Recent Advances in Surgical Technology

Dr. Parag Hadge

Microsurgery

a. Magnification Systems

Magnifying Loupes

Surgical Microscope

b. Periodontal Microsurgery

Root Preparation

Surgery under Magnification

Microsurgical Instruments

Ergonomics

Lasers in Periodontics

Photodynamic therapy

Microsurgery

- Def: Refinement in surgical technique by which visual acuity is increased using a microscope at magnifications exceeding 10x.
- Loupes- improve normal vision, but don't increase visual acuity to the degree required

Magnification Systems

Assumption – "more magnification is better" but must always be weighed against the decrease in the field of view and depth of focus that can occur as magnification increases.

Magnifying Loupes– most common - are dual monocular telescopes with side-by-side lenses convergent to focus on operating field. A convergent lens optical system is called a ***Keplerian optical system***.

Disadv: clinician's eyes must converge to view operating field– eyestrain, fatigue, vision changes after long use

3 types of Keplerian loupes used:

- Simple Loupes
- Compound Loupes
- Prism Telescopic Loupes

Simple Loupes

- Pair of single meniscus lenses
- Primitive magnifiers with limited capabilities
- Each lens is limited to only 2 refracting surfaces.
- Their magnification can only increase by increasing lens diameter & thickness.
- Disadv: size & weight constraints, impractical for magnification beyond 1.5x., affected by spherical & chromatic aberration

Compound Loupes

- Multi-element lenses with intervening air spaces to gain additional refracting surfaces
- Allows increased magnification with favorable working distance & depth of field
- Magnification of loupes can be increased by lengthening the distance between lenses, thereby avoiding excessive size & weight
- Adv: improved optical performance, can be achromatic
- Disadv: inefficient at magnification above 3x

Prism Telescopic Loupes

Eyeglass-mounted prism loupes

Coaxial lighted prism loupes

- Most advanced loupe available
- Employ ***Schmidt*** or ***rooftop*** prisms to lengthen the light path through a series of switchback mirrors between the lenses
- Adv: better magnification, wider depth of field, longer working distance, large field of view
- Barrels are short enough to be mounted on either eyeglass frame
- Increased weight of loupes with magnification above 4x makes headband mounting more comfortable than eyeglass frame
- Recent- coaxial fiberoptic lighted prism loupes to improve illumination

Magnification Range of Surgical Loupes

- Dental loupes – limited range of magnification
- 1.5x to 6x
- Less than 3x- inadequate for perio
- More than 4x- small field of view, shallow depth of focus & excessive weight.
- Excessively heavy loupes– unstable visual field
- Prism Telescopic Loupes with 4x adequate for some periodontal procedures
- Surgical microscope- higher magnification & superior optical performance

Surgical Microscope

- Employ ***Galilean optics with binocular eyepieces*** joined by offsetting prisms to establish parallel optical axes.
- Permits stereoscopic vision without eye convergence, no eyestrain/fatigue.
- Adv: allows the dentist to change working magnification easily to a value appropriate for clinical task.
- Have a rotating variable magnification element that changes magnification to match surgical needs
- Some– electronic foot controlled focus & magnification

- Periodontist must establish adequate working distance between surgical field & microscope lens. This permits surgical assistant to retract tissues. Assistant eyepiece attachment are available
- Useful working distance in dentistry is 250 to 350 mm
- Stability– ceiling, wall or floor
- Fiberoptic co-axial illumination
- Maneuverability- visual access to posterior areas
- Documentation– attached camera

Periodontal Microsurgery

Figure 70-7 Magnified root planing.

- Root preparation: more definitive root debridement
- Surgery under magnification: Gentle – atraumatic surgery

- Microsurgical Instruments- opthalmic scalpels, microsutures
- Ergonomics- hand position & body posture – improved motor skills due to microsurgical appraoch

Figure 70-8 Castroviejo microsurgical scalpel.

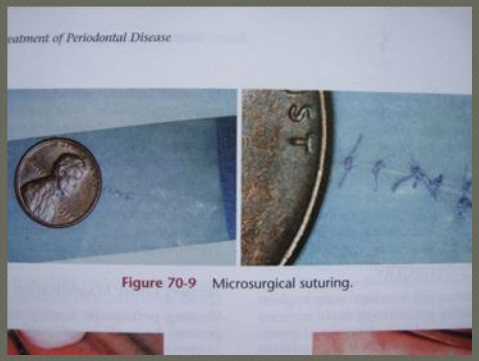


Figure 70-9 Microsurgical suturing.

- Microsurgical instruments - create clean incisions that prepare wounds for healing by primary intention.
- Microsurgical incisions are established at a 90-degree angle to the surface using ophthalmic microsurgical scalpels.
- Microscopy permits easy identification of ragged wound edges for trimming and freshening.
- For primary wound closure, microsutures in the range of 6-0 to 9-0.
- Microsurgical wound apposition minimizes gaps or voids at the wound edges. This encourages rapid healing with less postoperative inflammation and with less pain.

- Microsurgical instruments - circular in cross section to permit precise rotational movements.
- Made up of titanium because of it's strength, lightness, and nonmagnetic characteristics.
- Several types of ophthalmic knives such as crescent, lamellar, blade breaker sclera and spoon knife can be used in the field of periodontics.

i

- Microsurgery offers new opportunities for periodontal surgery that can enhance the therapeutic results for a variety of procedures.
- Its benefits include improved cosmetics, rapid healing, minimal discomfort, and enhanced patient acceptance.

Lasers in Periodontics

L-light

A-amplification by

S-stimulated

E-emission of

R-radiation

- Based on Albert Einstein's theory of spontaneous and stimulated emission of radiation, **Maiman** developed the first laser prototype in 1960.(ruby laser)
- Shortly thereafter, in 1961, Snitzer published the prototype for the Nd:YAG laser.

- The first application of laser to dental tissue was reported by **Goldman et al.** and **Stem** & **Sognnaes**

Lasers

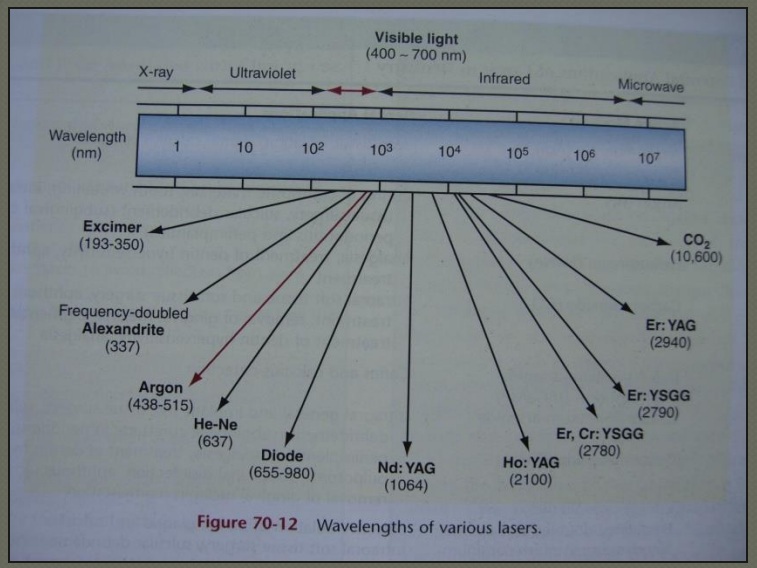


Figure 70-12 Wavelengths of various lasers.

- Stimulated emission of a photon by an excited atom, which triggers the release of a subsequent photon - responsible for generation of a coherent, monochromatic, & collimated form of light
- Can concentrate light energy & exert a strong effect, targeting tissue at an energy level much lower than natural light

Characteristics of Laser Wavelengths Used in Clinical Dentistry

Laser Type	Common Abbreviation	Wavelength	Waveform	Delivery Tip	Reported Periodontal Applications
Carbon dioxide	CO_2	10.6 μm	Gated or continuous	Hollow waveguide; beam focused when 1 to 2 mm from target surface	Soft tissue incision and ablation; subgingival curettage
Neodymium:yttrium-aluminum-garnet	Nd:YAG	1.064 μm	Pulsed	Flexible fiber optic system of varying diameters; surface contact required for most procedures	Soft tissue incision and ablation; subgingival curettage and bacterial elimination
Holmium:yttrium-aluminum-garnet	Ho:YAG	2.1 μm	Pulsed	Flexible fiber optic system; surface contact required for most procedures	Soft tissue incision and ablation; subgingival curettage and bacterial elimination
Erbium:yttrium-aluminum-garnet	Er:YAG	2.94 μm	Free-running pulsed	Flexible fiber optic system or hollow waveguide; surface contact required for most procedures	Soft tissue incision and ablation; subgingival curettage; scaling of root surfaces; osteoplasty and ostectomy
Erbium, chromium:yttrium-selenium-gallium-garnet	Er,Cr:YSGG	2.78 μm	Free-running pulsed	Sapphire crystal inserts of varying diameters; surface contact required for most procedures	Soft tissue incision and ablation; subgingival curettage; osteoplasty and ostectomy
Neodymium:yttrium-aluminum-perovskite	Nd:YAP	1,340 nm	Pulsed	Flexible fiber optic system; surface contact required for most procedures	Soft tissue incision and ablation; subgingival curettage and bacterial elimination
Indium-gallium-arsenide-phosphide; gallium-aluminum-arsenide; gallium-arsenide	InGaAsP (diode) GaAlAs (diode) GaAs (diode)	Diodes can range from 635 to 950 nm	Gated or continuous	Flexible fiber optic system; surface contact required for most procedures	Soft tissue incision and ablation; subgingival curettage and bacterial elimination
Argon	Ar	488 to 514 nm	Gated or continuous	Flexible fiber optic system	Soft tissue incision and ablation

Interaction of Tissue & Laser

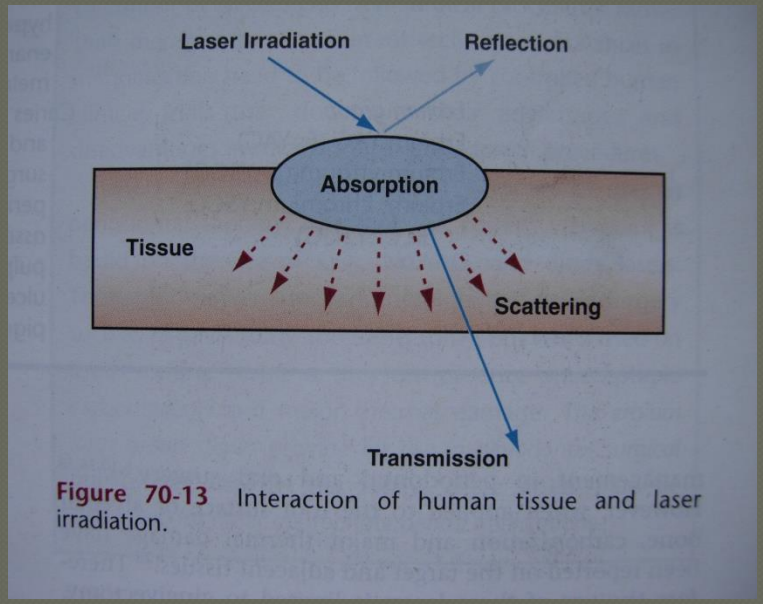


Figure 70-13 Interaction of human tissue and laser irradiation.

- Once in contact with tissue, laser energy is relfected, scattered, absorbed or transmitted to neighbouring tissues.
- The water molecules, proteins, pigments & other macromolecules present in tissues are responsible for absorption, but the absorption coefficient actually depends on the wavelength of the incoming laser.

- Variable parameters affecting energy absorption include
  - emission wavelength,
  - power (watts),
  - waveform (continuous / pulsed),
  - pulse duration,
  - energy/pulse, energy density,
  - duration of exposure,
  - peak power of pulse,
  - Angulation of the energy delivery tip to the target surface,
  - optical properties of the tissue

Types of lasers

Excimer laser	Argon-fluoride Xenon-chloride
Gas lasers	Argon Helium –neon Carbon dioxide
Diode laser	Indium gallium arsenide phophorus,GaAlAs,GaAs
Solid state laser	Frequency doubled alexandrite Nd:YAG Er:YAG

- The characteristics of a laser depend on its **wavelength.**
- The wavelength of lasers used in medicine and dentistry generally range from ***193 nanometers (nm) to 10,600 nm***, representing a broad spectrum from the ultraviolet to the far infrared range.
- Lasers commonly used in dentistry- **CO_2** *10,600 nm* (far infrared) and the **Nd:YAG** *1064 nm* (near infrared)

Application of Lasers

- Most often used in dentistry– Nd:YAG, CO2, Er:YAG, Er,Cr:YSGG, Argon
- Perio– high power lasers like CO2, Nd:YAG & Diode Lasers
- Laser designed for surgery, delivers concentrated and controllable energy to biological tissue.
- As the temperature increases at the surgical site, soft tissue are subjected to :

  warming (37 – 60^0 c),
  welding (60 – 65^0 c),
  Coagulation (65 – 90^0 c),
  protein coagulation (90 – 100^0 c),
  vaporization (>100^0 c)

- Adv: excellent soft tissue ablation, hemostasis, bactericidal effect, minimal wound contraction
- Disadv: When applied to root/bone- carbonization & thermal damage, eyes
- Use- limited to gingivectomy, frenectomy & other soft tissue procedures
- Investigated for- subgingival debridement, removal of granulation tissue during flap, & osseous recontouring, implant surgery, maintenance of implants & management of peri-implantitis.

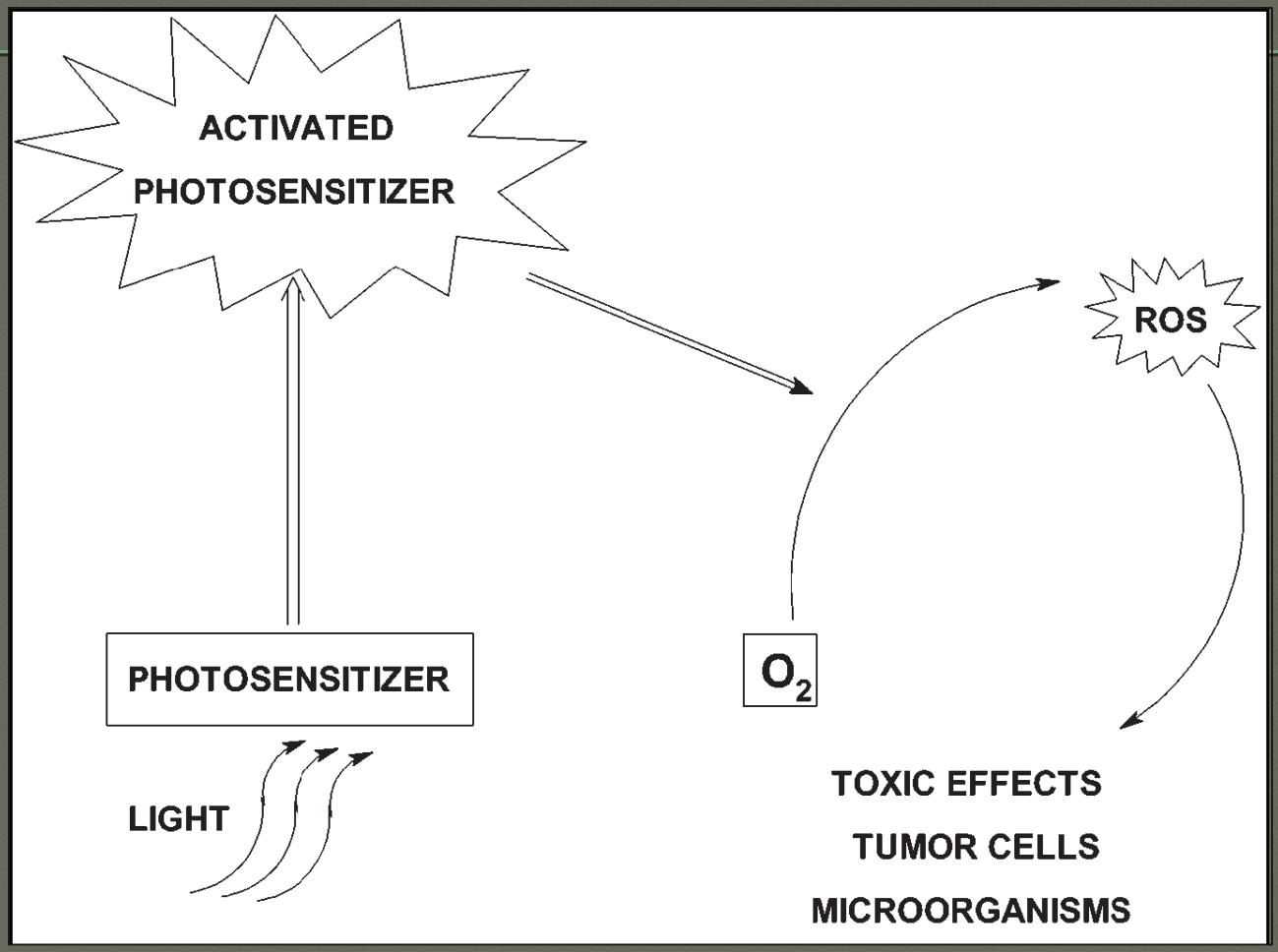
- Absorption of Er:YAG & Er,Cr:YAG lasers in water is highest.
- They ablate all biologic tissues that contain water molecules & applicable to both soft & hard tissues.

Precautions during laser surgery

- Protective eye wear , specific to block the wavelength of laser in use , should be worn by operator and assistant.
- Patient's eyes , throat and delicate oral tissues outside the surgical site should be protected from accidental beam impact through use of safety glasses , wet towels or gauze packs.

Photodynamic therapy

- Photodynamic therapy (PDT), also known as photoradiation therapy, phototherapy, or photochemo therapy
- Involves the use of a photoactive dye (photosensitizer) that is activated by exposure to light of a specific wavelength in the presence of oxygen. The transfer of energy from the activated photosensitizer to available oxygen results in the formation of toxic oxygen species, such as singlet oxygen and free radicals.
- These very reactive chemical species can damage proteins, lipids, nucleic acids, and other cellular components.


ACTIVATED
PHOTOSENSITIZER
ROS
PHOTOSENSITIZER
O_2
LIGHT
TOXIC EFFECTS
TUMOR CELLS
MICROORGANISMS

- Applications of PDT in dentistry are growing rapidly: the treatment of oral cancer, bacterial and fungal infection therapies, and the photodynamic diagnosis (PDD) of the malignant transformation of oral lesions.
- PDT has shown potential in the treatment of oral leukoplakia, oral lichen planus, and head and neck cancer. Photodynamic antimicrobial chemotherapy (PACT) has been efficacious in the treatment of bacterial, fungal, parasitic, and viral infections.

- Sites with difficult access (e.g., furcations, deep invaginations, concavities).
- Removes the biofilm in residual deep pockets during maintenance, no more root substance is removed by mechanical retreatment.
- Decrease the risk of bacteremia which routinely occurs after periodontal treatment procedures
- Useful against antibiotics resistant strains


Thank You