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An Update on Safety Measures in Laser Dentistry

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Abstract: *Laser technology is transforming the world of dentistry. It is being effectively utilized in many areas of the dental industry to provide patients with convenient, improved services. Through innovative application this technology is changing the way in which dental services are provided. Practitioners and patients are beginning to accept this tried and true form of technology. Though it is not without its drawbacks, there are many reasons to choose to introduce laser technology into a clinical setting. Over the years studies have proven that patients have grown to accept and even welcome this form of surgery. Laser technology provides patients with bloodless surgeries, reduced pain after surgery and shorter procedures. Patient satisfaction is high with this form of technology because of its less invasive nature. When done properly, laser technology can increase the efficacy of a practice. One simply has to plan for the appropriate training and safe usage of this tool to ensure practitioner and patient well-being. This article examines the ways in which a dental office can safely incorporate this form of technology into their practice by laying out safety measures that should be implemented when a dental practice uses laser technology.*

I. Introduction

In order to properly assess laser technology, one has to review its origins. Light in its various forms has been used to treat patients for centuries. Most notably it was used to treat skin conditions through a process that is commonly known as "Phototherapy" (1,32).

Indians around 1400 B.C. created a lotion to treat vitiligo called *psoraleus*. They then applied the lotion and used direct sunlight to activate its healing properties. Egyptians used the same drug and process to treat leukoderma(2). Thus the earliest form of light treatment was introduced into a therapeutic setting.

Laser technology today has benefitted greatly from the strides made in the field in the last 40 years. The fact that this technology has helped the dental industry create bloodless procedures is an advantage for patient and provider. This tool has reduced pain, procedural length, scarring and swelling (3).

For hard tissue, lasers are proving to be an enhancement as well. They are improving the adherence of resistance enamels to caries. Laser dentistry has improved the enamel etching, preparations of cavities, composite resin photopolymeriation and treatment of the root canal system (4-6).

Lasers are very beneficial to the practice if implemented properly, but they do come with hazards that must be accounted for in order to ensure patient and dental staff are properly protected. Class IV lasers are among the most powerful being used in dental practices today. These lasers result in an average of 35 injuries per year in the U.S. (8). Unfortunately, these injuries appear to be mainly in solo practices where laser use is unmonitored. Office dental staff tends to have less training in laser technology than hospital laser safety officers and laser surgical nurses. This discrepancy in experience could be the cause of some of the injuries found in solo practices that are associated with this technology (9).

This article's objective is to demonstrate how office dental staff and patients can remain protected by implementing precautionary steps designed specifically to reduce injuries.

II. Laser Hazard Classification

Although the laser light has many useful properties it is still a powerful, potentially hazardous instrument and should be used only after having undergone extensive training. This fact is evident in the types of injuries the use of the apparatus has caused. Misuse of the laser light itself is perhaps the largest problem faced by dental staff. A misdirected laser ray or light escaping from the unit can cause serious injury to those exposed to its powerful beam. Maintenance issues such as disconnected or damaged optical fibers can cause injury to persons in the vicinity of the tool. According to the Centre for Devices and Radiological Health (CDRH) a part of the U.S. Food and Drug Administration (FDA) the standards regarding the manufacturing of lasers are delineated in the Code of Federal Regulations (CFR) (10). This standardization of lasers divides them into four numerical classifications. Most lasers used in dentistry fall under class IV – the most hazardous group (Table I).

Table I

Class	Description
I	Low powered; safe
II a	Low powered; visible; exposure time of 1000 seconds cannot produce any known skin or eye injury during operation.
II b	Low powered; visible; will not cause any skin or eye injury as it is incapable of emitting radiation(Aversion response 0.25 Seconds).
IIIa	Medium powered; visible; harmful if viewed with less than 0.25sec without magnifying optics.
IIIb	Medium powered; direct view is hazardous.
IV	High powered(>0.5W); fire, skin and ocular hazards. (eg laser dentistry)

The International Electrotechnical Commission (IEC) has also set its own classification system for lasers. The IEC is a global organization that sets standards for all electrical technologies (Table 2)(11).

Table II

Class	Description
I	Very low risk; "under foreseeable use it is reasonably safe"
I M	Between 302.5 n and 4000nm wavelengths ; mostly safe except when used with optical devices (eg binocular).
II	Exposure beyond the class 2 AEL (Accessible Emission Limit) human access is not permitted ; between 400nm and 700nm wavelengths.
II M	Range from 400nm to 700nm wavelengths are hazardous when viewed with an optical aid.
III R	Between 302.nm and 106nm, risk is less as compared to class IIIB lasers.
III B	Normally safe while viewing diffuse reflections, but are hazardous when viewed under directly.
IV	Toxic under both diffuse and intra reflection and may also cause fire and skin hazards.

Standards are also being defined by the American National Standard Institute (ANSI). Their principles are now serving as the voluntary guidelines for laser use in both dentistry and medicine.

According to the Occupational Safety and Health Administration (OSHA) there are five types of hazards that could occur:

1. Ocular Hazards
2. Tissue Damage
3. Respiratory Hazards/Environmental Hazards
4. Combustion Hazards
5. Electrical Hazards

Each of these hazards listed in table 3 will be addressed as they could occur during dental procedures involving the Class IV laser (Table 3).

Table III

	The Laser associated hazards
1.	Ocular
2.	Tissue related changes
3.	Enviormental/Respiratory
4.	Combustion
5.	Electrical

Ocular Hazards

Reflection related injuries are a possibility. Lasers can bounce off of a reflective surface and cause injury to both the patient and the staff member administering the laser treatment. Non-reflective material is recommended for use when laser technology is being applied (12). Retinal or corneal burns may result from laser emissions. Even low intensity beams can cause extensive damage because of the nearly 95% absorption rate of the radiation entering the eye (13,31).

Tissue Damage

Damage to tissue occurs at wavelengths above 400 nm. Temperatures that are above 21ºC above normal body temperature (37ºC) can cause tissue damage. Laser beams can also produce non-thermal tissue interaction through single or multiple short soft pulses.

III. Respiratory/ Environmental Hazards

Bio hazards that are released into the air as a result of the use of lasers are a threat to respiratory health for both the patient and the dental health professional. These are considered non-beam hazards (15). Air borne contaminates are generally inhaled as smoke or plume generated from the laser process. Toxic gases and chemicals emitted by the actual laser can also create negative respiratory and environmental issues.

Combustion Hazards

Flammable materials and lasers should always be kept separate. Any flammable like paper, ethanol and oxygen can be ignited if contacted by a laser beam. The toxic fumes that result from the flames create their own hazardous circumstances (18, 19).

Electrical Hazards

Laser systems are high current electrical devices. Some of the nastiest incidents that have occurred regarding lasers have been electrocutions. These instances are frequently user error. Lasers should only be serviced by qualified professionals.

Laser Hazard Control Measures

There are four categories of control measures that have been identified as relevant to the safe use of lasers in dentistry according to OSHA and ANSI (22). They are as follows:

1. Engineering controls
2. Personal protective equipment
3. Administrative and procedural controls
4. Environmental controls

Engineering Controls

Today's lasers are very well appointed. The industry has been vigilant about building into the system items that, if used properly, virtually eliminate hazards (23). ANSI recommends the following controls (23):

- Laser activation warning system which includes a bell and light.
- Optical viewing system safety: filters and shudders used with microscopes, screens or other ways to view the beam.
- Beam stop or attenuator: reduces emission to the appropriate Maximum Permissible Exposure (MPE) level.
- Master switch control: a computer or key coded switch that automatically disables the laser when removed.
- Protective Housing: an insulated enclosure around the laser that limits its MPE levels.

IV. Personal Protection Equipment

Eyewear is an integral part of the protection plan for both the patient and the dental staff. The safety glasses must meet specifications (22) with the most important criteria being optical density. All eyewear must meet the Personal Protective Equipment at Work Regulations SI 1992/2966 (HMSO 1992) and the British Standard BS EN 207:2009 (BSI 2010) (24). This eyewear has to meet a standard that allows the wearer to be able to gaze directly at the laser's beam.

Administrative and procedural controls

Some dental procedures require general anesthesia. When this is the case a special silastic tube should be used. A wax spatula or periosteal elevator should be used to shield the tissue near the teeth (25). Always check the foot switch before each procedure to make sure it does not get stuck in position while operating. Many laser accidents could be avoided by simply following the recommended control measures (12,30).

Environmental controls

Each employee should be properly trained regarding laser safety because it is the duty of the employer (23). Employees should receive Laser Safety Awareness Training, Laser Safety Refresher Courses and Laser Safety Updates.

The operating room should have a dry floor and protective laser curtains. Each operating room entrance should have signage that clearly states "Danger" and "Laser Radiation" (26, 28).

The Laser Safety Officer (LSO) and the Laser Protection Advisor (LPA)

The LSO is an appointed, appropriately trained, member of the dental practice whose role is to ensure that a safety plan is in place and being followed by all members of the practice at all times (10). The LPA generally advises the staff regarding nominal ocular hazard distance (NOHD), MPE and mandatory protective

devices. Any practice using Class III and IV lasers is required to have both on staff. These two staff members are essential to a prevention plan.

V. Conclusion and Recommendations

Lasers, for many practitioners, are a useful addition to the dental practice. They can improve quality of care through shorter, less invasive, bloodless procedures. This tool has many merits, but must be utilized with safety as a top priority. All employees should be properly trained in the safety requirements regarding lasers. The standards set in place by OSHA and ANSI on the subject of lasers should be followed strictly by the dental practice when creating an operation room laser safety plan. Proper procedure can help the practitioner avoid many of the problems that can occur with laser use.

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