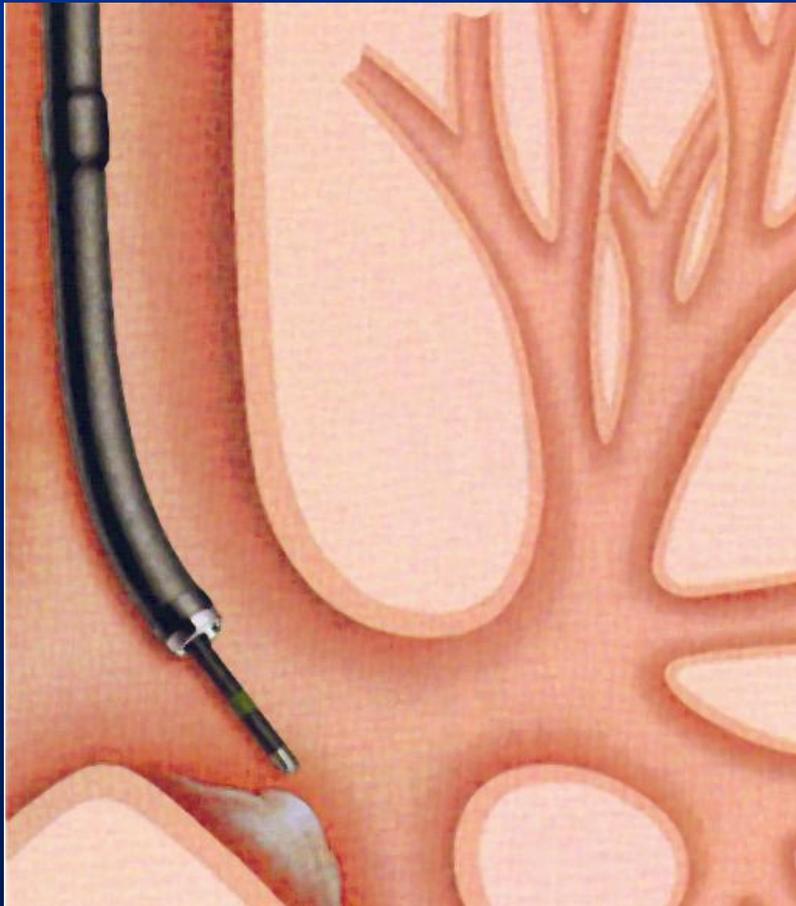


BRONCHOSCOPIC ELECTROSURGERY



Dr Steve Yang
Consultant
Dept of Respiratory & Critical
Care Medicine

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

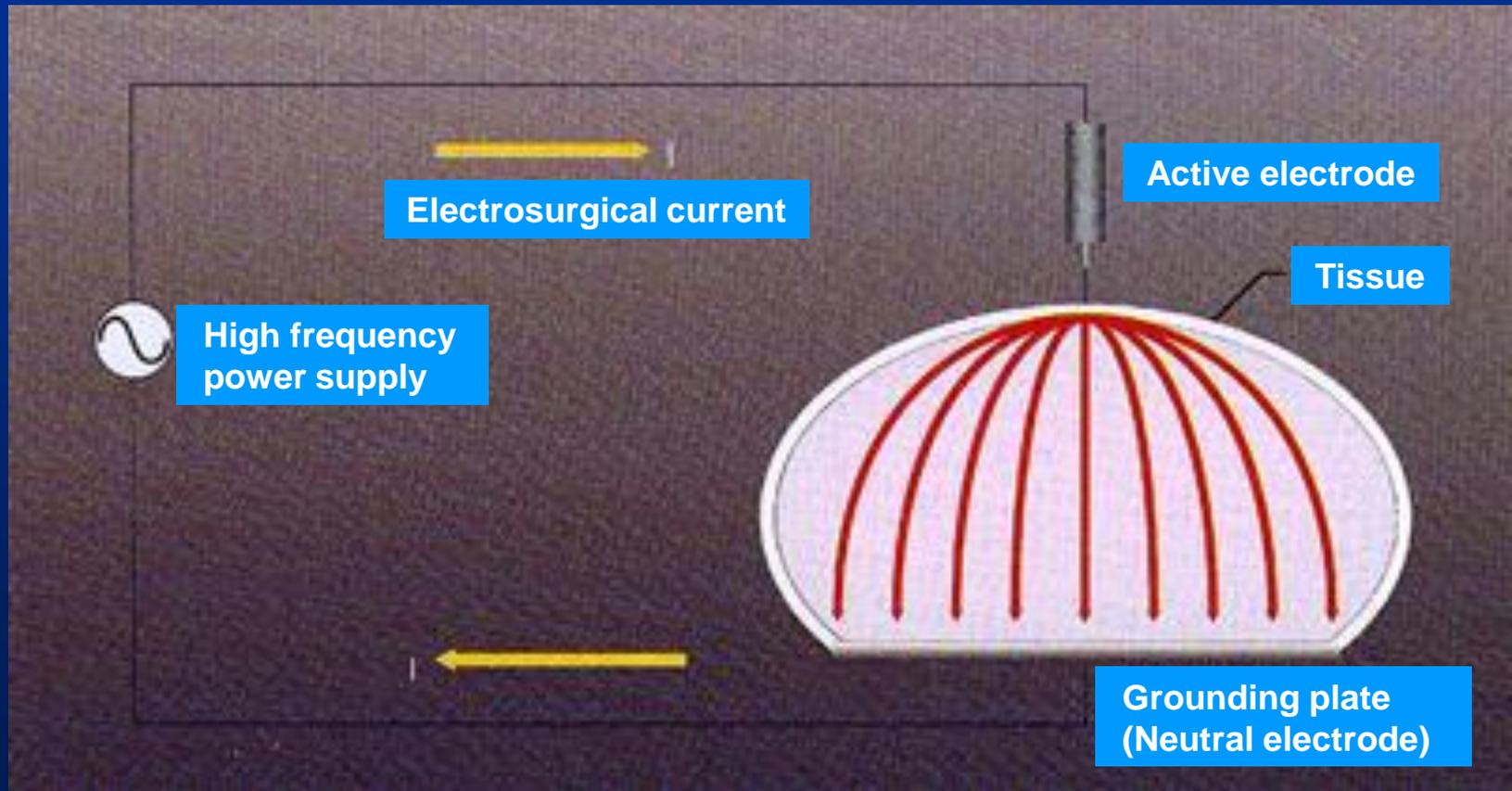
Physics (cont)

- Current flows through tissue between the active electrode of the accessory (eg, 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)

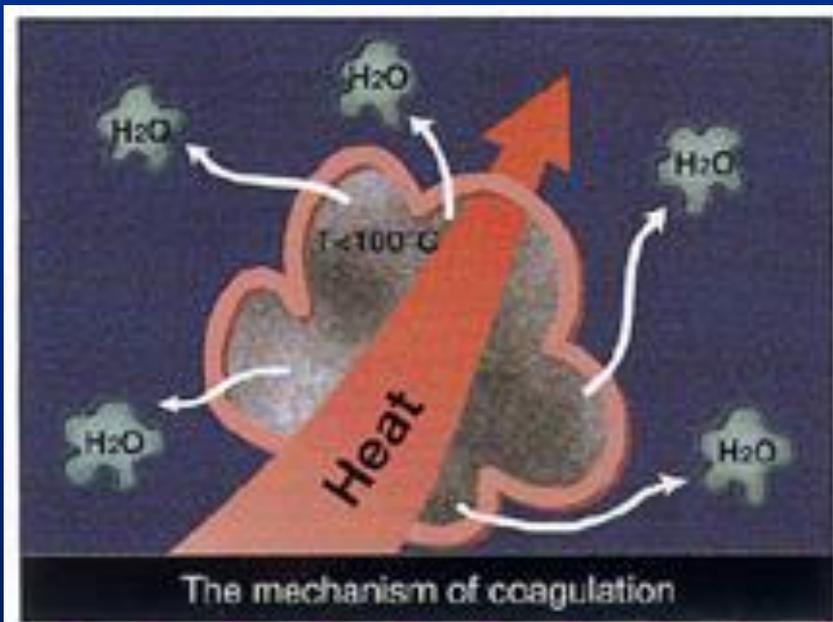
Flexible vs. Rigid Bronchoscopes

- 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

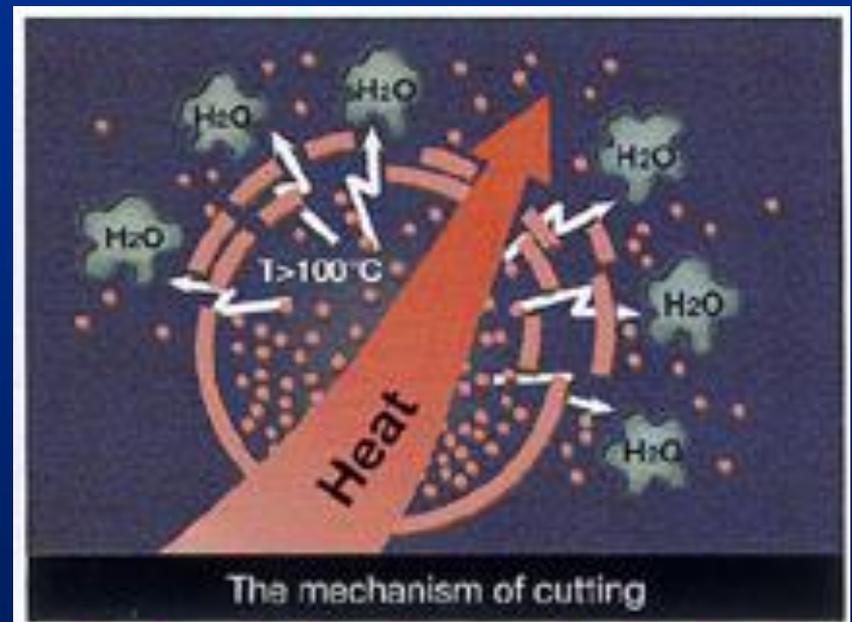
Electrosurgery Mechanism of Action: Review



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 electro-surgery
- Maintain FiO_2 below 40% during the electro-surgery
- Bronchoscopic electro-surgery may interfere with pacemaker and defibrillator
- In patients with implanted metal plates, place grounding plate close to treatment site

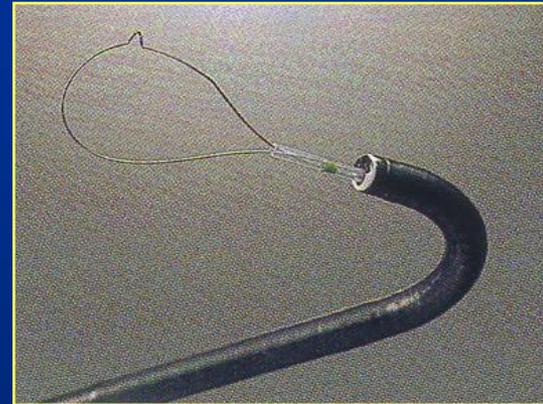
Cutting vs Coagulation

- 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



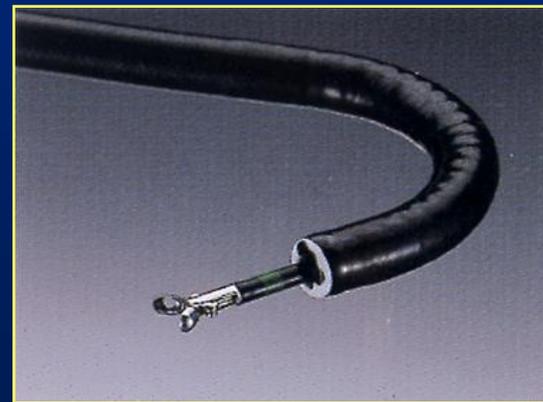
Probe



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 Photoresection

- 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 Photoresection (cont)

Nd-YAG laser vs bronchoscopic electrocautery for palliation of symptomatic airway obstruction: A cost-effectiveness study
van Boxem T et al. *Chest*. 1999;116:1108-1112

- 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)

| | Nd:YAG Laser | Electrosurgery |
|----------------------------------|---------------------|-----------------------|
| Alleviation of symptoms | 70% | 70% |
| Survival (months) | 8 ± 2.5 | 11.5 ± 3.5 |
| Number of treatments | 1.1 | 1.2 |
| Duration of hospital stay | 8.4 days | 6.7 days |
| Total cost per patient | \$ 5,321 | \$4,290 |
| Cost per session | \$ 218 | \$ 10 |
| Equipment cost | \$208,333 | \$6,701 |

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.

[1] van Boxem TJ et al. *Chest*. 2000;117:887-891. [2] Verkindre C et al. *Eur Res J*. 1999;14:796-799.

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

1. Hooper RG, Jackson FN. Endobronchial electrocautery. *Chest*. 1988;94:595-598.
2. Van Boxem TJ, Venmans BJ, Postmus PE, Sutedja TG. Tissue effects of bronchoscopic electrocautery: Bronchoscopic appearance and histologic changes of bronchial wall after electrocautery. *Chest*. 2000;117: 887-891.
3. Sutedja G, Bolliger CT. Endobronchial electrocautery and argon plasma coagulation., *Prog Respir Res*. 2000;30:120-132.
4. Gersin VA, Shafirovsky BB. Endobronchial electrosurgery. *Chest*. 1988;93:270-274.
5. Sutedja G, van Kralingen K, Scharmél F, Postmus PE. Fiberoptic bronchoscopy electrosurgery under local anesthesia for rapid palliation in patients with central airway malignancies: A preliminary report. *Thorax*. 1994;49:1243-1246.
6. Sutedja TG, van Boxem TJ, Scharmél FM, van Felius C, Postmus PE. Endobronchial electrosurgery is an excellent alternative for Nd:YAG laser to treat airway tumors. *J Bronchol*. 1997;4:101-105.
7. Coulter TD, Mehta AC. The heat is on: impact of endobronchial electrosurgery on the need for Nd:YAG laser photoresection. *Chest*. 2000;118: 516-521.

References (cont)

8. Van Boxem TJ, Venmans BJ, Scharmél FM, van Mourik JC, Golding RP, Postmus PE, Sutedja TG. Radiographically occult cancer treated with fiberoptic bronchoscopic electrocautery: A pilot study of a simple and inexpensive technique. *Eur Respir J*. 1998;11:169-172.
9. Van Boxem TJ, Venmans BJ, van Mourik JC, Postmus PE, Sutedja TG. Bronchoscopic treatment of intraluminal typical carcinoid: A pilot study. *J Thorac Cardiovasc Surg*. 1998;116:402-406.
10. Van Boxem T, Muller M, Venmans B, Postmus P, Sutedja T. Nd:YAG laser vs bronchoscopic electrocautery for palliation of symptomatic airway obstruction: A cost-effectiveness study. *Chest*. 1999;116:1108-1112.
11. Hooper RG. Electrocautery in endobronchial therapy. *Chest*. 1999;116:1820.
12. ACCP. Pulmonary and Critical Care Update Online. Lesson 21, Volume 14- Endoscopic Options in the Management of Major Airway Obstruction by FD Sheski, MD, and PN Mathur, MBBS, FCCP. Online at <http://www.chestnet.org/education/pccu/vol14/lesson21.html>.