ENDOBRONCHIAL ABLATIVE THERAPIES

Christopher Cortes, MD, FPCCP
Choice of Ablative Therapy

- Size of the lesion
- Location of the lesion
- Characteristics of the lesion
- Availability of the different therapies
- Training & skills of the bronchoscopist

Indications

- Lesion occupying >50% of the airway with symptoms of dyspnea
- Hemoptysis
- Recurrent pneumonia
- Intractable cough

Bolliger CT et. al., Eur Respir J. 2002
Amjadi K et. al., Respiration. 2008
Folch E et. al., Semin Respir Crit Care Med. 2008
Bolliger CT et. al., Eur Respir J. 2006
CONTRAINDICATIONS

ABSOLUTE
- Extrinsic compression of airway

RELATIVE
- Inability to lower FiO2 to 40%
- Distal airway obstructions
- Airway obstruction present for > 4 weeks
- Length of obstruction > 4 cm

Bolliger CT et al., Eur Respir J. 2006
Klopp AH et al., Clin Lung Cancer. 2006
Ung YC et al., Brachytherapy. 2006
## COMPARISON OF ENDOBRONCHIAL ABLATIVE THERAPIES

<table>
<thead>
<tr>
<th></th>
<th>LASER</th>
<th>ELECTROCAUTERY</th>
<th>ARGON PLASMA COAGULATION</th>
<th>CRYOTHERAPY</th>
<th>BRACHYTHERAPY</th>
<th>PHOTODYNAMIC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time to improvement</strong></td>
<td>Immediate</td>
<td>Immediate</td>
<td>Immediate to days</td>
<td>Days to weeks</td>
<td>Days to weeks</td>
<td>Days to weeks</td>
</tr>
<tr>
<td><strong>Control of bleeding</strong></td>
<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td><strong>Tumor specific</strong></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Depth of penetration</strong></td>
<td>Variable, dependent on power settings</td>
<td>Variable, dependent on power settings</td>
<td>3mm</td>
<td>Variable, dependent on radiation dose</td>
<td>3mm</td>
<td>3mm</td>
</tr>
<tr>
<td><strong>Expense</strong></td>
<td>+++</td>
<td>+</td>
<td>++</td>
<td>++</td>
<td>+++</td>
<td>+++</td>
</tr>
</tbody>
</table>

*chris_cortes_md_2014*
Uses light energy transmitted through fibers to desiccate endoluminal tissue

Types: potassium titanyl phosphate, yttrium aluminum pevroskite, carbon dioxide and Nd:YAG

Predictable tissue effects, precise area of treatment effect, rapid and immediate results, repeatability of treatments, and ability to blend with other airway interventions
Power Settings

- **Low-power:** shallow effect and coagulate tissue
- **High-power:** penetrate deeper and result in carbonization and vaporization of tissue

Distance from the tip of the laser fiber

- 1cm away from the lesion: shallow penetration
- 3mm-4mm away from the lesion: deeper penetration
LASER

Effects are immediate ~ dramatic improvement in patient’s complaints and symptoms

Surrounding tissue is also affected ~ thermal injury & cell death

Delayed effects seen in 48 to 96 hours

Results in further improvement in airway lumen size
ELECTROCAUTERY

- Uses the flow of electricity to generate heat
- Effects depend on several variables: nature of the lesion, current waveform properties, and the power setting, machine mode, and the type of probe used
- Electrical current waveforms
  - High frequency: cut mode
  - Low frequency: coagulation mode
ELECTROCAUTERY

Power Settings

- Low-power: shallow effect and coagulate tissue
- High-power: penetrate deeper and result in carbonization and vaporization of tissue

Immediate ablative effect

Delayed effect ~ cytocidal effect of heat generation

Cost is minimal

Common instruments: a probe, snare, knife, and forceps
ELECTROCAUTERY
ARGON PLASMA COAGULATION

Uses argon gas as the media through which the electrical current flows to the tissue.

It has superficial effects on tissues and is an excellent option for coagulation.

Shallow effects ~ not optimal for debulking.

Immediate tissue ablative effect as well as delayed cytocidal effect of heat transmission.
CRYOTHERAPY

- Uses extreme cold to treat airway lesions
- Special probe - rapidly expanding gas (e.g. nitrous oxide, liquid nitrogen) flows to the tip of the catheter and cools it to -40°C
- Active cooling (30-60 seconds) followed by period of passive rewarming
- Freeze-and-thaw cycle is repeated 2 to 3 times for maximal effect
CRYOTHERAPY

ISSUES:

- Lacks precision, shallow effect and has no immediate effect
- Maximal tissue destruction occurs 1 to 2 weeks after and requires repeated treatment
- Time consuming
BRACHYTHERAPY

Use of radiation to treat malignant lesions

- Specialized catheter placed under direct visualization or with assistance of fluoroscopy or ultrasound

- Radiation seed are advanced through the catheter and into the desired location

- Not used for lesions that are associated with acute complaints of dyspnea
BRACHYTHERAPY

Used for long lesions growing into the airways or compressing the airways.

Offered to patients who have already received maximal external beam radiation and who are not candidates for more conventional ablative techniques.

No immediate effect.

Maximal effect ~ several weeks after.

Expensive and requires specialized facilities.
PHOTODYNAMIC THERAPY

Application of light energy to tissues that have been penetrated with photosensitizer

Photosensitization agent (Photofrin) ~ administered through IV injection 2-3 days before

active metabolizing cells and malignant cells
PHOTODYNAMIC THERAPY

Light probe emits specific frequency and activates photosensitizing agent

Generation of reactive oxygen species — damage cellular structures and leads to cell death

Repeated as necessary to reach deeper tissue

Does not result in immediate effect

Maximal effect ~ several days after
## COMPLICATIONS

<table>
<thead>
<tr>
<th>Type of Therapy</th>
<th>Airway Perforation</th>
<th>Hemorrhage</th>
<th>Airway Fire</th>
<th>Air Embolism</th>
<th>Respiratory Failure</th>
<th>MI, Arrythmia</th>
<th>Death</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laser</td>
<td>Possible</td>
<td>Possible</td>
<td>Possible</td>
<td>Very rare</td>
<td>Possible</td>
<td>Rare</td>
<td>Very rare</td>
</tr>
<tr>
<td>Electrocautery</td>
<td>Possible</td>
<td>Possible</td>
<td>Possible</td>
<td>No</td>
<td>Possible</td>
<td>Rare</td>
<td>Very rare</td>
</tr>
<tr>
<td>APC</td>
<td>Unlikely</td>
<td>Unlikely</td>
<td>Possible</td>
<td>No</td>
<td>Possible</td>
<td>Rare</td>
<td>Very Rare</td>
</tr>
<tr>
<td>Cryotherapy</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Possible</td>
<td>Rare</td>
<td>Very rare</td>
</tr>
<tr>
<td>PDT</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Possible</td>
<td>Rare</td>
<td>Very rare</td>
</tr>
<tr>
<td>Brachytherapy</td>
<td>No</td>
<td>Unlikely</td>
<td>No</td>
<td>No</td>
<td>Possible</td>
<td>Rare</td>
<td>Very are</td>
</tr>
</tbody>
</table>

Rate of complication vary significantly among pulmonologist, airway centres, and patients. Precise estimates of risk are difficult to site as such qualitative estimates are commonly described.
COMPLICATIONS

- Rare complications (respiratory failure, MI, cardiac arrhythmia and death) - more frequent
- Prolonged sedation
- Need for decreased FiO2 which may allow transient or prolonged hypoxemia
- Airway perforation ~ pneumomediastinum, pneumothorax and hemorrhage
- Deploy therapy parallel to the airway
- Frequently re-evaluate tissue planes dissected
COMPLICATIONS

- **Bleeding/hemoptysis**
  - Laser and electrocautery - massive
  - PDT and brachtherapy - delayed (mucosal tissue breakdown and ulceration)

- **Airway fires**
  - Keep oxygen concentration below 40% or preferably below 30%
  - Keep tip of the laser fiber or electrocautery at least 1 cm away from the end of the bronchoscope
  - Consider using LMA or rigid bronchoscope
Air embolism - cerebral infarction

- Rare complication of laser therapy
- Result of bronchial wall blood vessel disruption in the setting of positive pressure ventilation and the use of gas cooled laser fiber
- Limited by using noncontact laser fiber and non-gas-cooled fibers
PRACTICAL CONSIDERATIONS

Hot therapies (laser, electrocautery, and APC)

FiO2 must stay below 40% to reduce the risk of airway fires

When advanced airways are needed, a LMA instead of an endotracheal tube should be considered to reduce the risk for airway fires

Using a rigid bronchoscope should be considered, when available and appropriate to the situation, to reduce the risk for airway fires

Ideal interventions often are associated with immediate clinical improvement
PRACTICAL CONSIDERATIONS

Electrocautery and APC

Due to the electrical current, caution should be used in patients with pacemakers

Wide array of specialized instruments that allow for unique interventions (for electrocautery)

Electrocautery achieves similar results to laser and is more economical

Cryotherapy

Results are delayed

It is able to be performed with any inspire level of oxygen

It is time consuming
PRACTICAL CONSIDERATIONS

Photodynamic therapy
- Associated with intense photosensitivity to sunlight
- Results may take days to weeks
- Repeat bronchoscopy is required to remove sloughed tissue
- Applicable only in patients with tumors that have significant blood flow

Brachytherapy
- Additional radiation may be delivered to areas that have received maximal external beam radiation
- It can be delivered to long lesions or lesions that are external to and compressing the airway
- It is expensive and requires special facilities
REFERENCES

THANK YOU!