

Laser Protection is Everyone's Apprehension! An Update

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Abstract

Today Laser is not anymore limited to big hospitals; it is easily accessible to the private clinics and private enterprises too. Anyone can go for laser practice today by attending a certified workshop on it. However, the main concern is the sound knowledge of its safety measures and management. This should be the primary goal for everyone involved in the sale, purchase and practice. There is a mandatory necessity of the safety administration or supervision to prevent or safeguard the laser hazards like understanding of standards, recognition of hazards and risks, carrying out of suitable control measures, and unfailing program audit to display eminence assurance. Hence, this review topic is taken to update the details of the dental laser hazards and its management.

Keywords: Lasers, Tissues, Absorptions, hazards, complications, management.

Introduction

The body tissue nicely absorbs the laser light. It can causes injury to the body tissues if the laser beam is much more enough powerful than the capacity of the tissue. The most sensitive part of our body to the laser beam is the skin and the eyes. The wavelength of the laser decides the amount of the laser beam to be absorbed by the targeted tissue. And the injury to the tissue is directly proportional to the amount of the laser light absorbed.¹

*Knowledge of Laser Science = Ability To Perform
Risk Assessment = Development of Appropriate Safety
Policies = Safer Staff = Safer Patient Care !!!*

Hazard Classification and Corresponding Control:

- A. **Set I:** This set of laser falls into the safest category as it is said to be nicely enclosed inside a safety cascade. Also it is not possible to remove the tightly enclosed cascade with hands. It can only be removed, if required, with the help of the respective tools meant for the removal of it.
- B. **Set II:** This set of laser is not that dangerous if accidentally and unintentionally viewed but may prove dangerous if viewed continuously at a stretch for a longer time. This is due to the natural aversion response of the laser. The caution tag should not be taken out at any cost for the safety reminder to the operator. And also the laser light should not be focused directly at the operator eye or the patient eye. Even the patient is directed not to stare at the laser light during the operation even though with the safety goggles.
- C. **Set II 1A:** This set of laser happens to be dangerous and cause injury when the optical safety tools wore by both the operator and the patient, accumulate the beam and reflect them directly into the eyes
- D. **Set II 1B:** This set of laser happens to be dangerous and cause injury when the optical safety tools were

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not aided by both the operator and the patient. On viewing the laser light without protective tools, it may prove highly dangerous.

- E. SET IV:** It is the same as class 111 risks. On direct exposure along with the reflection of it, with the powerful laser light, the injury is caused. These lasers cause biologic risk from either straight or distributed reflection. Commonly any laser able to produce power larger than 500 MW nonstop wave production falls in this set.²

Types of Laser Hazards: There are many types of hazards observed during the clinical practice of laser in dentistry like³

1. Ocular/Optical injury
2. Tissue damage hazards
3. Respiratory hazards
4. Fire and explosion hazards
5. Electric hazards

1. **Optical/Ocular hazards:** The direct emission of the laser light along with the reflection of the same from the surface having a mirror effect can cause tremendous injury to the eyes. The primary optical injury found is the burning of the retina or the cornea. The wavelength with visible (400-780nm) and near-infrared (780-1400nm) are enough for the injury of the retina. Different types of wavelengths may cause different types of optical injuries. This is possible because of the much more focusing capacity of the retina and the cornea. This injury can also happen with a constant low-intensity reflection and turn into an irreversible injury leading to permanent destruction of the retina and the cornea, and finally into blindness. The blindness is due to the high heat energy which takes hardly a fraction of a second. Laser-like Argon and Nd: YAG can get transmitted into the eyes directly and the power becomes increased nearly 100, 000 times more because of the lens focus. Surfaces such as instruments, mirrors, and polished restorations have the potential to redirect laser energy. Nd: YAG lasers demand the safety glasses which are of green in color and argon laser demand for the colored glasses which are amber. However, CO₂ laser demand s for the clear glasses. The keys should be removed from the laser during the non-use period. Also, there should be a

separate safety and a security maintenance room for the laser. The team with LSO-approved only should be eligible to access it. There should be clear safety warnings posted on the laser room entrance or the door for creating awareness.⁴ The laser room should be nicely sealed with an opaque material to prevent leaching and leaking of the hazardous laser beam to the bystander. However, it is very much safe for the CO₂: laser, as only plastic and glass walls, can absorb the laser radiation. There should always be an extra pair of goggles stored at the entrance of the laser room for the person entering the room for his eye safety.

2. **Tissue Damage hazards:** Skin hazards from the laser should not be ignored as it seems to be much painful than ever imagined. At times, there may be severe deep damage to the skin tissue. It happens sometimes by a mere accident and at times due to the negligence and carelessness of both the operator as well as the assistant. Especially it happens due to the lack of coordination between the assistance and the operator, assistance hands come in front of the laser optic tip causing a burn to the skin.⁵ Skin burn can even happen to the patient if he is not made aware beforehand to keep off his hands from the operated site during the procedure. The patient must be well trained to raise his hand and give signs to interrupt the procedure if he wants to deliver something. But strictly he should be prevented from touching the operated area during the ongoing procedure to prevent mishap. The moment the skin comes in contact with the contact mode of the laser fiber optic, the laser misfire and causes very painful burns. Hence, the operator is expected to take off his foot from the foot pedal and keep the laser in the “standby“mode, till everything gets ready to start with the procedure. Once the assistance checks everything ready and gives thumbs up and changes the standby mode to start mode, then the operator can keep the foot on the pedal. The patient facial skin, adjacent teeth, and the adjacent soft tissue next to the operated site should be taken care of by placing wet sponge or wet gauze on it. Or else shattering of the tooth takes place if the adjacent enamel of the tooth and the pulp gets penetrated by the unwanted laser radiation. However, the tooth damaged by laser is highly resistant to dental caries though it looks very ugly.⁴
3. **Fire and Explosion hazards:** The surgical

materials used at the site of laser operation are highly vulnerable to catch fire and produce fire hazards. The material can be from the disposable drape made from the pulp of the wood, dry cotton and gauze swabs or sponges, tongue blades made of wood, and of course the material made out of plastic. Hence to prevent the mishap, surgical drapes made of polypropylene material are very much popular as they melt but never burst into fire in contact with the high energy laser tip.⁶ Secondly, is the endotracheal tube, which is the highest source of risk during oral surgical procedures. Enough attention should be given to avoid the endotracheal tube coming in get in touch with the laser tip during the surgical procedures. This seems to be caused by the blow torch effect inside the airways of the patient which ignites. Hence these days new endotracheal tube supposed to be laser safe are available. Also it is mandatory to have the endotracheal tube airtight with the reflective part of the metal exposing outside to detect the endotracheal tube during the surgery. So that special attention can be provided to prevent the laser tip when it comes in contact with the tube. The distal end of it is the cuff which is always filled with the saline solution and blue dye made of methylene. It is to protect the laser beam from coming in contact with it. The time the fiber optic gets touched with the cuff, the dye which is a distinct blue, and visible, spills outside only to draw the attention of the surgeon and the anesthesiologist to take care of the laser-related puncture of the endotracheal tube cuff.⁷ Also it is made up of stainless steel body which puts enough resistance to the laser perforation. In a little time back, the endotracheal tube was manually wrapped with foil but it is obsolete now to prevent the unwanted open area left unintentionally which can be a vulnerable issue for the laser to get ignited. Thirdly, safety measure is, to lessen the oxygen gas content of the anesthesia mixture by around nearly 30 % to prevent ignition mishap. Also the isolation of the nasopharyngeal throat with the pack of wet cotton or gauze pieces is recommended. It prevents the absorption of the high laser radiation and gives maximum protection to the patient.⁸ The surgeon should not forget to remove the intrapharyngeal packs soon after the surgery is completed. The anesthesiologist should remind the surgeon by asking questions as: Is the removal of the pack done. It is in the guideline of anesthesiology practice by the MCI. Additionally, the anesthesiologist is also

expected to keep an eye over the period from the pack insertion until the pack removal only to ensure that the pack is safely removed before the closure of the surgical procedure. Along with the surgeon, even the anesthesiologist should work hand to hand with the minute details of the surgical procedure to safeguard the patient from any mishap. However, even the surgeon must be aware of all the anesthetic details given to the patient to ensure the safety of the patient if at all any mishap happens. Not being aware will cause only chaos at the much needed time and it can cost the life of the patient instead of life-saving. Last but not least, the whole team comprises of the staff nurse, operator assistance, laser technical assistant and even the fire safety concerned department, emergency dept. should be very well informed of everything much before the safe going of the whole process. Not to forget, beforehand, a well prepared written plan of the action should be made among the entire team and well versed with minute details for the safety concern. A good and the right plan of action if properly taken, it helps rapidly at the time of mishap and proves a commanding life-saving action.

The sequence or the protocol recommended during any fire mishap: Immediately switch off the laser. Switch off all the anesthetic gases including the oxygen cylinder. The patient shifted to a safe place immediately. With the help of the bag and the mask, the patient should be ventilated with 100% oxygen gas in the other room by the emergency department. Saline solution to be used at the earliest to extinguish the flame. Cuff should be deflated immediately and it should be removed simultaneously. The entire tube should be taken off with care. Bronchoscope should be used to make the airways clean off from any foreign bodies like pack material or any combustible material which may block the airways. If the damage is under control care should be taken to restart the incomplete surgical procedure after assuring the patient assistance that everything is well. Even the patient is assured with enough faith if he is in a consciousness state to understand it. But in case of the extensive damage, the airway ventilator should be carried out with an emergency tracheotomy. Steroids of high dose and the indicated antimicrobials should be injected keeping the vital parameters of the patient in the watch. And the reschedule of the targeted surgical procedure is again newly planned keeping the patient parameters in watch. The fire mishap should be properly conveyed with all the, minute details and the

respective concerned officers of the fire mishap as well. Risk management team, manufacturer companies, law officers, humanrights, insurance companies, and the quality controlled hospital management too. Pt and his family should be well conveyed too with assurance and faith to prevent the unwanted unpleasant illegal issues later on. It is also to keep the faith on the hospital team too. Water should never be used to Do not use water to put off fires on electrical tools. The entire team accessing the laser should be aware of the fire extinguishers at the entrance of the laser room, and its application that is P.A.S.S. - pull, aim, squeeze, and sweep.⁴

4. Electrical hazards: At times back, out of all the laser hazards, electrical hazard was the most fatal during the initiation period of laser usage. The reasons were many, from the untrained to the uncertified and unauthorized or even quack practitioners. The qualities of the electrical safety were not taken care of and less knowledge of the precautions to be taken to control the mishaps, were brought into notice. Electric shock because of coming in contact with the capacitor, which is said to be charged to its maximum.⁹ It resulted in electrocution and death immediately. Proper inspection and evaluation were not carried out at the earlier stage and even the repair work was neglected which brought many mishaps. Technicians were not well trained and even the surgeons were not certified with the special laser workshop and were not trained with the sound knowledge of the handling of the accidents and safety measures to be taken at the right time. Even the manufacturers did not give a clear caution tag on the laser to make the surgeon well cautioned enough. The proper wavelengths were not followed for the respective procedure. The high unwanted radiation because of high voltage caused many a times electric mishap. Also the direct current DC of the laser kept on charging for hours together even after the unplugged and switch off which became the reservoir of high fatal electric current. The indicator light which stands for the electrical malfunction should be very much aware of and if it goes off, immediately the laser technician or the service in charge should be informed to come and interrogate the problem. It should not be ignored and the procedure requiring laser should be immediately called off till it is repaired or it can be continued if there is any stand by laser available during the time.⁷

5. Respiratory hazards: The most unwanted is the byproduct of the laser, laser smoke, or the laserplume. Laser plume is a very unpleasant scent and this malodorous consists of steam that is then vaporized water, the particles of carbon, and few cellular products, which all together form laser plume.¹⁰ This plume is very choking and uncomfortable for the team working there in the operating room. It is also believed that this laser plume may prove highly dangerous to the respiratory patients as it is said to have consisted of various substances, such as formaldehyde, hydrogen cyanide, hydrocarbons, and other airborne mutagens. The size is hardly a little more than 0.3 u. It is found in the literature that the laser also gets filled with deadly human papilloma virus DNA, at the time of the surgery carried out to coagulate or to remove the papillomas growth through the laser. It can prove to be fatal for the patient next to him or the person coming in contact during the particular time, as it is an airborne infection. Huge evacuation for the laser smoke and with the filter size of 0.1 um is indicated in the operation area. The evacuation suction should successfully remove the laser plume in and around the area of 10 cm of the surgical area. Evacuation filters should be regularly monitored and should be replaced immediately when the time indicated of blockages of the pore and the efficiency ends here. To replace the blocked and old evacuation filters the service given person should be asked to wear the disposable gloves with proper mouth mask to get prevented from any air borne pathogens built inside. Then the waste should be carefully disposed of with the recommended biohazard bags. The accumulated charred accumulated by the laser from the surgical area should be cleanly wiped out with an antimicrobial solution. Proper and righteous biohazard handling should be maintained for the materials used during the laser procedure. The right kind of the face mask and eye wear is highly recommended during the laser procedure in the infected patient to avoid the splattering of the infected tissues into the eyes or nose. Both for the operator as well as for the assistant too. And they too should be disposed of or sterilized for the next use.⁷ Lastly, but not least, all the instruments used during the surgery touched or even not used or touched, including the loupes should be wiped off with approved sterilizing method and liquid.⁴

Conclusion

Safety is everyone's responsibility! Routine audit, troubleshooting, training, policy and procedure development, and compliance enforcement, are duties of

the LSO, but case by case, day by day, patient by patient, laser safety depends on every healthcare professional's commitment and vigilance. Lasers can offer patients a wonderful range of treatment options, from standard of care to experimental innovation. Laser users are constantly challenged to redefine who they are, what they do, and their scope of practice, with each new laser system or application. It must be remembered that every new system demands risk assessment and a review and revision of facility safety policies and procedures. Only through teamwork, communication, continuing professional education and training, and respect for the technology, can we establish the foundation for a truly effective laser safety program.

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