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Medical Laser Applications

Third Stage

Lec 5

Laser in dentistry

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1. Basics of Lasers

Before diving into their dental applications, let's revisit the basic principles of lasers:

- **Definition of Laser:** Laser stands for Light Amplification by Stimulated Emission of Radiation. It is a device that emits light through a process of optical amplification.
 - **Key Properties of Laser Light:**
 1. **Monochromatic:** The light is of a single wavelength.
 2. **Coherent:** The light waves are in phase.
 3. **Collimated:** The beam is highly directional.
 - **Components of a Laser System:**
 1. **Gain Medium:** Determines the laser's wavelength (e.g., solid, liquid, or gas).
 2. **Energy Source:** Supplies energy to the gain medium.
 3. **Optical Resonator:** Reflects and amplifies the light.
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2. Interaction of Lasers with Biological Tissue

Lasers interact with tissues in distinct ways based on their wavelength, power, and pulse duration. These interactions include:

- **Reflection:** Light bounces off the surface.
- **Absorption:** Light is absorbed by tissue molecules, leading to specific effects.
- **Scattering:** Light is dispersed in different directions.
- **Transmission:** Light passes through the tissue.

The degree of absorption depends on the tissue's composition and the laser's wavelength. For instance, water, hemoglobin, and hydroxyapatite in dental tissues have specific absorption peaks.

3. Types of Lasers Used in Dentistry

Several types of lasers are employed in dental procedures, including:

- **Erbium Lasers (Er:YAG, Er,Cr:YSGG):**
 1. Ideal for hard and soft tissue applications.
 2. High water absorption.
 3. Used for cavity preparation and soft tissue surgeries.

- **Diode Lasers:**
 1. Operates in the near-infrared range.
 2. Absorbed primarily by pigments and hemoglobin.
 3. Commonly used for periodontal therapy and soft tissue procedures.

- **CO₂ Lasers:**
 1. Excellent for soft tissue surgeries.
 2. High absorption by water and hydroxyapatite.
 3. Used for frenectomy, gingivectomy, and lesion excisions.

- **Nd:YAG Lasers:**
 1. Works in the near-infrared spectrum.
 2. Absorbed by melanin and hemoglobin.
 3. Effective for periodontal therapy and bacterial decontamination.

4. Applications of Lasers in Dentistry

Lasers are utilized in a variety of dental procedures. Some notable applications include:

- **Hard Tissue Procedures:**
 1. **Cavity Preparation:** Precise removal of decayed tooth structure with minimal heat generation.
 2. **Tooth Whitening:** Activating bleaching agents for cosmetic enhancement.
 3. **Caries Detection:** Using fluorescence-based systems.
- **Soft Tissue Procedures:**
 1. **Gingival Reshaping:** For esthetic improvements.
 2. **Frenectomy:** Removal of the frenum.
 3. **Treatment of Ulcers:** Promotes faster healing.
- **Periodontal Treatments:**
 1. **Bacterial Reduction:** Targets pathogenic bacteria in periodontal pockets.
 2. **Scaling and Root Planing:** Enhances traditional techniques.
- **Surgical Procedures:**
 - Biopsy and lesion removal with minimal bleeding.
- **Endodontics:**
 - Disinfection of root canals.

5. Advantages of Using Lasers in Dentistry

- a) **Precision and Control:** Minimally invasive with reduced collateral damage.
- b) **Reduced Bleeding:** Coagulation properties minimize bleeding during surgery.
- c) **Lower Pain Levels:** Reduced need for anesthesia in many cases.
- d) **Faster Healing:** Promotes tissue regeneration.
- e) **Enhanced Sterilization:** Kills bacteria effectively.

6. Limitations and Challenges

While lasers offer numerous benefits, they also have some limitations:

- a) **Cost:** High initial investment.
- b) **Learning Curve:** Requires specialized training.
- c) **Limited Indications:** Not suitable for all dental procedures.
- d) **Thermal Damage:** Improper use can damage surrounding tissues.

7. Future Directions

The field of laser dentistry continues to evolve. Future advancements may include:

- 1) Development of more versatile laser systems.
- 2) Enhanced integration with imaging technologies.
- 3) Improved affordability and accessibility.
- 4) Exploration of nanotechnology and biophotonics.

Conclusion

Lasers have revolutionized modern dentistry by offering precise, efficient, and patient-friendly solutions. Understanding the physics behind their operation and their interaction with biological tissues is crucial for harnessing their full potential in clinical settings. As science progresses, the role of lasers in dentistry will only expand, making it an indispensable tool for practitioners.

Discussion

1. What does LASER stand for?

- A. Light Atomic System
- B. Light Amplification by Stimulated Emission of Radiation
- C. Light Absorption System
- D. Laser Active Source
- E. Light Emission Radiation

Correct answer: B

2. Which property means single wavelength?

- A. Monochromatic
- B. Collimated
- C. Coherent
- D. Polarized
- E. Amplified

Correct answer: A

3. Coherent laser light means waves are:

- A. Random
- B. Out of phase
- C. In phase
- D. Reflected
- E. Scattered

Correct answer: C

4. Highly directional laser beam is called:

- A. Diffuse
- B. Collimated
- C. Absorbed
- D. Reflected
- E. Transmitted

Correct answer: B

5. Which component sets wavelength?

- A. Power supply
- B. Optical fiber
- C. Cooling system
- D. Gain medium
- E. Detector

Correct answer: D

6. Function of optical resonator is:

- A. Cool laser
- B. Absorb light
- C. Reflect and amplify
- D. Scatter beam
- E. Block radiation

Correct answer: C

7. Which interaction causes heating?

- A. Reflection
- B. Transmission
- C. Scattering
- D. Absorption
- E. Diffraction

Correct answer: D

8. Laser absorption depends mainly on:

- A. Color only
- B. Tissue composition
- C. Room temperature
- D. Operator skill
- E. Fiber diameter

Correct answer: B

9. Which tissue component absorbs lasers strongly?

- A. Calcium only
- B. Enamel prism
- C. Water
- D. Air
- E. Saliva ions

Correct answer: C

10. Erbium lasers are ideal for:

- A. Hard and soft
- B. Hard tissue only
- C. Soft tissue only
- D. Imaging
- E. Whitening only

Correct answer: A

11. Erbium lasers have high absorption in:

- A. Melanin
- B. Hemoglobin
- C. Pigments
- D. Dentin tubules
- E. Water

Correct answer: E

12. Diode lasers operate in:

- A. Ultraviolet
- B. Visible
- C. Near-infrared
- D. X-ray
- E. Microwave

Correct answer: C

13. Diode lasers are absorbed mainly by:

- A. Water
- B. Enamel
- C. Calcium
- D. Hydroxyapatite
- E. Pigments

Correct answer: E

14. CO₂ lasers are best for:

- A. Hard tissue
- B. Soft tissue
- C. Imaging
- D. Caries detection
- E. Whitening

Correct answer: B

15. CO₂ laser absorption is high in:

- A. Water
- B. Hemoglobin
- C. Melanin
- D. Collagen only
- E. Air

Correct answer: A

16. Nd:YAG lasers are absorbed by:

- A. Water only
- B. Enamel
- C. Melanin and hemoglobin
- D. Hydroxyapatite only
- E. Saliva

Correct answer: C

17. Laser cavity preparation advantage is:

- A. More vibration
- B. More heat
- C. Precision
- D. Tooth cracking
- E. Noise

Correct answer: C

18. Fluorescence-based lasers are used for:

- A. Surgery
- B. Whitening
- C. Frenectomy
- D. Caries detection
- E. Root filling

Correct answer: D

19. Gingival reshaping is a:

- A. Hard tissue procedure
- B. Soft tissue procedure
- C. Diagnostic method
- D. Imaging technique
- E. Endodontic step

Correct answer: B

20. Laser frenectomy involves:

- A. Bone removal
- B. Root cleaning
- C. Whitening
- D. Enamel polishing
- E. Frenum removal

Correct answer: E

21. Laser periodontal therapy targets:

- A. Enamel
- B. Dentin
- C. Cementum only
- D. Pulp
- E. Bacteria

Correct answer: E

22. Laser surgery advantage includes:

- A. More bleeding
- B. Less precision
- C. Tissue coagulation
- D. Longer healing
- E. Higher pain

Correct answer: C

23. Laser use often reduces need for:

- A. X-rays
- B. Antibiotics
- C. Fillings
- D. Anesthesia
- E. Crowns

Correct answer: D

24. Major limitation of lasers is:

- A. Low precision
- B. High cost
- C. Poor sterilization
- D. Slow healing
- E. Weak power

Correct answer: B

25. Improper laser use may cause:

- A. Thermal damage
- B. Fracture
- C. Infection
- D. Color change
- E. Noise

Correct answer: A