Part 1

The Anticipated Hazards Due To Errors In Using Laser In Medicine And Recommendations For The Safe Use Of Medical Laser Systems In Iraqi Hospitals.

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Summary

On one hand, laser medical systems are very useful in several medical fields. They are used for diagnosis and treatment. In addition, they are used in medical researches.

On the other hand, laser hazards may cause irreversible injuries, especially eye injuries. Therefore the safe use of medical laser systems is very important to protect the laser operators who are always exposed to laser hazards, and also to protect patients treated by medical laser.

This academic research was designed to achieve the safe use of laser medical systems in Iraqi hospitals by:

a- Knowing the basic laser concepts.
b- Concentrating on the responsibilities of the medical staff that operate the laser units.
c- Identifying the anticipated laser hazards to the patients and laser operators.
d- Presenting recommendations for the safe use of medical laser systems in Iraqi hospitals.

Introduction

Medical laser systems are relatively newly used in Iraqi hospitals. Ophthalmologists were the first ones who used laser for treatment of certain diseases. Later the uses of medical laser systems were expanded to include other branches as plastic surgery, ENT, general surgery, dermatology and gynecology. And it is expected for laser to be used in most fields of medicine for treatment, diagnosis or researches.

The safe use of medical laser systems in Iraqi hospitals and clinics to protect the medical staff that operates the laser units and to protect patients treated by laser could be achieved by "[i)]:

1- Ensuring that all laser activities are adhered to the applicable regulations and using the proper safety precautions.
2- Providing the basic laser safety training to all employees involved in the laser activities. This training includes the basic laser information and fundamentals, the laser operation training and the laser safety training.
3- Ensuring receiving appropriate training for the manufacture or distributor, especially for unique operation by this type of laser.
4- Providing copies of all records to laser safety officer. **These records include:**

- Laser operator records including full information, medical surveillance and training.
- Laser device records including the device description, the intended uses location and laser features.
- The necessary safety requirements.
- The records of purchase acquisitions of laser to ensure update.
- The records of contacts with the American National Standards Institute committee (ANSI-Z136.1) for the Safe use of Laser and other laser safety organizations.

Fundamental Laser Concepts

- **Laser Components**

The basic three com onents of laser devices are: (2)

1- The active media, which is either solid, semiconductor, gas or liquid
2- The energy source; which is electric, light or chemical source.
3- The resonant cavity with two mirrors, one completely reflecting and the other one partially reflecting.

- **Lasing Action**

The energy applied on the active media excites electrons to high energy levels. Then these electrons decay to the metastable state. By pumping large amount of energy, most of the electrons in the active media become in the metastable state, making population inversion. Then stimulated emission occurs, and the electrons traveling along the longitudinal axis of the resonator will amplify. A part of the laser light will pass through the partially reflecting mirror. The laser output is either continuous or

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pulsed, depending on the energy source [2] Laser passes to the target through a delivery system,

• **Characteristics of Laser Light**

Laser light is electromagnetic waves. Its wavelength is in the visible, infrared or ultra-violet region of the electro-magnetic spectrum. Laser light is monochromatic, directional, collaminated and coherent.

- **Laser Parameters**

1- Wavelength

2- Pulse duration and pulse repetition rate 3- Power density and energy density 4- Spot size, divergence and brightness

- **Accessories of Medical Laser Devices**

1- Goggles and filters 2- Beam splitters 3- Light guides 4- Plume suckers

5- Application catheter and introducers

- **Laser-Tissue Interaction**

When applying laser on a tissue, it is absorbed, refracted, reflected or scattered. The reflected and back-scattered laser caused harm to the laser operators and patients; so they need safety measures. The absorbed laser affects the tissue by wavelength depended interaction (thermal or chemical effect) or wavelength independed interaction.

Responsibilities

The medical staffs who operate the laser units are the Laser Safety Officers (LSO) and Laser Operators (LO) (1 & 3)

- **Laser Safety Officers (LSO)**

The laser safety officers, who control laser units in Iraqi hospitals, are the specialist physicians who have knowledge on the basic laser theory and laser-tissue interaction and have been trained on medical laser systems

Their safety responsibilities include:

1- Administration of laser safety programs for to ensure safety of all peoples in laser units.

2- Conducting training to LO

3- Monitoring facilities and personal protective equipment (PPE).

4- Reviewing purchase and acquisition laser, and maintenance of update laser inventories throughout the hospital.

5- Recording medical surveillance for laser operators 6- Registrar class 3 and 4 laser.

7- Contact with other regulations as ANSI

8- Making precaution labels

9- Making the standard operating procedures (SOP), which includes: a. Location of the laser in the hospital

b. Description of the laser devices c. Intended uses of laser d. Potential hazards

e. Safety parameters

f. PPE as goggles clothes and filters.

g. Complete step by step operation procedures. h. Emergency procedures in accidents.

Laser Operator (LO)

which is either fibro-optics or pipes with articulating mirrors.

LO are physicians, nurses and employees working in laser units. **Their laser safety responsibilities are:**

1- They must be familiar with the characters of laser devices in the hospital. 2- They must complete the basic laser safety-training course. 3- They must adhere to the instruction of SOP. 4- They must have knowledge of emergency response. 5- They must complete the medical surveillance requirements 6- They must operate only lasers that are trained on.

The Anticipated Laser Hazards

- **Classification of Laser Hazards**

The aim of the classification is to describe the capability of the laser system to produce injuries to personnel, i.e. potential hazards.

The hazard classification is a set of accessible emission limits (AEL) which depend on exposure limits for occupational occurrence within anticipated exposure duration. (1)

AEL derived from:

1- Maximum permissible exposure (MPE). It is the level of laser radiation to

which a person may be exposed without hazards affected neither on nor

adverse biological changes in the eyes or skin.

2- Area of limiting aperture through which the laser beam travels. It is

compared with 7 mm, as pupil aperture in human eyes.

Also hazards classification includes other parameters: 1- Wavelength of laser

2- Average power of laser and duration of exposure in the working day. 3- Pulse energy, pulse duration and pulse repetition rate.

Class I Laser

The emitted power is less than MPE (i.e. <0.4 uW). As laser printers, CD players, CD-ROM and optical communications. No hazards anticipated, so it is safe and no need for protection.

Class I enclosed laser.

These are high power lasers embedded in protective housing with safety interlock. So no harm to users, but should have precaution labels.

Class II Laser

These are lower power laser (<1mW and >100uW). They are visible laser light as laser pointers, aiming devices and range finders.

These lasers cause damages to eyes if directly viewing for more than 15 min, but usually not happened due to blinking reflex. Protective precautions

1- Avoid looking into class II laser beam

2- Avoid pointing class II laser beam into another person eye.

3- Avoid viewing class II laser beam with

telescopic devices, because
they amplify laser.

Class IIA; allow exposure for 1000 sec or less.

Class III Laser

These are medium power laser, and divided into:

Class IIIA Laser

These are visible laser or IR or UV laser with a power range 1-5 mW. As laser pointers and laser scanners. They cause damage to eyes by direct viewing for duration less than blinking reflex.

Protective precautions

1- Avoid looking into class IIIA laser beam.
2- Avoid pointing class IIIA laser beam into another person eye.
3- Avoid viewing class IIIA laser beam with telescopic devices, because
they amplify laser.

Class IIIB Laser

The power is 5-500mW if continuous laser and 10 J/cm2 if pulse laser; as pulse and dye laser used for spectroscopy and entertainment light show. Hazards to eyes by direct viewing and by specular or diffuse reflection.

Protective precautions

1- Avoid looking into class IIIB laser beam.
2- Avoid pointing class IIIB laser beam into another person eye.
3- Avoid viewing class IIIB laser beam with telescopic devices, because
they amplify laser.
4- Use eye protection as goggles and filters. 5- beam control
6- Define emergency procedures.

Class IV Laser

These are high power laser, more than 500 mW if continuous laser and more than less more than 10 J/cm2 if pulse laser. As most of medical laser systems. Hazards to eyes and skin by direct laser beam and by specular or diffuse reflected laser beam. Also class IV laser may cause fire hazards.

Protective precautions

1- Avoid looking into class IV laser beam.
2- Avoid pointing class IV laser beam into another person eye.
3- Avoid viewing class IV laser beam with telescopic devices, because
they amplify laser.
4- Use eye protection as goggles and filters. 5- Beam control.
6- Define emergency procedures.
7- Make laser controlled area.
8- Decrease specular reflection from walls and instruments. 9- Define SOP.