HAZARDS OF LASERS: A PERIODONTAL INSIGHT

[1]Navneet Singh,[2] Bir Sukhman Thind ,[3]Gurkeerat, [4]Parul Goel
Department of Periodontology, Desh Bhagat Dental College and Hospital, Mandi Gobindgarh, Punjab, India

ABSTRACT

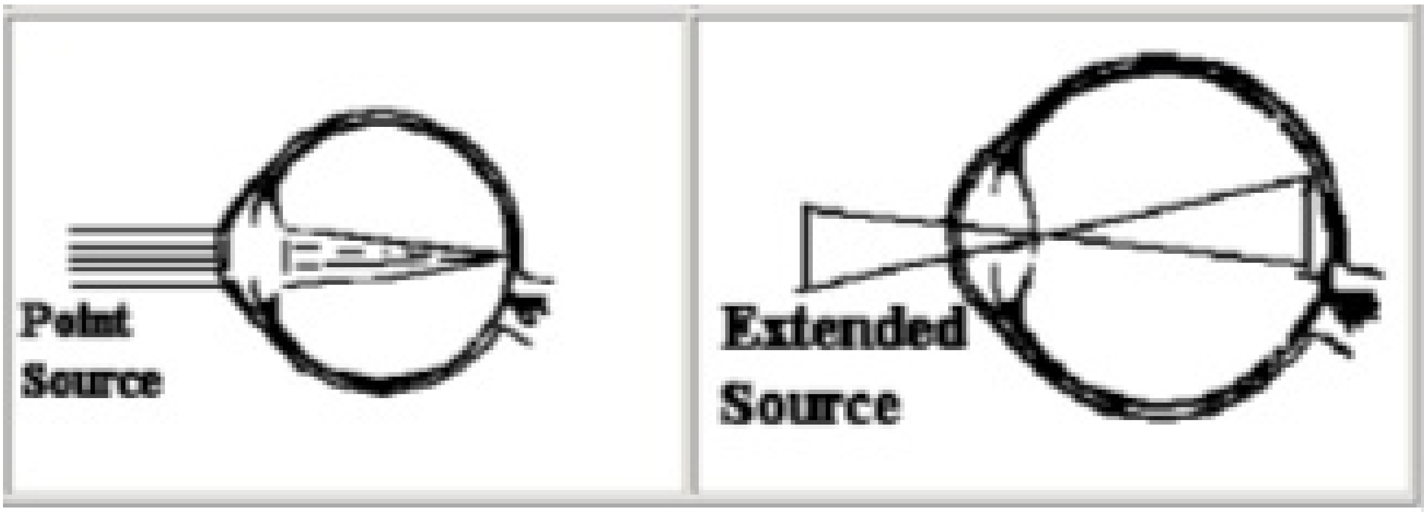
Traditional management of periodontal disease primarily involves mechanical debridement, such as scaling and root planing (SRP), coupled with oral hygiene education and, in some cases, adjunctive antibiotic therapy. While these methods are effective in managing mild to moderate cases, they have limitations. Deep periodontal pockets can be challenging to clean thoroughly with mechanical methods, and systemic conditions like diabetes may impair wound healing and response to treatment.
Keywords :Lasers, root planing, hazards

INTRODUCTION

The potential for injury to the different structures of the eye depends upon which structure absorbs the energy. Laser radiation may damage the cornea, lens or retina depending on the wavelength, intensity of the radiation and the absorption characteristics of different eye tissues.

Ocular Image

Wavelengths between 400 nm and 1400 nm are transmitted through the curved cornea and lens and focused on the retina. Intra beam viewing of a point source of light produces a very small spot on the retina resulting in a greatly increased power density and an increased chance of damage. A large source of light such as a diffuse reflection of a laser beam produces light that enters the eye at a large angle called an extended source. An extended source produces a relatively large image on the retinaand energy is not concentrated on a small area on the retina as in a point source.[1]



Point Source and Extended Source Making an Image on the retina

Effects of Irradiation on Eyes

Ultraviolet-B+C (100 - 315 nm)

The surface of the cornea absorbs all UV of these wavelengths which produce a photokeratitis (welders flash) by a photochemical process which cause a denaturation of proteins in the cornea. This is a temporary condition because the corneal tissues regenerate very quickly.

Ultraviolet –A (315 - 400 nm)

The cornea, lens and aqueous humour allow Ultraviolet radiations of these wavelengths and the principal absorber is the lens. Photochemical processes denature proteins in the lens resulting in the formation of cataracts.[1]

Visible light and Infrared-A (400 - 1400 nm)

The cornea, lens and vitreous fluid are transparent to electromagnetic radiation of these wavelengths. Damage to the retinal tissue occurs by absorption of light and its conversion to heat by the melanin granules in the pigmented epithelium or by photochemical action to the photoreceptor. The focusing effects of the cornea and lens will increase the irradiance on the retina by up to 100,000 times. For visible light 400 to 700 nm, the aversion reflex which takes 0.25 seconds may reduce exposure causing the subject to turn away from a bright light source. However this will not occur if the intensity of the laser is great enough to produce damage in less than 0.25 sec. or when light of 700 - 1400 nm (near infrared) is used as the human eye is insensitive to these wavelengths.[1]

Infrared-B and Infrared-C (1400 to 1.0 x 10+6 nm)

Corneal tissue will absorb light with a wavelength longer than 1400 nm. Damage to the cornea results from the absorption of energy by tears and tissue water causing a temperature rise and subsequent denaturation of protein in the corneal surface. Wavelengths from 1400 to 3000 nm penetrate deeper and may lead to the development of cataracts resulting from the heating of proteins in the lens. The critical temperature for damage is not much above normal body temperature.

LASER RADIATION EFFECTS ON SKIN

Skin effects are generally considered of secondary importance except for high power infrared lasers. However with the increased use of lasers emitting in the ultraviolet spectral region, skin effects have assumed greater importance. Erythema (sunburn), skin cancer and accelerated skin aging are produced by emissions in the 200 to 280 nm range. Increased pigmentation results from exposure to light with wavelengths of 280 to 400 nm. Photosens itization has resulted from the skin being exposed to light from 310 to 700 nm. Lasers emitting radiation in the visible and infrared regions produce effects that vary from a mild reddening to blisters and charring. These conditions are usually repairable or reversible however depigmentation, ulceration, and scarring of the skin and damage to underlying organs may occur from extremely high powered lasers.[1]

Summary of Wavelengths of Light and their Effects on Tissues

Below is a summary of interaction of optical radiation and various tissues. The wavelengths are divided into bands as defied by the International Commission on Illumination (CIE).1

CIE band	UV-C	UV-B	UV-A	VISIBLE	IR-A	IR-B	IR-C
	100	280	315	400	700	1400	3000
Adverse effects	Photokeratitis		Retinal Burns	Corneal Burns			
		Cataracts		Cataracts			
	Erythema		Colour Vision Night Vision Degradation				
		Thermal Skin Burns					

ASSOCAITED HAZARDS

Electrical hazards

The most lethal hazard associated with lasers is the high voltage electrical systems required to power lasers. Several deaths have occurred when commonly accepted safety practices were not followed by persons working with high voltage sections of laser systems.2

Chemical hazards

Laser dyes

Most dyes come in a solid powder form, which must be dissolved in solvents prior to use in the laser system. Improper use of dyes or solvents may present a range of hazards for the laser researcher.

Although little is known about them, many organic laser dyes are believed to be toxic and/or mutagenic. Because they are solid powders, they can easily become airborne and be possibly inhaled and/or ingested.3When mixed with certain solvents (Dimethylsulphoxide), they can be absorbed through unprotected skin. Direct contact with dyes and with dye/solvent solutions should always be avoided.

A wide variety of solvents are used to dissolve laser dyes. Some of these (alcohols) are highly flammable and must be kept away from ignition sources.4 Fires and explosions resulting from improper grounding or overheated bearings in dye pumps are not uncommon in laser laboratories. Dye pumps should be inspected, maintained, and tested on a regular basis to avoid these problems. Additionally, dye lasers should never be left running unattended.

Some of the solvents used with laser dyes may also be skin irritants, narcotics, or toxics. One should refer to the Material Safety Data Sheet (MSDS), which is supplied by the solvent manufacturer for additional information on health effects.

Cryogenic fluids

Cryogenic fluids are used in cooling systems of certain lasers. As these materials evaporate, they replace the oxygen in the air. Adequate ventilation must be ensured. Cryogenic fluids are potentially explosive when ice collects in valves or connectors that are not specifically designed for use with cryogenic fluids. Condensation of oxygen in liquid nitrogen presents a serious explosion hazard if the liquid oxygen comes in contact with any organic material. Although the quantities of liquid nitrogen that are used are small, protective clothing and face shields must be used to prevent freeze burns to the skin and eyes.5

Compressed gases used in lasers present serious health and safety hazards. Problems may arise when working with unsecured cylinders, cylinders of hazardous materials not maintained in ventilated enclosures, and gases of different categories (toxins, corrosives, flammable, oxidizers) stored together.

Collateral radiation

Radiation other than that associated with the primary laser beam is called collateral radiation. Examples are X-rays, UV, plasma, radio frequency emissions.

Ionizing Radiation

X-rays could be produced from two main sources in the laser laboratories. One is high-voltage vacuum tubes of laser power supplies, such as rectifiers, thyratrons and crowbars and the other is electric-discharge lasers. Any power supplies which require more than 15 kilovolts (keV) may produce enough X-rays to cause a health hazard. Interaction between X-rays and human tissue may cause a serious disease such as leukemia or other cancers, or permanent genetic effects which may show up in future generations.

UV and Visible

UV and visible radiation may be generated by laser discharge tubes and pump lamps. The levels produced may exceed the Maximum Permissible Exposure (MPE) and thus cause skin and eye damage.

Plasma Emissions

Interactions between very highpower laser beams and target materials may in some instances produce plasmas. The plasma generated may contain hazardous UV emissions.

Radio Frequency (RF)

Q switches (Quality switches) and plasma tubes are RF excited components. Unshielded components may generate radio frequency fields which exceed federal guidelines.

Fire Hazards

Class 4 lasers represent a fire hazard. Depending on construction material beam enclosures, barriers, stops and wiring are all potentially flammable if exposed to high beam irradiance for more than a few seconds.

Explosion Hazards

High pressure arc lamps, filament lamps, and capacitors may explode violently if they fail during operation. These components are to be enclosed in a housing which will withstand the maximum explosive force that may be produced. Laser targets and some optical components also may shatter if heat cannot be dissipated quickly enough. Consequently care must be used to provide adequate mechanical shielding when exposing brittle materials to high intensity lasers.

Laser Accidents

Below is the summary of reported laser accidents in the United States and their causes from 1964 to 1992. It indicate that the majority of injuries involve the eye and occur during alignment procedures, or because the protective eyewear was either inappropriate or not used.

REFERENCES

1. Batchelor P. Is periodontal disease a public health problem? Br. Dent. J. 2014;217:405–409. doi: 10.1038/sj.bdj.2014.912.
2. How K.Y., Song K.P., Chan K.G. Porphyromonas gingivalis: An Overview of Periodontopathic Pathogen below the Gum Line. Front. Microbiol.2016;7:53.doi: 10.3389/fmicb.2016.00053.
3. Wamala S., Merlo J., Boström G. Inequity in access to dental care services explains current socioeconomic disparities in oral health: The Swedish National Surveys of Public Health 2004–2005.J.Epidemiol.CommunityHealth.2006;60:1027–1033.doi: 10.1136/jech.2006.046896.
4. Garcia R.I., Henshaw M.M., Krall E.A. Relationship between periodontal disease and systemichealth. Periodontology 2000.2001;25:21–36.doi:10.1034/j.1600-0757.2001.22250103.x.
5. Ramesh T., Sundar M., Ranjani S.S., Kurian B. Efficacy of Scaling and Root Planing with and Without Adjunctive use of Diode Laser or Tetracycline Fibers in Patients with Generalised Chronic Periodontitis: A Comparative study. J. Investig. Clin. Dent. 2017;8:e12188.