



المرحلة الثانية ٢٠٢٣-٢٠٢٤

LASER in Ophthalmology

Lecture 2nd : **LASER advantages and Dis-advantages**



Light is electromagnetic radiation, comprising of an electric and magnetic fields. An electric field is undulating in the vertical direction and a magnetic field is undulating in the horizontal direction and both of them fluctuate perpendicularly to the direction of propagation.

Light exhibits properties of both waves and particles.

light is emitted and absorbed in tiny "packets" called photons.

Photon : It is the elemental unit of light.

It has motion, but no mass or charge.

It is characterized by (wavelength (λ), frequency (ν) and energy (E).)

$$E = h\nu \quad E = \frac{hc}{\lambda} \quad : \text{Where } c \text{ is the speed of light} = 2.998 \times 10^8 \text{ m/s; } h \text{ is Planck's constant} = 6.626 \times 10^{-34} \text{ joule}\cdot\text{s}$$

Light is composed of packets of energy called **photons**



Energy Levels of the atoms:

Energy levels, also called energy shells. Electrons fill the shells starting at the lowest energy levels closest to the nucleus and then filling the outer shells. When the electrons are in their lowest energy configuration this is called **"ground state."**

Introducing **energy** to the system can temporarily excite an electron into a higher shell. They must always absorb fixed amounts of energy as electrons cannot exist between energy potentials. However these energy levels are not evenly spaced out. the absorption, will only take place *if there is an energy level to which the electron can move with that amount of extra energy.*

Energy is **released** when the electron drops back down a level although often not in the same form. For example if an atom absorbs wavelength of light that excites it two energy levels higher in one go it may drop back one energy level at a time and each time release light at a different wavelength to the one it absorbed (known as fluorescence).

Population inversion:

In physics, Population inversion happens when there are more atoms or molecules in an excited state than in a lower energy state, like the ground state. This is really important in lasers because you need a population inversion to make a laser work. Basically, it means that in a population inversion, there are more atoms in a higher energy level than in a lower one.

Generating a population inversion:

- 1) Atoms are pumped (excited) into the highest of energy levels.
- 2) Spontaneous de-excitation from the pump level to the metastable level.
- 3) Laser emission between the metaestable level and the ground state.
- 4) Alternatively, if a fourth excited level is included as lower laser level, which relaxes fast into ground state, lasing is favored since the bottom level involved is empty.

Potential advantages of laser

Why we use laser in surgery?

- Laser Surgery may have certain advantages as compared with other surgical instruments. These include:
1. Provides a *clear, dry surgical field* (bloodless field), thus aided to the surgeon visibility and precision during the surgery i.e.: cuts and coagulates at the same time.
 2. **Reduce Bleeding:** (in very vascular lesions there is minimal bleeding), laser energy cauterizes and seals small blood vessels, so achieves homeostasis.
 3. **Reduce Swelling and edema:** laser energy seals lymphatic vessels, and reduces tissue trauma, so minimizes inflammatory responses, reducing swelling.
 4. **Reduce Infection:** The laser energy acts as an antimicrobial/antibacterial agent by producing high temperatures, which effectively eliminating microorganisms.
 5. **Reduce risk of transmitted infection** because no physical contact with the patient ("no touch" technique).
 6. **Reduce local tumor recurrence** Reduction in the spread of metastasis by killing of malignant cells by (*direct anticancer effect*) and sealing of lymphatic vessel.
 7. **Reduce Pain:** The laser beam seals nerve endings as it incises through tissue.
 8. **Reduce the need for G.A:** Commonly under local or no anesthesia
 9. **Reduce recovery time:** so the patient returns rapidly to normal daily activities
 10. **Reduce of operative time.**
 11. **Precision**, highly precise incision, **not affect the surrounding tissues.** i.e. -This advantage is very helpful when a doctor must operate in a **tiny area** that is surrounded by important structure or organs. (Microsurgery). A focused laser can make incisions **half a micron** wide, compared to about **80 microns** for the diameter of a human hair.
 12. Less scarring and better cosmetic effect
 13. Fewer instruments in the field.
 14. **Finally:** Laser surgery is *much safer* than conventional surgery because:
 - Reducing the need for **general anesthesia**
 - Reducing the need for **blood transfusions**
 - Reducing the risk of **infection**
 - Shorter **hospital stay** .
 - 15- **Outpatient Procedures:** No need for hospitalization.
reduce healthcare costs, and burden (load) on hospital resources, and allow patients to return to their normal activities more quickly.

NOTE:-

Although **laser surgery** provide many advantages, it is unlikely that they will completely replace scalpels and other “standard” instruments.

Within the **last 30 years**, **laser surgery** has become a widely performed procedures.

If properly used effective and safe

If improperly used not effective and unsafe **dangerous**

For this reason, a **basic** knowledge of lasers and their **applications** is essential to every surgeon.

Disadvantages of laser:-

- ❖ **Loss of tactile sensation** in using laser (commonly non touch technique).
- ❖ Laser surgery is far **more expensive** than the conventional surgery (i.e. cost effectiveness is poor).
- ❖ Laser surgery requires **training** in laser basic and surgical techniques.
- ❖ Need **safety precautions** so that the patients, the staff, and the surgeons are protected from laser hazard especially the eyes, so protective glasses are required during its use.

❖ Limited Penetration Depth:

- Laser energy has limited effectiveness in penetrating tissues deeply.
- requiring treatment of deep-seated tumors or conditions.
- Alternative treatment modalities or combination approaches may be needed for such cases.

- ❖ Specialized training and expertise are necessary for operators.
- ❖ Control of laser settings is vital to prevent tissue damage.
- ❖ Limited availability of laser technology and expertise can restrict access to treatments, particularly in less-developed regions.

**THANKS SEE YOU IN NEXT
LECTURE**