Quicklase A-Z Lasers

This document is intended for advice on lasers including laser knowledge, benefits, applications, FAQ’s and LPA - laser protection advice for health and safety.

Introduction to LASERS

Types
- Diode
- Nd:YAG
- CO2
- Argon
- Erbium:Yag
- Ho:YAG
- Nd:YAP

Clinical Applications

Diode (used mostly in Dentistry)
- Soft tissue management (crown lengthening, Veneers re-contouring to curettage
- Hygienists gum management
- Replaces Electrosurgery better cutting
- Smallest type of Lasers (2.5 pounds, 1.1Kg)
- Portable, fast easy and effective
- Very competitively priced

Erbium:YAG with water
- Soft tissue surgery (you will get bleeding)
- Hard tissue (Caries removal, Cavity preparation)

Argon
- Soft tissue surgery
- Curing of Composite materials
- Tooth whitening
- Illumination for caries detection
- Illumination for endodontic orifice location

CO2
- Soft tissue surgery
- Curing of Composite materials
- Tooth whitening

Nd:YAG Like Diode (used for years in dentistry)
Technical Triad

Patient

Practice

Dentist

**Advantage**
- Less traumatic
- Less Anesthesia
- Faster recovery
- Decreased practice time
- Increase in productivity
- Control bleeding
- Antisepsis (Kills bugs)
- Reduced fatigue & Stress

**Disadvantage**
- Used to be relatively expensive
- Specialized training not needed for the Diode
- Not for use on bone or Amalgam

**Definition of LASER:**

*Light*
*Amplification by*
*Stimulated*
*Emission of*
*Radiation*

**Laser Spectrum**

Power w/cm²

<table>
<thead>
<tr>
<th>NM</th>
<th>Gamma rays</th>
<th>Xrays</th>
<th>UV</th>
<th>VL</th>
<th>IR</th>
<th>Micro wave</th>
</tr>
</thead>
<tbody>
<tr>
<td>810nm</td>
<td>980nm</td>
<td></td>
<td></td>
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</table>
Laser components

- Active medium
- Pumping mechanism
- Optical resonator

pumping mechanism

optical resonator (optical resonator)

active medium
Benefits of the lasers versus Electrosurge, scalpel and retraction cord

- Bloodless
- Coagulation of bleeding tissue
- Clear visual field allows for better visual working area
- Creates better contouring for accurate impression
- Precise crown lengthening and veneers margin re-contouring
- Less damage to soft tissue, no collateral damage
- Simple removal and shaping of soft tissue surface
- Easy to use
- Faster healing time
- Can touch hard tissue (teeth), implant and metal posts
- Can be used on pacemaker patients

Integrating the Diode Laser into dental practices

- Easy training
- Easy technique
- Easy care & fiber maintenance & sterilisation
- Follow up support by our staff
- Staff & Patient education & training reinforcement
- BILD clinical laser training – Core of knowledge

Soft tissue Applications

Soft tissue management

- Troughing (accurate impression)
- Gingival incisions & excisions
- Gingivoplasty (crown lengthening & veneers re-contouring)
- Gingivectomy (cutting gum)
- Vestibuloplasty (reshaping)
- Papillectomy (growth)
- Ulcers (good revenue)
- Implant Recovery and relieving tissue for abutment placement
- Sulcular debridement (Curettage - tissue flap)

Hygienists gum management

- Laser Sulcular Debridement and curettage -Perio, reduces the risk of CardioVascular diseases)

Sterilisation - Endo & Perio sterilisation

Therapy and whitening - TMJ therapy and teeth Whitening prisms
Uses for the QuickLase Lasers – Dr Ashley Watson

The QuickLase is only for use on soft tissue. It is an 810-980nm wavelengths laser operating in continuous and pulsation modes which make it the best laser for coagulation and cutting tissue that contains Haemoglobin, Oxyhaemoglobin, and Melanin. Being solid state it is also the most reliable as well as fast, easy and effective.

It is a proven fact that laser surgery heals faster with less scarring than a scalpel or electrosurgery, and requires no suturing.

The following procedures are therefore the most likely ones that a general dental practitioner will use more frequently.

1  **Crown preparation impressions** – *(Tissue retraction for Impression)*
   If an impression is not clear it will need to be taken again or the crown will not fit leading to extra clinical time adjusting it (money) or embarrassment to the dentist (loss of goodwill).

2  **Stopping Gums Bleeding** – *(Haemostasis)*
   Now that more fillings rely on glue (bonding) any contamination such as blood from the gums can frustrate a dentist trying to do a good job.

3  **Cutting or Reshaping the gums** – *(Gingivectomy/Gingivoplasty)*
   Good looking restorations rely on having the correct shaped gums as well as the correct colour and shape of teeth and lasers are the best and least painful way of doing this.

4  **Frenectomy**
   Very often this can be done with little or no anaesthesia and rarely requires suturing, even lingual frenectomy can be carried out with small amounts of LA and no sutures.

5  **Cauterising exposed nerve tissue** – *(High Pulpotomy)*
   If the nerve is exposed during a dental procedure bleeding can be stopped, the area sterilised and the patient has a greater chance of healing without further problems meaning the tooth is less likely to need root canal treatment.

6  **Sterilisation of tooth sockets following extractions** –
   By using the laser in a recent extraction site haemostasis can be achieved quicker and the patients report quicker and less painful healing times. This is due to an increase in temperature locally above 60˚C which causes plasmolysis of the bacteria and denaturation of bacterial proteins.
7 Sterilisation of gum pockets – (Sulcular Debridement)
   If the laser is used in a recently cleaned gum pocket the area can be sterilised for up to 60 days resulting in less after pain following extensive periodontal (gum) treatments. This is also true for wisdom tooth problems which are extremely common in young patients and for which there is no other minimally invasive treatment as comfortable.

8 Removal of unwanted tissue –
   If a denture does not fit well because of flabby tissue or “extra” gum then this can be removed more predictably with less postoperative pain than conventional techniques.

9 Stopping the pain of ulcers –
   This can be an extremely painful condition for some people and use of the laser can ensure the ulcer is non-painful within minutes without anaesthetic.

There are many other applications for the laser and it is futile to list its ability completely, as the list of oral surgical procedures is vast.

In general the laser replaces two instruments in the vast majority of cases, the scalpel (scalpel knife – lots of blood and unpredictable scarring and healing) and the electrosurgery unit (electrical burn – very useful but not as refined as the laser).

It is generally accepted that lasers are a far superior way of carrying out most procedures and they are used in the best plastic surgeon’s theatres for good reason, however until now the cost has been restrictive.

The diode laser is generally accepted as the most reliable laser as it consists of electrical circuits only and has a very flexible fibre optic cable making it very easy to use.

The size used to betray its ability and will allow even the most minimalistic dentist to hide it somewhere. But now with the Quickwhite™ Lase this is not an issue.

However the best idea is to show these instruments off as investment in a laser suggests high-tech dentistry to the vast majority of patients and very often just advertising the possession of a laser will increase a dental surgery revenue without even using it!

List of most useful applications of soft tissue laser in order of most common

- Veneers re-contouring
- Haemostasis after cavity preparation
- Gingivectomy to expose cavities
- Tissue troughing for perfect impressions every time
- Removal of hyperplastic gum tissue that has grown into cavity
- Crown lengthening prior to preparation
- Gingival recontouring prior to aesthetic work
- Sterilisation of tooth sockets post extraction
- Pulpotomy for painless recovery
- Removal of fibromatous or hyperplastic tissue around dentures
- Curing ulcers
- Operculectomy
- Incision of abscess and sterilisation
- Sterilisation of gum pockets
- Frenectomy
- Excisional biopsies
- Vestibuloplasty
- Removal of drug induced gingival hypertrophy
Diode Laser Dentistry (Patients Frequently Asked Questions)

What will I notice?
- No vibration, no noise, more relaxing treatment all round. Your dentist will now be able to do much more work on gum problems and so help you to keep your teeth much longer.

Will I feel anything?
- Even without an injection - you may only feel that something is going on - nothing particularly unpleasant.

What are the sounds?
- There are no sounds when your dentist is using the laser – just a beeping sound to indicate the use of the laser.

Will the drill be used as well?
- The drill will only be used to work on the teeth to remove any fillings and to polish your teeth.

Will laser treatment be available on the NHS?
- No, but you will quickly realise that this treatment is very good value - even relaxing!

How new is this?
- It has been available throughout the world for some years.

How common are lasers?
- Very common: Laser printers, CD players, Supermarket checkouts, Wheel alignment on cars.

Is it safe?
- Yes, very safe. But your dentist will give you a pair of protective glasses to wear to protect your eyes.

What have other patients said about this sort of treatment?
- Most patients are quite pleased with laser treatment using words like: relaxing and enjoying! Because it there is nothing touching you – really there is no pressure and NO vibrations even when drilling deep into a tooth.

- Will it whiten my teeth?
The tooth whitening treatment will not only make the teeth more white, but will give them an overall luster. The improvement in whiteness will depend on a number of factors - your dentist will explain more.
The Need for a laser protection Advisor - LPA

Similar to x-ray users, all laser users (including Employers and Employees) have a responsibility for maintaining a safe place of work, and for ensuring that their work activities do not present unacceptable levels of risk to themselves or to others.

In any place of work in which lasers are in use, it is the employer's responsibility to ensure that the risks to health arising from the use and reasonably foreseeable misuse of laser equipment are properly assessed. The employer must take all necessary steps to ensure that these risks are either eliminated or, where this is not reasonably practicable, reduced to an acceptably low level.

Wherever potentially hazardous lasers are in use, the employer needs to establish a general policy for the safe management of these hazards, although specific safety tasks may be delegated to others. This policy, which should be an integral part of the organisation's overall safety policy, should require that all reasonably foreseeable hazards arising from laser use are identified and that a risk assessment is carried out. Significant findings of this assessment should be documented and appropriate protective measures implemented where necessary to reduce these risks. The effectiveness of such protective measures should be reviewed regularly.

The laser safety standard also requires that, where lasers in Class 3B or Class 4 are in use, a Laser Safety Officer, a member of staff (often called a Laser Protection Supervisor in healthcare environments) should be appointed to take day-to-day responsibility, on behalf of the employer, for maintaining safe laser use. Quite often, however, especially when undertaking the initial risk assessment, in determining the safety controls and procedures that are necessary, and in providing safety training to staff. It is the role of the Laser Protection Adviser (As Quicklase are the manufacturers, they could be the LPA) to provide this expertise (see Risk Assessment Check List below).

Source: Association of Laser Safety Professional
LASER PROTECTION ADVICE - LPA
LASER RISK ASSESSMENT OPERATIONAL CHECKLIST

Before the procedure
- Make sure that only persons who need to be there and who are sufficiently trained are present.
- Do not lase till you are inside the mouth cavity.
- Make sure the caution/warning sign is on your surgery door.
- The person using the laser has removed all unnecessary reflective items from the area in which the beam will be located to avoid unwanted reflections/stray radiation. This includes shiny medical instruments, jewellery, watches, plastic ID card, etc.
- Ensure that there are sufficient pairs of protective eyewear available for dentist, technicians, and patients and that each pair is the correct type with regards to the laser wavelength.
- Airborne contaminant control systems (local exhaust suction, etc.) must be operational.

During the procedure
- Everybody present who has a reasonable likelihood of being exposed to laser radiation must wear protective eyewear. Keep protective eyewear on during the entire process. This includes the patient being treated especially if the treatment area is near his/her face.
- The beam must be carefully controlled in the oral cavity at all times.
- Never leave a laser operating and unattended in an unsafe condition.
- Laser firing foot pedals and finger switches must be separate from any similar switches to avoid confusion.
- Keep in mind that the most dangerous lasers are the invisible beam lasers, particularly near infrared lasers. Use a high degree of caution when operating these types of lasers.

After the procedure
- Keep protective eyewear on until the laser system is off or placed into a safe mode (standby).
- Remove any temporary warning signs and lift restricted access to operatory.
- Always store the protective eyewear near the lasers for which it is worn such that it will not get lost, scratched, or broken. Keep the eyewear in protective cases, if possible, in a clean and dry location.

This assessment checklist is offered as an example and is in addition to the health and safety guidelines within your surgery.
Quicklase Ltd accept no legal responsibility for its completeness or its use, this is only a guide.
Laser damage threshold and beam divergence – Dr Colin Pett

Dental lasers are not used like “conventional”, medical, surgical lasers. Generally the dental lasers do not have enough power/energy to ablate tissue in the classical surgical context where a beam of energy is applied directly to the tissue to vaporize it. Dental lasers are generally operated in a manner similar to hot-wire cautery (See section 2.2.2).

When tested in its “clean” state the power emitted from the fibre will be typically 70-80% of that injected into the fibre pigtail emission by the laser. The analysis below shows that the due to the divergence of the emission (from a perfectly clean, cleaved fibre end) the power density falls off dramatically with distance from the fibre end. In actual normal operation the level of laser emission will be substantially reduced, thus further reducing any residual risks of collateral (accidental) damage to surrounding tissue.

The highest level laser emission would be from a clean, perfectly cleaved fibre-end. In practice this is very unlikely hence is considered to be the absolute “worse-case”.

The multimode optical fibres used on the equipment will only propagate light that enters the fibre within a range of angles, known as the acceptance cone of the fibre. The half-angle of this cone is called the acceptance angle, $\theta_{\text{max}}$. For step-index multimode fibre, the acceptance angle is determined only by the indices of refraction:

$$n \sin \theta_{\text{max}} = \sqrt{n_1^2 - n_2^2},$$

where $n_1$ is the refractive index of the fibre core, and $n_2$ is the refractive index of the cladding and $n$ is the refractive index of air (taken to be 1). This has the same form as the numerical aperture in other optical systems, so it has become common to define the NA of any type of fibre to be,

$$\text{NA} = \sqrt{n_1^2 - n_2^2},$$

Thus $\theta_{\text{max}} = \sin^{-1}(\text{NA})$. Due to reciprocity, this is also determines the maximum exit angle for the particular fibre.
From the above it is apparent that.
\[ r(D) = D \tan (\theta_{\text{max}}) + r_o = D \tan (\sin^{-1}(NA)) + r_o \]

And that the Power Density \( P/A_D = P/(\pi r^2) = P/\pi \cdot (D \tan (\sin^{-1}(NA)) + r_o)^{-2} \)

The plots below show the variation of normalized power density (Log) with distance in mm from the exit of the fibre.

The fibres used in the product have the following range of parameters,
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Ro (low)</th>
<th>Ro (high)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NA = 0.22</td>
<td>0.2 mm</td>
<td>0.4 mm</td>
</tr>
</tbody>
</table>

The damage threshold power density is 38.8 W/mm². This level will ablate approximately 0.5 mm depth of tissue, 0.4 mm in diameter, in approximately 0.5 seconds. Hence in the worst practical case for the equipment the damage threshold would only be exceeded within < 1 mm from the end of the fibre.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power (Worst case)</td>
<td>~10 W</td>
</tr>
<tr>
<td>“Transmission” factor</td>
<td>0.8</td>
</tr>
<tr>
<td>NA</td>
<td>0.22</td>
</tr>
<tr>
<td>Ro</td>
<td>200 µm</td>
</tr>
<tr>
<td>D_{threshold}</td>
<td>&lt;&lt; 1 mm</td>
</tr>
</tbody>
</table>

![Graph showing damage threshold and power density](image)
Table 4 – Accessible emission limits for Class 1 and Class 1M laser products and $C_0 = 1$ a, b

<table>
<thead>
<tr>
<th>Wavelength $\lambda$ nm</th>
<th>Emission duration $t$ s</th>
<th>10$^{-13}$ to 10$^{-11}$</th>
<th>10$^{-11}$ to 10$^{-9}$</th>
<th>10$^{-9}$ to 10$^{-7}$</th>
<th>10$^{-7}$ to 10$^{-5}$</th>
<th>10$^{-5}$ to 10$^{-3}$</th>
<th>0.35 to 1</th>
<th>10 to 10$^2$</th>
<th>10$^2$ to 10$^3$</th>
<th>10$^3$ to 3 × 10$^4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>180 to 302.5</td>
<td>3 × 10$^{10}$ W m$^{-2}$</td>
<td>30 J m$^{-2}$</td>
<td>Thermal hazard</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>302.5 to 315</td>
<td>2.4 × 10$^4$ W</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>315 to 400</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7.9 × 10$^{-7}$</td>
<td></td>
</tr>
<tr>
<td>400 to 450</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>450 to 500</td>
<td>5.8 × 10$^{-9}$ J</td>
<td>1.0 + 0.75 C$_4$ J</td>
<td>2 × 10$^{-7}$ C$_4$ J</td>
<td></td>
<td></td>
<td></td>
<td>3,9 × 10$^{-3}$ J</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>500 to 700</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3,9 × 10$^{-3}$ C$_4$ W</td>
<td></td>
</tr>
<tr>
<td>700 to 1050</td>
<td>5.8 × 10$^{-9}$ J C$_4$ J</td>
<td>1.0 + 0.75 C$_4$ J</td>
<td>2 × 10$^{-7}$ C$_4$ J</td>
<td></td>
<td></td>
<td></td>
<td>3,9 × 10$^{-4}$ C$_4$ J</td>
<td></td>
<td></td>
<td>3,9 × 10$^{-4}$ C$_4$ G W</td>
</tr>
<tr>
<td>1000 to 1400</td>
<td>5.8 × 10$^{-9}$ C$_7$ J</td>
<td>10.4 + 0.75 C$_7$ J</td>
<td>2 × 10$^{-3}$ C$_7$ J</td>
<td></td>
<td></td>
<td></td>
<td>3.9 × 10$^{-5}$ C$_7$ J</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1400 to 1500</td>
<td>8 × 10$^{5}$ W</td>
<td>8 × 10$^{-4}$ J</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.4 × 10$^{-3}$ J</td>
<td></td>
<td></td>
<td>10$^{-2}$ t J</td>
</tr>
<tr>
<td>1500 to 1800</td>
<td>8 × 10$^{5}$ W</td>
<td>8 × 10$^{-3}$ J</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.8 × 10$^{-2}$ J</td>
<td></td>
<td></td>
<td>10$^{-2}$ t J</td>
</tr>
<tr>
<td>1800 to 2000</td>
<td>8 × 10$^{5}$ W</td>
<td>8 × 10$^{-4}$ J</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.4 × 10$^{-3}$ J</td>
<td></td>
<td></td>
<td>10$^{-2}$ t J</td>
</tr>
<tr>
<td>2000 to 4000</td>
<td>8 × 10$^{4}$ W</td>
<td>8 × 10$^{-5}$ J</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.4 × 10$^{-3}$ J</td>
<td></td>
<td></td>
<td>10$^{-2}$ t J</td>
</tr>
<tr>
<td>4000 to 10$^6$</td>
<td>10$^{11}$ W m$^{-2}$</td>
<td>100 J m$^{-2}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5,800 J$^{0.25}$ m$^{-2}$</td>
<td></td>
<td></td>
<td>10$^{3}$ W m$^{-2}$</td>
</tr>
</tbody>
</table>

NOTE: Laser products that meet the requirements for classification as Class 1 by satisfying measurement conditions 1 and 2 may be hazardous when used with viewing optics having greater than x7 magnification or objective diameters greater than those specified in Table 11.

a For correction factors and units, see Table 10.
b The AELs for emission durations less than 10$^{-13}$ s are set to be equal to the equivalent power or irradiance values of the AEL at 10$^{-13}$ s.
c In the wavelength range between 450 nm and 500 nm, dual limits apply and a product's emission must not exceed either limit applicable to the class assigned.
For the wavelength in question C4 ~ 3.6 and C7= 1, giving a “Class 1” ~ 1.4 mW. Assuming this falls on a fully dilated pupil (8mm diameter), this gives a “safe” power density of .03mW.mm⁻². The high level of divergence means that the emission would drop below the “Class 1” level in less than 0.5 m from the end of the fibre. This does show that the use of laser goggles is essential for close in work.

Conclusion

The Quicklase laser units (single and Dual wavelengths) are considered to comply with the requirements of EN 60601-2-22:1996 Medical electrical equipment. Particular requirements for safety. Specification for diagnostic and therapeutic laser equipment. and EN60601-1-2 :2007 Medical Electrical Equipment – Electromagnetic Compatibility and the Essential Requirements of given in Annex 1, and hence is considered to be compliant with the Medical devices Directive 93/42/EEC as amended.
# Laser References relevant to Diode Laser Therapy

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Title</th>
<th>Journal</th>
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<tbody>
<tr>
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<td>Clinical and Histological Study on Continuous Wave and Pulsed Biopsies with a Diode Laser</td>
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<td>Gloria E. Monzon, RDH</td>
<td>Periodontal Therapy for Advanced Periodontal Disease</td>
<td></td>
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<tr>
<td>Milpitas, California</td>
<td></td>
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