800 nm to 980 nm) are solid-state semiconductor lasers that use some combination of Aluminium, Gallium and Arsenide to change electrical energy into light energy. Diodes deliver laser energy fibre-optically in continuous wave and gated pulsed modes in semi-contact with the tissue. All of the diode wavelengths are well absorbed by pigmented tissue, although haemostasis is not quite as good as with the Argon laser. Like the Argon laser, diodes are relatively poorly absorbed by tooth structure so that soft tissue surgery can be safely performed in close proximity to teeth. The diode is an excellent soft tissue surgical laser, and indicated for cutting and coagulating gingiva and mucosa and for soft tissue curettage, or sulcular debridement. Care must be taken when using the continuous emission mode because of the rapid thermal increase in the target tissue. The main advantage of a diode laser is a smaller size, compact, reliable and relatively cheap laser unit; this laser would probably find widest use in general practice. These lasers entered dental use in 1995[11] and their bactericidal effect in root canals and periodontal pockets are well documented.[12-14]

The Nd:YAG laser has a solid crystal of Yttrium Aluminium Garnet doped with Neodymium, and is fibre-optically delivered in a free-running pulsed mode, used most often in contact with the tissue. As with the diodes, the Nd:YAG fibre is usually used bare-ended, in contact with the tissue, but needs to be cleaved and cleaned, otherwise the laser light will rapidly lose its effectiveness. When used in a non-contact, defocused mode, this wavelength can penetrate several millimetres into soft tissue, which can be used advantageously for delivering the laser energy to the inner surface of, for example, an ulcerated lesion. Transmission of this laser wavelength, like diodes, can be beneficial in having a bactericidal effect in accessory and lateral root canals. It is highly absorbed by pigmented tissue allowing use for clinical applications such as cutting and coagulating soft tissues with a good haemostatic ability. The free-running pulse mode also allows the clinician to treat very thin tissue with a reduction in heat build-up in the surrounding area. Nd:YAG laser energy is slightly absorbed by dental hard tissue, but there is little interaction with sound tooth structure, allowing tissue surgery adjacent to the tooth to be safe and precise. However, the laser beam must not be directed straight at the tooth to avoid pulpal damage caused by absorption of this energy by haemoglobin.

Hard tissue lasers

The Erbium:YAG has an active medium of a solid crystal of Yttrium Aluminum Garnet doped with Erbium, while the crystal in Erbium Chromium: YSGG is Yttrium Scandium Gallium Garnet doped with Erbium and Chromium. The Erbium:YAG wavelength is delivered in a free-running pulse mode via an articulated arm or hollow waveguide, while the Erbium Chromium:YSGG is delivered fibre-optically.

The Erbium Chromium:YSGG laser is reported to utilize the concept of accelerated water from the dental laser unit and hydrokinetic effect to enhance the laser's ability to cut hard tissue.[15] This theory has, however, been disproved by many studies[16,17] and, in fact, the mechanism of action of this laser wavelength is the same as the Erbium:YAG described above but is less efficient at hard tissue removal owing to slightly less absorption of this wavelength in water.

These lasers, introduced in 1997,[18] are routinely used for caries removal and cavity preparation with preferential removal of caries owing to the increased water content compared to sound tooth structure. These lasers can also be used in soft tissue procedures without the use of the water spray and with lower energies, but haemostasis is limited as water vaporization only occurs superficially without the deep penetration of heat to cause vessel shrinkage. They are especially useful in removing slightly subgingival decay and recontouring the gingiva at the same time.

A tooth surface fluoresces when irradiated by a light of given wavelength. This laser-induced fluorescence interaction is used to diagnose dental decay by a diode laser of 652 nm wavelength (*Diagnodent*, Kavo UK Ltd, Amersham, Bucks).

The removal of dental calculus using lasers was first suggested using Nd:YAG lasers but this was not considered useful. Erbium and Holmium YAG lasers were then investigated for this purpose but there was a risk of inadvertent laser-etching of the root surface in subgingival areas. Recently, with the introduction of the advanced *KEY 3* laser system (Kavo UK Ltd, Amersham, Bucks) combining laser-induced fluorescence with Er:YAG, calculus removal is possible without risk of laser etching as the diagnostic fluorescence feedback system ensures the Er:YAG laser is inactivated once the calculus is removed.

Caries prevention using lasers has involved various continuous wave and pulsed lasers being used *in vitro* to alter the surface of the enamel, making it more resistant to chemical attack by acids. The mechanism of action seems to involve the vaporization of the organic component and melting or fusing of the inorganic component of enamel, producing a less porous surface more resistant to demineralization by acids.[19] Other modes of action have concentrated on trying to increase the uptake of fluoride into teeth using CO_2 lasers.[20]

Lasers vs scalpels

Lasers are routinely used to perform what would normally be

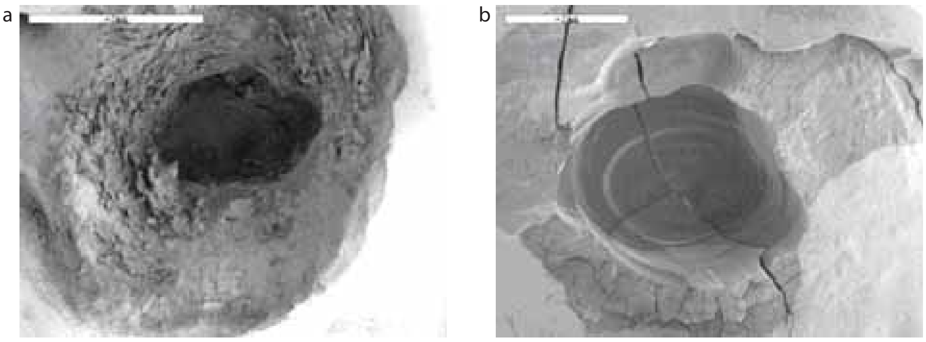

Figure 1. Scanning electron microscope view of: **(a)** laser cut enamel; **(b)** conventional cut enamel using air rota.

done using a scalpel but with important differences. The ability to provide complete haemostasis, or at least reduced bleeding using lasers, is probably the most obvious difference between the two instruments. The loss of tactile feedback as provided by a scalpel has been partially resolved with newer semi-contact diode lasers that are used much like a scalpel but with a feather touch.

When used at high powers, continuous wave lasers cut smoothly through soft tissues much like a scalpel, but pulsed lasers with a low pulse rate provide a rougher cutting action. However, at higher powers with a high enough pulse rate, the pulsed lasers provide a good smooth cut. In general, scalpel cuts are faster than lasers but the improved vision provided by a relatively dry surgical field makes the use of lasers an attractive proposition for the clinician.

Shallow penetration of laser energy due to high absorption by chromophores in tissue results in increased surgical precision because there is a very thin zone of collateral thermal injury at cut tissue edges. However, high laser energies, especially from pulsed lasers, may cause inadvertent thermal necrosis and photoacoustic damage to the surrounding area, thereby reducing the precision of the cut. In these situations, there is delayed healing time and a slightly increased risk of post-operative infection, but this is not normally considered clinically relevant. When used in focus mode, laser energy at maximum power density is directed on a small spot which incises the tissue because there is rapid tissue vaporization. Beyond this focal point, the laser beam diverges and moving the laser handpiece either towards or away from this point has important clinical implications. By pulling the handpiece back from the tissue, the laser beam is defocused, with the resultant lower power density produced giving rise to coagulation rather than incision. Pre-focusing the beam can result in deep thermal damage to the tissue and should be avoided. Many manufacturers have addressed this by incorporating a focusing beam alongside the main laser beam, or by placing a focal point guide that enables the clinician to keep a certain distance from the tissue to avoid deep thermal damage.

Lasers vs conventional drill

Lasers used to remove hard tissue such as enamel and dentine do so in a totally different manner to conventional dental burs (Figure 1). The mechanism of action involves the vaporization of water molecules within these tissues and this explosive mechanism takes with it the surrounding hard tissue, leaving a small crater behind. This process is slower than the use of conventional burs that cut faster and in more than one direction, providing a lateral as well as an end cutting action. Laser light is monochromatic providing a unidirectional end cut without the lateral cutting element. In addition, the laser energy only penetrates to a depth of less than 0.01 mm into the tooth surface, having quite a superficial effect. Obviously, increasing the laser energy and pulse rates used will provide faster cutting with the laser, but at the expense of control to the operator who does not have tactile feedback and relies on direct vision and sound for feedback. The risk of photoacoustic damage to surrounding areas is also increased, resulting in microfractures much the same as those seen with the use of burs under scanning electron microscopy, which may not be clinically significant.

Another difference between the two modalities of treatment is that a laser is used in a slow deliberate motion, with the beam perpendicular to the tooth surface where it will cut deeper, as opposed to fast lateral movements with burs providing better cuts.

Soft tissue clinical applications

As mentioned above, lasers can be used for conventional surgery much like standard mechanical instruments. Lasers are used to ablate tissue, as with a curette, or to incise, excise, resect, dissect, or amputate tissue, as one would use a scalpel.

Generally, lasers can replace the scalpel for all soft tissue surgery and can also be used uniquely in place of other conventional dental techniques that involve the soft tissues.

Pre impression troughing procedures

Lasers can be used in place of retraction cord with haemostatic agents prior to taking impressions and provide very accurate margins of preparation as their haemostatic effect seals the margin, thereby sealing all sources of fluid and bleeding. Unlike electrosurgery, which may cause unwanted shrinkage of tissue after troughing, lasers do not cause post-operative exposure of finishing lines. In fact, laser radiated tissue has the ability to 'bounce back' slightly after troughing as the laser works by dehydrating the tissue when used at low power settings. This leads to a dry sulcus as the crevicular fluid is dehydrated away along with a thin portion of the inner epithelial lining of the pocket, creating sufficient space for injection of the impression material in the sulcus. When the tissue rehydrates, the sulcular tissues 'bounce back' to a natural form.[9]

Gingivectomy, gingivoplasty and other periodontal procedures

Lasers can be used to ablate large areas of gingival proliferation in a

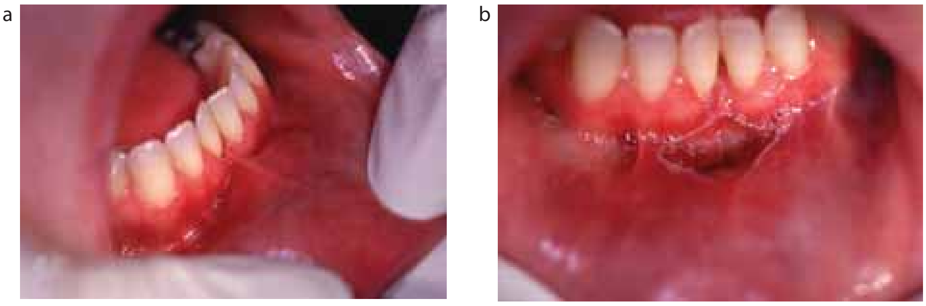

Figure 2. Frenectomy using a carbon dioxide laser: **(a)** pre-operative view; **(b)** post-operative view showing diamond-shaped surgical wound.

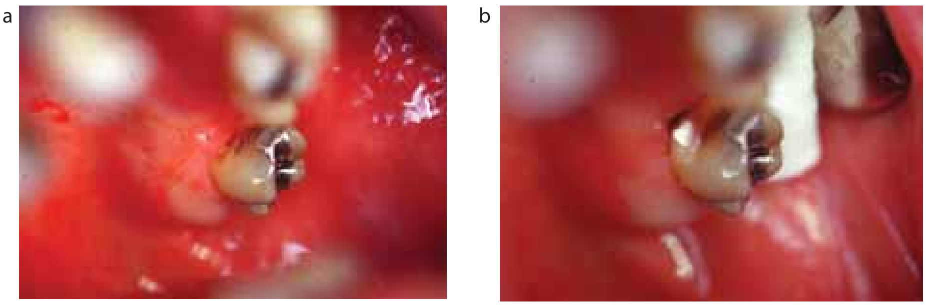

Figure 3. Exposure of sub-gingival decay using a diode laser: **(a)** pre-operative view; **(b)** post-operative view following exposure and removal of decay and placement of a lining into the cavity.

totally bloodless manner thereby enabling the operator to perform bulk reduction of the gingivae precisely and quickly. Similarly, the many different types of handpieces available enable very extensive recontouring of the gingivae, especially used in aesthetic dentistry. Lasers are recognized as a very good treatment option for early intervention in periodontal disease used alongside conventional treatments, not as a replacement for them. They can slow or stop the progression of the disease by their bactericidal effect and can be a kinder option to conventional periodontal surgery. That is, they sterilize the periodontal pockets by vaporizing the bacterial population in the pocket and any necrotic tissue present, thereby leading to reduction of pocket depths over several weeks of healing.

Frenectomy

Both maxillary and mandibular frenae are frequently cut using lasers in a bloodless manner to produce a diamond-shaped wound, which is not sutured afterwards. Instead, the laser is used in a de-focused mode to apply a slight carbonized layer to the surface of the wound which serves two purposes, one to prevent the incised tissue from re-apposing, and to act as an alternative to a conventional dressing (Figure 2).

Operculectomy

Soft tissue is either excised or vaporized away from areas where operculums surround the tooth surface, such as around wisdom teeth.

Crown lengthening

Crown lengthening with a laser can give very good results in terms of very little recession of the margin post-operatively. Different precautions are taken to protect the tooth during the procedure, depending on the type of laser used. For example, with a carbon dioxide laser the tooth surface can be protected using a metal instrument with a dulled surface.

Biopsy

Both incisional and excisional biopsies can be performed with lasers following conventional protocol. However, there is slight thermal damage at the margins**,** which must be taken into account during the procedure.

Exposing unerupted/impacted teeth, subgingival decay, implant exposure/recovery

The laser's ability to vaporize areas of gingivae in a controlled manner is frequently used to expose unerupted or impacted teeth or, more frequently, subgingival decay, especially in class V cavities (Figure 3). Similarly, implants can be exposed which can mean taking impressions in the same visit, as the procedure is relatively bloodless and there is very little recession during healing.

Tuberosity reduction

Carbon dioxide lasers are used here at high powers owing to their ability to remove large amounts of fibrous tissue in a bloodless manner.

Pre-prosthetic surgery

Flabby ridges are easily reduced or ablated away and areas of proliferation induced by poorly fitting dentures can also be excised away.

Leukoplakia

These lesions can be quickly vaporized with a carbon dioxide laser with very little thermal injury to the underlying normal tissue. Special techniques, such as the orange peel technique, are used in removing very large lesions very easily and quickly. Non-contact vaporization greatly facilitates removal of lesions in the floor of the mouth, tongue and buccal surfaces.

Other uses

Many different procedures are performed using lasers:

- The sterilization of root canals, accessory or lateral canals;
- Incision and drainage of abscesses;
- Providing pain relief by coagulating the surface of aphthous ulcers;
- Cold sores can also be coagulated but the laser plume from the vaporization is highly infective material and good suction is mandatory;
- Dentine de-sensitization using either a carbon dioxide or Er:YAG laser.

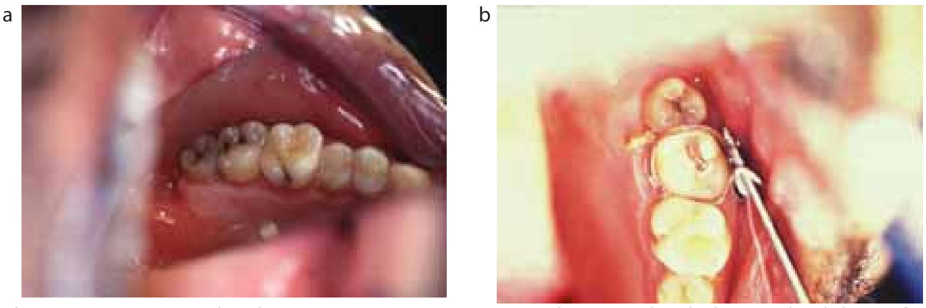

Figure 4. Caries removal and cavity preparation using Er:YAG laser: **(a)** 7| with disto-occlusal decay; **(b)** post-operative view following laser caries removal and cavity preparation.

Hard tissue clinical applications

The use of lasers in hard tissue dental applications is very exciting and can truly revolutionize dentistry in the twenty-first century. Not only can lasers be used in new methods of treatment, they can also supplement conventional instrumentation to give enhanced results.

Enamel etching

Laser etching may enable stronger bonds with restorative materials.[21-23] However, other studies have suggested a weaker bond produced with the use of laser etching alone but an even more improved bond than normal if laser etching is combined with acid etching.[22] It is important to note that etching with lasers during cavity preparation is not a separate step but results as part of preparing the cavity with the laser.

Cavity preparation and caries removal

Er:YAG and Er,Cr:YSGG lasers are able to vaporize or ablate enamel, dentine and bone. These lasers are commonly used to cut class I to V cavities in unrestored teeth precisely, while restored teeth may require the aid of conventional instrumentation (Figure 4). The removal of amalgam using lasers is not advisable, as the method would involve precisely cutting points around the restoration to release the filling. However, composite resin and cements can be ablated using lasers. The removal of caries can be selective since the energy needed to vaporize moist caries in the mouth is less than that required to remove sound dentine or enamel. The energy required to remove caries is 30 mJ, whereas sound dentine and enamel require 50 mJ and 80 mJ, respectively. An added advantage to the process is that the prepared cavity is sterile owing to the bactericidal effect of the laser. Lasers are also used to de-bride incipient carious lesions in pits and fissures of occlusal surfaces prior to placing sealant type restorations. Again, selective ablation at low energies enables the removal of minimal caries, leaving healthy enamel unaffected.

Apicectomy

After raising a gingival flap, the laser is used to vaporize the bone above the apical lesion and expose the root apex. Then it is used to open up the root apex to gain access to the root canal.[24]

Root amputation/hemi section/surgical extractions

Er:YAG and Er,Cr:YSGG lasers have been used for removal of bone around roots with little or no thermal injury to surrounding bone with minimal post-operative pain and swelling. Once the bone is removed, the roots are elevated out conventionally. Similarly, root amputations or hemi-sections can be performed very precisely and quickly.

Laser safety

Laser safety can be considered along similar lines to X-radiation. The operator, nurse and patient must all wear protective glasses to protect against chance reflection as laser energy, which has the potential to cause ocular damage. All the doors to the operating area must display warning signs and be kept closed. Entry into the operating room must not be allowed during operation of the laser. Shut out blinds must be present on all internal and external windows of the operating area. A laser safety officer must be appointed who enforces and supervises the local safety rules.

All surgical lasers used in dentistry are class 4, meaning their high power and diffuse beam may be potentially hazardous, with a requirement for registration and inspection.

Prior to the introduction of the National Care Standards Commission (NCSC) in the spring of 2003, general practitioners using class 4 lasers had to be registered with the Local Health Authority under the Nursing Homes Act 1990. This essentially involved two visits yearly to inspect the premises and verify compliance, as well as an initial registration and annual fee. Various health authorities enforced the rules differently, some requiring inter-locking operating theatre type doors linked to the laser unit, while others required a separate laser daybook where all patient details and treatment were recorded, including the details of the procedure carried out.

With the introduction of the NCSC, it was initially thought that it wasn't necessary for general practitioners to be registered as it was sufficient to practice under the guidance of the General Dental Council regulations, and only those practitioners using lasers under general anaesthesia needed to register with the NCSC. However, the situation was not clear with different members of the NCSC interpreting the same legislation differently.

The NCSC was replaced in April 2004 by the Commission for Healthcare Audit and Inspection (CHAI), and the situation has changed with registration being required again for all the laser wavelengths used in dental practice.

Acknowledgements:
Figures 1 a and b courtesy of Mark Chapman.

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Book Review

Medical Problems in Dentistry 5th edn. By Crispian Scully CBE and Roderick A. Cawson. Elsevier Churchill Livingstone, London, 2004 (£59.00). ISBN 0-44310-145-0.

Professors Scully and Cawson's *Medical Problems in Dentistry* is already a well established and popular reference text for the whole dental team, from dental student through to postgraduate clinician. In this, the fifth edition, it is much improved with a more reader-friendly lay-out and many more colour photographs (there were only 25 in the fourth edition). It has been greatly expanded and now includes many illustrations in the form of tables and diagrams.

The authors have endeavoured to include current topics (such as HIV and MRSA), as well as all those conditions which may have implications for the dental clinician in providing safe treatment. New sections include complementary and alternative medicine, preventive medicine and tropical medicine. Websites are also listed to give the reader further references in addition to quoted journal papers; this is a novel approach that should be encouraged.

A negative comment is that the book, by providing a great deal of information on very rare diseases, does not give the clinician a feel for which conditions are common (and, therefore, likely to be encountered). The same criticism applies to some of the photographs, for example, cleidocranial dyostosis is shown whilst the classical tongues associated with common anaemias are not.

All in all, however, this edition of the book is sure to be popular amongst undergraduates and practising clinicians alike.

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May

CPD Answers

1. A, D	6. A, B
2. C, D	7. A, C, D
3. B, C, D	8. B, D
4. B, C, D	9. B, C
5. A, B, C, D	10. A, B, D