Lasers in Gastroenterology, Otorhinolaryngology & Pulmonology

Eloise Anguluan
Laser-Tissue Interactions
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Gastroenterology

the branch of medicine which deals with disorders of the stomach and intestines

Why use lasers in gastroenterology?
Endoscope

- Laser fiber
- Balloon dilators
Lasers

**CW Nd:YAG**

- 1064 nm
- Typical volume coagulator; deep unspecific coagulation
- At different power densities: coagulation, vaporization, or to cut tissue
- Can be transmitted through an optical fiber

**Dye lasers or diode lasers**

- Wide range of wavelengths available (can be tunable)
- For PDT, 630 nm (Photofrin® II)

*Vessels greater than 5mm diameter cannot be coagulated by laser.*
## Laser treatment - Effects

<table>
<thead>
<tr>
<th>Laser effect</th>
<th>Clinical use</th>
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</thead>
<tbody>
<tr>
<td>High power (CW Nd:YAG, 1064 nm)</td>
<td>Short, sharp shots - Thermal contraction, providing hemostasis</td>
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<td></td>
<td>Longer shots - Cutting or debulking of tissue by vaporization and</td>
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<tr>
<td></td>
<td>coagulation</td>
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<tr>
<td>Low power (CW Nd:YAG, 1064 nm)</td>
<td>Gentle coagulation of lesions within solid organs (no vaporization)</td>
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<td>Photochemical: (Photodynamic therapy PDT, dye</td>
<td>Non-thermal destruction of tissue by activation of a previously</td>
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<td>laser or diode laser)</td>
<td>administered photosensitising drug</td>
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*Hemostasis – halting the flow of blood*  

Laser treatment – Stenoses treatment

Stenosis – abnormal narrowing of a passage in the body (pl. stenosis)

• Esophagus Stenoses
  • 1: Mechanical widening using dilatators
  • 2: Coagulated with Nd:YAG (CO2 gas cools fiber tip) – tissue shrinks
  • If stenosis is induced by a tumor, the tumor is coagulated from its interior
  • Induced bleeding can be stopped by a temporary increase in laser power

• Lower Gastrointestinal tract
  • Apply 80-100 W of laser power and slowly move the fiber back, inducing 1-2mm grooves
  • Several treatments
  • No mechanical pressure applied
Laser treatment - Tumors

• Conventional technique – cryotherapy
  • Induce tumor necrosis by freezing tissue to -180°C
  • Complete anaesthetization of the patient is needed
  • CONS: complete anaesthetization should be avoided for older patients (harmful side-effects)

• Laser treatment
  • Coagulate tumor from the interior
  • CONS: enhanced formation of edema (can be treated with proper medication)
Laser treatment - Hemorrhage

- All acute and localized hemorrhages are suitable for treatment using laser coagulation

- Rectum (50-70 W) and stomach (70-100 W)
  - 1: Complete clearance of bleeding source
  - 2: Coagulate the tissue by impinging with a laser beam 5-10 mm away using circular movements (no time limit, doctor’s discretion)
Laser treatment - PDT

- Delivery modes
  - IV injection of photosensitizer + carrier
  - PS encapsulated in a colloidal carrier such as oil dispersion, liposomes, polymeric particles – surface modified to increase uptake by tumors and decrease uptake by phagocytic cells
- 48-72 hours to wait before exposure to laser
- Tumors are curable by PDT only if their infiltration depths are below 5-10 nm
- Photofrin® II (630 nm) – most common 2002
  - Poor tissue penetration of light
  - 6-8 weeks photosensitive
- Normal epithelium may cover the interior of the esophagus again
- CONS: Tumors of the stomach are difficult to treat using PDT
Otorhinolaryngology & Pulmonology

- Diseases of the ear, nose, and throat
- Diseases involving the respiratory tract
Laryngoscope

Endoscopes are flexible

Laryngoscopes are rigid
Lasers

CO₂ Laser

• 10 600 nm
• high absorption in water, leading to explosive vaporization of tissue surface
• Precise cutting, with very low penetration depth
• No significant thermal damage to the surrounding area
• CONS:
  • Hemostatic capabilities are limited to small vessels
  • Risks associated with complete anesthetization (ventilation)
  ➢ Minimum O₂ concentration
Laser treatment – microsurgery of the larynx

In stenoses

* Large stenosis (several cm) should be treated using conventional surgery
Laser treatment – microsurgery of the larynx

In benign and malignant tumors of the vocal cords, and other laryngeal carcinoma

Hemangiomas of the larynx (benign tumor of blood vessels)
Laser treatment – Otosclerosis

bone disease of the inner ear

Stapedectomy – removal of stapes

Before: pulsed Er:YAG (2940 nm) or Er:YSGG (2790 nm) lasers (strongly absorbed in bone)

RISKS:
- high ablation depths - perforations at only 5 pulses;
- excessive increase in temperature - high pressures induced in the cochlea

Stapedotomy – drill holes into the stapes to improve propagation of sound

Mechanical removal by drill or CO₂ laser (pulsed mode, 50 ms)
Laser treatment – Tracheobronchial tumors

Risks of hemorrhage – Nd:YAG laser provides immediate coagulation

Other options: mechanical removal, electrocoagulation, and cryotherapy
Questions?

“Quick! Somebody call a lawyer!”