

The use of Laser-based Technologies in dentistry: Ethical issues and safety considerations

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The use of laser-based technologies in general dental practice in South Africa is growing each year both in numbers and in scope of use. It has been shown to be beneficial in treating a wide range of oral and dental conditions as well as being used as a therapeutic tool in tissue management.¹ They have been used in the practice of dentistry for over thirty years and recently there have been numerous advertisements in the dental press regarding the advantages of owning and using lasers and how it can be a good marketing tool for a dental practice. In the United States patients seek out practices utilising laser technology and nearly two thirds of patients surveyed thought that dentists should own a laser.² How can practitioners ensure that they are using laser treatment for their patients in a responsible and ethical manner?

Laser devices vary in their potential for light energy emission from low-powered hand-held or integrated devices, to high-powered units capable of cutting and ablating tissue and material.³ The dynamics of laser energy beams pose general risks to non-oral tissues and the immediate environment is at risk from direct or scattered exposure. Practitioners who own or are considering adding lasers to their treatment repertoire have an ethical and legal responsibility to ensure that the best interest and safety of the patient is paramount above the consideration of improving profit or personal gain.⁴ When considering the possibility of offering laser treatment to their patients, practitioners must make a decision based on the information available in terms of the laser application after reviewing meta-analysis or adequately conducted clinical trials prior to utilising lasers for dental procedures.

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ACRONYM

LSO: Laser Safety Officer

Furthermore, health professionals should adhere to their scope of practice, as defined in the Scope of the Professions of Dentistry under the Health Professions Act, 1974.⁵ The Health Professions Council of South Africa (HPCSA) guidance is set out in the following Ethical Rule 21, Performance of Professional Acts: "A practitioner shall only perform, except in an emergency, a professional act for which he or she is adequately qualified and sufficiently experienced". In cases where a practitioner is not adequately qualified and sufficiently experienced, the practitioner: "shall not fail to communicate and co-operate with appropriately qualified health practitioners in the treatment of a patient." Each dental laser has its defined intra-oral use, but when assessing the various extra-oral uses of lasers the practitioner must ensure adherence to the scope of practice.⁵

When choosing a laser-based technology, the professional must first decide which laser will be the appropriate adjunct to the practice. Dental lasers have a large initial capital investment. There are additional set-up costs and running costs that should also be considered. Prior to purchasing a dental laser, the professional should ensure that they are able to register the laser with the South African Department of Radiation Control. The Department of Health has appointed the Radiation Control as the regulatory body to ensure safe use of lasers in practice. Radiation Control expects that there is a Laser Safety Officer (LSO) present during use and this is usually the primary user or owner. All lasers used in healthcare are classified based on the "Classification of risk". The classification recognises risk associated with laser use and hazards pertaining to exposure of the eye and other tissues to the laser beam⁶⁻⁷ and the most commonly used in dentistry include³:

Class I: For example, laser caries detectors. Viewing with the naked eye poses no implicit risk, but caution should be observed if wearing spectacles or using optical devices (Class IM – 'magnifying'). The maximum power output of these lasers is 40W (blue light) and 400W for red light emissions.

Risks associated with laser use (adapted from Parker, 2007) ³	
Risk	Description
Laser beam	Exposure of non-target tissues. Due to the intensity of the output beam and high concentrations of optical power at considerable distances, lasers can cause serious injuries to eyes and skin.
Optical	Majority of laser-induced ocular injuries are due to operator error and can affect the retina and cornea. Visible wavelengths may selectively destroy red or green cones, resulting in colour blindness, but the majority of retinal laser burns affect complete areas of tissue due to the high invisible wavelengths in dental lasers. Longer wavelengths affect the structure of the front of the eye and may cause ablation, scarring and distortion of vision.
Skin	May be combined risks of ablative damage to skin and possible ionising effects that may be pre-cancerous.
Non-beam	Physical damage arising from moveable components of the laser. Fire risks, through the ignition of tubing. Anesthetic gases or chemicals (eg. alcoholic disinfection) should be identified and avoided. Products of tissue ablation (plume) are a considerable hazard that can affect not only the clinician but also auxillary personnel and the patient. Fine mesh face masks specific to surgical laser use, gloves and high-speed suction aspiration must be used to control the spread of all laser tissue ablation products.
Laser plume	The products of laser tissue ablation are collectively known as a "laser plume". Whenever non-calcified tissue is ablated, such as caries removal and soft tissue surgery, a complex chemical compound is emitted. Plume inhalation can be serious and result in nausea, breathing difficulties and inoculation of bacteria. The plume from dental hard tissues is potentially less dangerous.

Class III: The 'old' Class IIIA was replaced by Classes IIM and IIM. Class IIIB represents maximal power output of 0.5 W. Examples include 'soft' medical lasers (LLLT).

Environmental controls, protective eyewear, appointment of assigned safety personnel (laser safety officer, laser protection advisor) and training in laser safety are required by personnel using these lasers. Class IIIR includes some low level medical devices and targeting lasers, but are generally lasers of lower power outputs than IIIA. For emission in the visual range of wavelengths (400-700nm), the maximum power output is 5mW and with invisible wavelengths, 2mW. The same safety measures are required as with Class IIIB lasers.

Class IV: This Class includes all high-powered, surgical and other cutting lasers. There is no upper limit of power output. All surgical lasers used in dentistry and oral and maxillofacial surgery are included. The protective measures applicable to Class III lasers are further endorsed with the additional risk of fire hazards, due to flash-point temperatures being reached in chemicals used adjunctively to surgical procedures. This group of lasers represents the greatest risk of damage, both to unprotected persons and target tissue, either through direct or reflected and scattered beams.

Many dental lasers are classified as Class IIIB or IV. The Department of Health's Radiation Control "Requirements for the safe use of Class IIIB and Class IV lasers or laser systems, radiation control" advise on the various approaches that the LSO need to employ in the practice to ensure that the relative laser and radiation hazard is limited during the laser application. The relevant assessment of hazard controls⁵ that the LSO must assess may include, but is not limited to:

- Access restriction during use and storage
- Eye protection
- Laser room access: area control during use and storage
- Laser safety features: barriers, shrouds, locked panels, beam stops etc.
- Administrative and procedural controls
- Education and training

It is essential that all practitioners are familiar with laser safety requirements before purchasing a laser for use in the dental setting.⁸ The safety of laser equipment is based on proper design of laser equipment and on the adoption of appropriate precautions during use. The safe, responsible and ethical use of lasers will ensure that risks are reduced and that the dental team work in a safe environment based on the Occupational Health and Safety Act.⁹ It is not easy to use a laser as it is unlike the use of a scalpel, hand piece or hand instruments and training is required¹⁰ based on the user's scope of practice.⁵ The need for constant accredited Continuous Professional Development (CPD) refresher courses remain essential to keep up with relevant peer reviewed scientific research to ensure that the treatment provided is evidence based.¹⁰

All treatment decisions must be based on ethical principles, including that of patient autonomy, beneficence, non-maleficence, justice and veracity and informed consent.¹¹

For informed consent to be valid patient autonomy is critical. Autonomy refers to the right of the patient to make decisions for him/herself regarding his/her treatment options, after having been provided with all the necessary and relevant information. Before subjecting a patient to any investigations, we need to obtain their agreement and consent. Patients should be fully informed about the use of laser technologies and the risks and benefits thereof enabling a reasoned assessment of the proposed treatment options. Consent must be voluntary and it is essential that the relevant information is provided in language that is easily understandable.¹²

Apart from the fact that dental practice is firmly rooted in the principle of "*primum non nocere*" – first do no harm, it is imperative the benefits and the potential harm of any treatment is balanced. The use of laser technologies can play an indispensable role in the clinical management of patients and is an important tool in the practice of modern day dentistry. However, it is accepted that it does involve risk to laser beam exposure and it is essential that any exposure has a potential net benefit to the patient against any possible detrimental effects.³ The risks, benefits and

effectiveness of alternative techniques must be considered. This decision-making process is called ‘justification’ and is both an ethical and legal requirement. Dentists should not misrepresent the use of the laser technology as an adjunct in treatment. The patient’s history, diagnosis and proposed treatment will determine its use and it should not be used routinely or for screening purposes. In some cases an additional fee might be charged for the use of the laser but it will be an ethical breach if it is used with no advantage or improvement to the treatment to be provided.

CONCLUDING REMARKS

The “best interest” of the patient means that professional decisions must include reasonable alternatives and that the dentist considers the values and personal preferences of the patient. This must be done in a manner that allows the patient to be involved in the decision-making process. Anyone working with or responsible for potentially hazardous laser equipment should be properly trained in laser safety, be aware of the nature of laser hazards and understand the procedures and safeguards that need to be implemented. The safe use of lasers in dentistry extends to all personnel and the lead clinician must ensure that an adequate safety policy is in place for the management and control of the risks of accidental exposure.

Readers are invited to submit ethical queries or dilemmas to Prof. S Naidoo, Department of Community Dentistry, Private Bag X1, Tygerberg 7505 or email: suenaidoo@uwc.ac.za

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