BRONCHOSCOPIC ELECTROSURGERY

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Definition

Application of high-frequency alternating electrical current for the coagulation and/or destruction of tissue via introduction of accessories through the bronchoscope
Physics

- As the electric current passes through the tissue, electrons collide with tissue molecules
- These collisions cause dissipation of energy into the tissue in the form of heat
- Heat generated is directly proportional to the amount of current, duration of contact, and tissue resistance
Physics (cont)

- Current flows through tissue between the active electrode of the accessory (e.g., probe, knife) and the patient plate.
- Tissue current density is high at the treatment site because of the small surface area in contact with the electrode.
- Tissue subjected to high current density heats up, causing evaporation of intracellular water and tissue coagulation (<100 °C) or cutting (>100 °C).
Flexible vs. Rigid Bronchoscopes

- Electrosurgery is feasible using both flexible and rigid bronchoscopes.
- This module focuses on electrosurgery with flexible bronchoscopes.
- For large tumors in proximal airways, it may be advisable to perform electrosurgery via rigid bronchoscopy and to control ventilation perioperatively.
Electrosurgery Mechanism of Action: Review

- Electrosurgical current
- Active electrode
- Tissue
- High frequency power supply
- Grounding plate (Neutral electrode)
Tissue Effects of Electrosurgery: Review

Coagulation

Cutting
Procedure

Setting:
• Outpatient or
• Inpatient

Anesthesia:
• Local anesthesia and conscious sedation
• General anesthesia (jet or conventional ventilation)
Indications for Bronchoscopic Electrosurgery

1) Endobronchial tumors that are not immediately life-threatening
2) Endobronchial granulation tissue (anastomotic, metallic stent-related, airway inflammatory disorders)
3) Tracheobronchial webs
4) Fibrotic strictures
5) Diagnosis of “vascular” endoluminal masses (eg, bronchial carcinoids) using electrosurgical forceps
6) Removal of polypoid airway lesions with electrosurgical snare
7) Curative treatment of radiographically occult lung cancer
Contraindications for Bronchoscopic Electrosurgery

1) Completely obstructing tracheal masses
2) Massive hemoptysis
3) Patients requiring >40% FiO$_2$ for prolonged periods
4) Lesions adjacent to endotracheal tube or radio-opaque silicone stent
5) Lesions adjacent to vocal cords. These should be managed in concert with ENT
6) Patients with pacemakers or automated implantable defibrillators that cannot be turned off temporarily for the procedure
7) Extrinsic compression of airway by tumor
8) Patients with uncorrectable bleeding diathesis
Bronchoscopic Electrosurgery: Benefits

- Simple
- Cutting, coagulation, or “blend” applications
- Comparable success rates to Nd:YAG laser
- Application under conscious sedation via flexible scope
- Outpatient procedure
- Safe
- Cost-effective

Important General Precautions

• Use bronchoscope designed for bronchoscopic electrosurgery
• Maintain FiO$_2$ below 40% during the electrosurgery
• Bronchoscopic electrosurgery may interfere with pacemaker and defibrillator
• In patients with implanted metal plates, place grounding plate close to treatment site
Cutting vs Coagulation

- **Continuous** high-voltage current causes rapid vaporization of intracellular water, rupturing cells and cutting tissue.
- **Blend mode** uses continuous current with periodic differences in amplitude to achieve simultaneous cutting and coagulation.
- **Intermittent** bursts of current applied to tissue cause a gradual increase in heat, leading to intracellular water evaporation and tissue coagulation.
Accessories

Probe

Snare

Knife

Forceps
Uses of Electrosurgical Accessories

- **Probe (Coagulation Electrode):** Tumor coagulation and hemostasis (similar to direct contact laser)
- **Electrosurgical Knife:** Broad-based surface coagulation and tissue resection (eg, of webs, scars, and sessile and pedunculated lesions) in narrow airway lumens
- **Electrosurgical Snare:** “Lassoing” and removal of polypoid and pedunculated endobronchial lesions
- **Hot Biopsy Forceps:** Biopsies and cauterizes simultaneously for tissue collection and tumor debulking
Electrosurgery vs Laser Photo resection

- Electrosurgery burns and destroys tissue, but does not vaporize; debridement required
- Wet surfaces (bleeding, secretions, lavage) spread out contact point and interfere with electrosurgery action
- Probe more flexible than laser fiber and can be directly applied to sessile lesions
- Electrosurgical snare ideal for polypoid lesions; not available with laser
Electrosurgery vs Laser Photoablation (cont)

Nd-YAG laser vs bronchoscopic electrocautery for palliation of symptomatic airway obstruction: A cost-effectiveness study

• Retrospective analysis
• 31 patients with inoperable non-small cell lung cancer and symptomatic intraluminal tumor
  – electrosurgery: 17 patients
  – laser photoresection: 14 patients
• Electrosurgery equally effective, less expensive, more accessible than laser
# Electrosurgery vs Laser Photoresection (cont)

<table>
<thead>
<tr>
<th></th>
<th>Nd:YAG Laser</th>
<th>Electrosurgery</th>
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<tbody>
<tr>
<td>Alleviation of symptoms</td>
<td>70%</td>
<td>70%</td>
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<tr>
<td>Survival (months)</td>
<td>8 ± 2.5</td>
<td>11.5 ± 3.5</td>
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<tr>
<td>Number of treatments</td>
<td>1.1</td>
<td>1.2</td>
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<tr>
<td>Duration of hospital stay</td>
<td>8.4 days</td>
<td>6.7 days</td>
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<tr>
<td>Total cost per patient</td>
<td>$5,321</td>
<td>$4,290</td>
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<tr>
<td>Cost per session</td>
<td>$218</td>
<td>$10</td>
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<tr>
<td>Equipment cost</td>
<td>$208,333</td>
<td>$6,701</td>
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Bronchoscopic Electrosurgery: Safety Concerns

• Bleeding (snare > probe)
• Airway perforation/pneumothorax (unlikely with snare)
• Snare entrapment (inability to cut)
• Endobronchial fire
• Electric shock to patient or endoscopist
Tissue Effects of Electrosurgery Applied to the Bronchial Wall

• **Early:** Coagulative necrosis of mucosa and intense acute inflammation extending into bronchial wall [1]
• **Delayed:** Extensive transmural fibrosis and cartilaginous destruction [1]
• The severity of the damage appears to be related to the duration of contact with the probe [2]
• The amount of energy used does not seem to correlate with severity of tissue effect [2]

* **CAUTION:** Electrosurgical treatment of bronchial wall lesions (eg, carcinoma in situ) can cause **stenosis**. This also occurs with brachytherapy and photodynamic therapy.

Potential Effects of Electrosurgery on Pacemakers

- Inhibition of pacemaker
- Reprogramming of pacemaker
- Resetting of pacemaker to its “backup” mode
- Permanent damage to the pulse generator (rare)
- Induction of ventricular fibrillation (rarely, energy can be picked up by the AICD/pacemaker and/or the leads and delivered directly to the heart)
- Increasing the capture threshold by causing an endocardial burn at the electrode-myocardial interface; this may lead to loss of capture (rare)
References


