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Dep. Medical physics

Medical Laser Applications

Third Stage

Lec 10

Laser Skin Treatment

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Laser Skin Treatment

Introduction

Laser skin treatment is a branch of medical physics that utilizes laser technology to address various dermatological conditions, including skin rejuvenation, scar treatment, hair removal, and the correction of pigmentation disorders. This lecture will explore the fundamental principles of lasers, their interaction with biological tissues, and their applications in dermatology.

1. Fundamentals of Laser Technology

- **Definition of Laser:** LASER stands for **Light Amplification by Stimulated Emission of Radiation**.
- **Key Properties of Laser Light:**
 - **Monochromaticity:** Emits a single wavelength of light.
 - **Coherence:** The emitted photons are phase-aligned.
 - **Collimation:** The light is highly directional.
 - **High Intensity:** Concentrated energy for medical applications.
- **Types of Lasers Used in Dermatology:**
 - **Ablative Lasers** (e.g., CO₂, Er:YAG): Used for resurfacing and scar reduction.
 - **Non-Ablative Lasers** (e.g., Nd:YAG, Alexandrite): Used for pigmentation correction and hair removal.
 - **Fractional Lasers:** Deliver energy in a grid pattern for controlled treatment.

2. Interaction of Laser with Biological Tissue

- **Absorption:** Depends on chromophores such as melanin, hemoglobin, and water.
- **Scattering:** Can influence the depth of laser penetration.
- **Thermal Effects:** Can cause coagulation, vaporization, or photochemical reactions.
- **Selective Photothermolysis:** Precise targeting of tissue based on wavelength and pulse duration.

3. Applications of Laser Skin Treatment

a) Skin Rejuvenation

- Stimulates collagen production.
- Reduces wrinkles, fine lines, and sun damage.

b) Scar and Tattoo Removal

- **CO₂ and Er:YAG lasers:** Used for acne and surgical scars.
- **Q-Switched lasers:** Break down tattoo pigments for removal.

c) Hair Removal

- Targets melanin in hair follicles.
- Common lasers: **Diode (810 nm), Alexandrite (755 nm), Nd:YAG (1064 nm).**

d) Treatment of Vascular and Pigmentation Disorders

- Treats conditions such as rosacea, spider veins, and hyperpigmentation.
- **Pulsed Dye Lasers (PDL)** are commonly used for vascular lesions.



4 .Advantages and Limitations of Laser Skin Treatments

Advantages:

- Non-invasive or minimally invasive.
- High precision targeting of affected areas.
- Faster recovery compared to surgical interventions.

Limitations:

- Potential for side effects such as redness, swelling, or pigmentation changes.
- Multiple sessions often required for optimal results.
- Cost and accessibility may be limiting factors.

5. Safety Measures and Patient Considerations

- **Pre-Treatment Assessment:** Skin type (Fitzpatrick Scale), medical history, and expectations.
- **Safety Protocols:**
 - Use of protective eyewear.
 - Appropriate selection of wavelength and fluence.
 - Cooling techniques to prevent burns.



- **Post-Treatment Care:**
 - Avoiding sun exposure.
 - Using prescribed skincare products.
 - Managing potential side effects with appropriate aftercare.

Conclusion

Laser skin treatment is a crucial application of medical physics, offering precise and effective solutions for dermatological conditions. Understanding the physics behind laser-tissue interactions enables medical physicists to optimize treatment protocols, enhance safety, and improve patient outcomes. Future advancements in laser technology continue to refine these treatments, making them more efficient and accessible.

Discussion Questions:

- What are the main differences between ablative and non-ablative lasers?
- How does selective photothermolysis ensure targeted treatment?
- What safety precautions should be taken during laser procedures?

Discussion

1. The term LASER stands for:

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

2. Which property means single wavelength emission?

- A. Coherence
- B. Collimation
- C. Intensity
- D. Monochromaticity
- E. Diffraction

3. Phase alignment of photons refers to:

- A. Intensity
- B. Absorption
- C. Coherence
- D. Reflection
- E. Refraction

4. Highly directional laser light is described as:

- A. Diffuse
- B. Collimated
- C. Scattered
- D. Divergent
- E. Random

5. Which laser type removes tissue layers?

- A. Non-ablative
- B. Fractional
- C. Ablative
- D. Low-level
- E. Pulsed

6. CO₂ laser is classified as:

- A. Non-ablative
- B. Ablative
- C. Diode
- D. Dye
- E. Semiconductor

7. Fractional lasers deliver energy in:

- A. Continuous beam
- B. Single spot
- C. Grid pattern
- D. Random pulses
- E. Wide field

8. Which chromophore absorbs laser energy in hair removal?

- A. Water
- B. Keratin
- C. Hemoglobin
- D. Melanin
- E. Oxygen

9. Laser penetration depth is mainly affected by:

- A. Reflection
- B. Scattering
- C. Refraction
- D. Diffusion
- E. Polarization

10. Thermal coagulation is a result of:

- A. Mechanical effect
- B. Electrical effect
- C. Thermal effect
- D. Acoustic effect
- E. Magnetic effect

11. Selective photothermolysis depends mainly on:

- A. Skin pressure
- B. Pulse duration
- C. Patient age
- D. Beam angle
- E. Treatment time

12. Which laser is commonly used for tattoo removal?

- A. Diode
- B. CO₂
- C. Er:YAG
- D. Q-Switched
- E. Continuous wave

13. Skin rejuvenation mainly stimulates:

- A. Melanin
- B. Elastin loss
- C. Collagen production
- D. Blood vessels
- E. Epidermal peeling

14. Which wavelength is typical for Alexandrite laser?

- A. 532 nm
- B. 694 nm
- C. 755 nm
- D. 810 nm
- E. 1064 nm

15. Diode laser wavelength is approximately:

- A. 633 nm
- B. 694 nm
- C. 755 nm
- D. 810 nm
- E. 1064 nm

16. Nd:YAG laser commonly operates at:

- A. 532 nm
- B. 755 nm
- C. 810 nm
- D. 980 nm
- E. 1064 nm

17. Vascular lesions are best treated using:

- A. Diode laser
- B. CO₂ laser
- C. Pulsed Dye Laser
- D. Er:YAG laser
- E. Alexandrite laser

18. Rosacea is considered a:

- A. Pigmentation disorder
- B. Vascular disorder
- C. Hair disorder
- D. Scar condition
- E. Epidermal disease

19. One main advantage of laser treatment is:

- A. Long hospitalization
- B. High blood loss
- C. High precision
- D. Large scars
- E. Permanent pain

20. A common limitation of laser treatment is:

- A. Infection risk
- B. Multiple sessions
- C. No precision
- D. Long surgery
- E. Deep anesthesia

21. Skin type assessment uses the:

- A. ABC scale
- B. WHO scale
- C. Fitzpatrick scale
- D. UV index
- E. Melanin chart

22. Protective eyewear is used to protect:

- A. Skin only
- B. Hair follicles
- C. Blood vessels
- D. Eyes
- E. Nerves

23. Cooling techniques mainly prevent:

- A. Infection
- B. Bleeding
- C. Burns
- D. Scarring
- E. Pigment loss

24. Post-treatment patients should avoid:

- A. Water
- B. Exercise
- C. Sun exposure
- D. Sleep
- E. Medication

25. Laser skin treatment belongs to:

- A. Nuclear physics
- B. Solid state physics
- C. Medical physics
- D. Astrophysics
- E. Biophysics only