Keeping Current on Emerging *Trends* in Interventional GI Endoscopy and Electrosurgical Safety

*Kristie Briggs, RN, BSN*

*December 19, 2013*
Objectives

• Describe the evolution of Endoscopic Resection.

• Define various techniques for Endoscopic Resection and emerging trends and technologies.

• Describe electrosurgical clinical considerations in optimizing patient outcomes and safety.
## Historical Review: Endoscopic Resection in Flexible Endoscopy

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1969</td>
<td>Shinya</td>
<td>First colonic electrosurgical snare polypectomy</td>
</tr>
<tr>
<td>1973</td>
<td>Dehyle</td>
<td>Saline lift of flat colonic lesion</td>
</tr>
<tr>
<td>1983</td>
<td>Tada</td>
<td>First EMR (strip biopsy) EGC</td>
</tr>
<tr>
<td>1992</td>
<td>Inoue</td>
<td>First cap-assisted EMR</td>
</tr>
<tr>
<td>1993</td>
<td>Masuda</td>
<td>First ligation EMR</td>
</tr>
<tr>
<td>1995</td>
<td>Hosokawa</td>
<td>IT knife</td>
</tr>
<tr>
<td>1999</td>
<td>Yamamoto</td>
<td>Hyaluronate</td>
</tr>
<tr>
<td>2000</td>
<td>Oyama</td>
<td>Hook knife</td>
</tr>
<tr>
<td>2000</td>
<td>Yahagi</td>
<td>Flex knife</td>
</tr>
<tr>
<td>2007</td>
<td>Kaehler</td>
<td>Waterjet hydrodissection</td>
</tr>
</tbody>
</table>
Types of Polyps

Pedunculated
- Stalk is present
- Varying thickness
- May contain vessel supply

Sessile
- No stalk is present
- Varying sizes
- Flat
- Carpet
- Laterally spreading tumor (LST)
Types of Polyps

Hyperplastic
- Most common type
- Non-neoplastic
- Inflammatory
- Lower risk of malignancy

Adenoma
- Pre-malignant
- Neoplastic
- Dysplastic
- Greater risk of malignancy
Types of Adenomas

- **Tubular**
  - Tube-like
  - Most common

- **Villous**
  - Ruffled
  - Least common

- **Tubulovillous**
  - Mixed tubular / villous tissue
Endoscopy Polypectomy Techniques

Quality indicators for colonoscopy
Douglas K. Rex, MD, John L. Petrini, MD, Todd H. Baron, MD, Amitabh Chak, MD, Jonathan Cohen, MD, Stephen E. Deal, MD, Brenda Hoffman, MD, Brian C. Jacobson, MD, MPH, Klaus Mergener, MD, PhD, Bret T. Petersen, MD, Michael A. Safdi, MD, Douglas O. Faigel, MD, ASGE Co-Chair, Irving M. Pike, MD, ACG Co-Chair

ASGE/ACG Taskforce on Quality in Endoscopy
Submucosal injection

Submucosal injection provides an additional cushion to protect the muscularis and also aids in dispersing electrosurgical current during electrosurgical procedures, including APC.

<table>
<thead>
<tr>
<th>Submucosal Injection Therapy</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commonly Used Fluid Mediums</td>
<td></td>
</tr>
<tr>
<td>As reported in literature</td>
<td></td>
</tr>
<tr>
<td>(Note: most are used off-label)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Commonly Used Fluid Mediums</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9% sodium chloride / normal saline (NS)</td>
<td>Approved and most common</td>
</tr>
<tr>
<td>Vasoconstrictors</td>
<td>Epinephrine</td>
</tr>
<tr>
<td></td>
<td>Used in attempts to decrease the risk of bleeding</td>
</tr>
<tr>
<td>Tissue staining solutions</td>
<td>Indigo Carmine and Methylene Blue</td>
</tr>
<tr>
<td></td>
<td>Used to differentiate pathological and non-pathological tissues</td>
</tr>
<tr>
<td>Sodium hyaluronate (SH)</td>
<td>Long-lasting bleb, very expensive</td>
</tr>
<tr>
<td>Hydroxypropyl methylcellulose (HPMC)</td>
<td>Inexpensive and accessible solution</td>
</tr>
<tr>
<td></td>
<td>Creates long lasting lifts with minimal harm to the injected tissue</td>
</tr>
<tr>
<td>Hypertonic solutions</td>
<td>20% Glucose, 20% Mannitol, and Glycerol</td>
</tr>
<tr>
<td></td>
<td>Longer lasting bleb</td>
</tr>
<tr>
<td></td>
<td>Increased tissue damage has been reported</td>
</tr>
<tr>
<td>Electrolytic solutions</td>
<td>Hyaluronic acid (HA)</td>
</tr>
<tr>
<td></td>
<td>Type of Glycosaminiglycan</td>
</tr>
<tr>
<td></td>
<td>Long-lasting fluid cushion</td>
</tr>
<tr>
<td></td>
<td>Expensive and lack of FDA approval have limited its use</td>
</tr>
<tr>
<td>Colloidal solutions</td>
<td>Hydroxyethyl starch (HES)</td>
</tr>
<tr>
<td></td>
<td>A plasma expanding solution that dissipates slowly</td>
</tr>
</tbody>
</table>

Submucosal Injection

Needle-free submucosal injection
Endoscopic Mucosal Resection - EMR

Most lesions are less than 2cm

Developed for removal of sessile lesions and pathology confined to superficial layers of GI tract (mucosa and submucosa).

Studies suggest most common techniques:
• Injection-assisted EMR
• Cap-assisted EMR
• Ligation-assisted EMR

Resection by:
• Piecemeal
• En bloc

Image compliments of: Kenneth F. Binmoeller, M.D.
EMR – Injection Assisted

1. Marking
2. Submucosal Injection
3. Snaring
4. Cutting
EMR - Cap Method

1. Submucosal Injection
2. Pre-looping
3. Suctioning
4. Snaring
5. Cutting
EMR - Cap & Ligation Method

- Soft Snare
- Straight O.D 13mm
- Wide Oblique O.D 15.5mm
- EMR Caps
  - Crescent
  - Soft Snare
  - EMR Snare
  - Straight O.D 13mm
  - Wide Oblique O.D 15.5mm
EMR – Case Study

- 54-year old female
- Screening colonoscopy
  - 5 cm adenomatous growth sigmoid colon.
  - Biopsies revealed a tubulovillous adenoma.
- Referred for EMR
- Endoscopic ultrasonography
  - thickening of the mucosa with preservation of the submucosa and muscularis propria layers.
- Saline-assisted piecemeal EMR performed.

*Case study and images compliments of Kenneth F. Binmoeller, M.D.*
Residual Tissue Ablation Post Polypectomy

Long term clinical study results show 50% reduction in adenomatous polyp re-growth with Argon Plasma Coagulation (APC) use of residual tissue.

• 78-year-old male, ex-smoker with emphysema, long history of GERD
• Upper Endoscopy revealed a 1 cm nodular lesion identified along a “tongue” of Barrett’s mucosa:
  - Nodule biopsy = carcinoma-in-situ
  - Neighboring Barrett’s = intestinal metaplasia without dysplasia.
• EMR performed (5 x 3 cm strip of Barrett’s mucosa containing the nodular lesion).
  - Pathology confirmed carcinoma-in-situ with tumor-free margins.

Case study and images compliments of Kenneth F. Binmoeller, M.D
Endoscopic Submucosal Dissection - ESD

- Technically challenging and complex - greater risks
- Allows intact specimens – optimal pathological assessment
- En bloc resection - less invasive than surgery
- Attempt curability
- Inadequate reimbursement

Endoscopic Submucosal Dissection (ESD)
Gastric ESD

(B.H. Min- Dig. Endos.)
All in one dissection tool

Steps:
1. Lesion marking
2. Submucosal Injection
3. Initial/circumferential cutting
4. Dissection with hemostasis
Endoscopic submucosal dissection with a water-jet HybridKnife (ESDH) of mucosal and submucosal lesions in the upper GIT

Horst Neuhaus, M.D.
Evangelisches Krankenhaus
University of Duesseldorf
Germany
Variables Impacting Tissue Effect

- Waveform: Cut vs. Coag, Preconditioning
- Physician technique
- Pad placement
- Patient variables: age, body type, hydration, tissue, IED’s etc.
- Type (size) of Electrode, current density
- Length of activation
- Anatomical location
- Type of Generator: Constant voltage vs. constant power
History of Electrosurgery

In 1978, Dr. Glover published an article on the use of thermal knives in comparison to other modalities and stated, “There is no group of instruments in the surgical armamentarium that is used as frequently and understood as poorly as Electrosurgery units….”
This Happened to Experts?
Let’s take a look at the basic principles…

- **Clinical Circuit**: flow of current from the ESU to the active electrode, to the patient, to the pad, and back to the ESU.

- Three properties of electrosurgery:
  - *Current* – negatively charged electrons moving from one atom to another (measured in amperes).
  - *Voltage* – force that pushes electrons from one atom to another through the circuit (measured in Volts).
  - Impedance – (Resistance) or opposition to flow (measured in Ohms).

- Patients tissue – the ever changing variable.

*Electricity always seeks ground and prefers the path of least resistance.*
Ohm’s Law

“The amount of current flowing in a circuit made up of pure resistances is directly proportional to the electromotive forces impressed on the circuit and inversely proportional to the total resistance of the circuit.”

- Ohm’s law is a set of formulas used in electronics to calculate an unknown amount of current, voltage or resistance. It was named after the German physicist Georg Simon Ohm (1787-1854).
- Ohm’s law helps to predict how ESUs will interact with tissue.

\[
I = \frac{V}{R} \quad \text{or} \quad V = I \times R
\]
Properties of Electrosurgery

• Power
  – The amount of work performed (or energy produced over time) throughout the circuit.
  – The rate is measured in watts.
  – $P$ (Watts) = $V$ (Voltage) x $I$ (Current).
Tissue Resistance (Impedance) the Ever Changing Variable…

Least to Most Resistance

Liver, Oral Cavity
Muscle, Kidney, Eye
Gallbladder
Bowel, Fat
Mesentary, Brain
Scar Tissue, Lung, Adhesions

Least to Most Resistance
Patient Return Electrode Monitoring

• Introduced in the 1980’s.
  – Return Electrode Monitoring (REM)
  – Aspen Return Monitoring (ARM)
  – Neutral Electrode Safety System (NESSY)

• According to AORN guidelines, return-electrode contact quality monitoring (RECQM) should be furnished on general purpose electrosurgical units.

2010 Perioperative Standards and Recommended Practices, AORN.
Types of Current

• Two forms of electrical energy:
  – Direct current
    • Electrons flow in direction (positive to a negative pole)
    • Electrocautery (not “Electrosurgery”).
    • Current does not enter the patient’s body – only the heated wire tip comes in contact with tissue.
  – Alternating Current (AC)
    • Electrons flow back and forth, depending on polarity and frequency
    • Electrosurgery uses High-Frequency AC Current.
    • Circuit must be completed: includes the electrosurgical generator, active electrode, the patient and return electrode.

Direct Current (Electrocautery)

Alternating Current (Electrosurgery)

350 kHz
Frequency – Alternating Current

- With alternating current the direction of the current changes periodically.

- The frequency (f) indicates the number of direction changes of the current in an electrical conductor per second.

- The unit of measurement for this is a Hertz (Hz).
Why Use High-Frequency Alternating Current? (patients do not get electrocuted...)
Neuromuscular Stimulation

- Causes of current demodulation:
  - Loose wires/cables
  - Damaged internal cable wires
  - Broken adapters

- Preventive Measures:
  - Replacement schedule for cables
  - Visual inspection of electrosurgical cables for insulation damage
  - Visually and physically check cables for damage

Principles of Electrosurgery
Two Types of Circuits

- **Monopolar**
  - Current is conducted throughout the body.
  - Grounding pad is used.

- **Bipolar**
  - Current is delivered and returned at the tip of the probe.
  - No current throughout the body.
  - No grounding pad needed.
## ESU Thermal Effects on Cells

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Tissue Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>104°F:</td>
<td>Reversible cellular trauma</td>
</tr>
<tr>
<td>120°F:</td>
<td>Irreversible cellular trauma</td>
</tr>
<tr>
<td>158°F:</td>
<td>Coagulation (Dessication)</td>
</tr>
<tr>
<td>212°F:</td>
<td>Cutting</td>
</tr>
<tr>
<td>392°F:</td>
<td>Carbonization</td>
</tr>
</tbody>
</table>
ESU Thermal Effects - Waveforms

- **CUT**
  - Voltage quickly raises water temperature in the cell to boiling point.
  - Cell water turns to steam.
  - Cell explodes, separating from adjoining cells.
  - Cleavage plane is created = clinical "CUT".
  - Cutting requires a spark – a minimum of 200 volts.
  - Yellow Pedal.
ESU Thermal Effects - Waveforms

- **COAG**
  - Waveform consists of spikes of high voltage followed by rest periods.
  - This allows the cellular proteins to slowly denature.
  - Coagulation occurs.
  - Blue Pedal.

Modulated
(with resting points)
ESU Thermal Effects - Waveforms

- **ENDO CUT**
  - *Constant VOLTAGE generator*
  - ENDO CUT is a specialized waveform which involves a fractionated cutting mode with patented spark recognition technology, characterized by alternating cutting and coagulation cycles.
  - Constant Voltage/Power Dosing Technology
  - ENDO CUT I was developed to assist the physician during sphincterotomy.
  - ENDO CUT Q was developed to assist the physician during snare polypectomy (endoscopic resection).
  - Yellow Pedal.
  - The pedal is held down, not tapped for ENDO CUT functions.
Dispersive Electrodes

- **MONO Foil or Single pad:**
  - Perform only completion of the electrical circuit.
  - The current density of the pad edges is not measured.
  - The correct orientation of the pad is not measured.

- **DUAL Foil or Split Pad:**
  - Completes the electrical circuit.
  - Disperses the current density.
  - Engages the safety system of the unit to monitor for high current density (and correct orientation with NESSY).

Mono Pads bypass the pad safety system of generators...

Always recommended
Dispersive Electrodes

- **According to AORN:**
  - Dispersive electrode site burns are the most reported electrosurgical injury.
  - With improved technology and the use of safety features, pad-site burns have decreased from 50 to 100 in the late 1970’s to one to two per month in 2007.
  - Return electrode quality monitoring must be furnished.
  - Dual pads should be used.

2010 Perioperative Standards and Recommended Practices, AORN.
Dispersive Electrode Pad Placement

- Well vascularized area
- Shortest circuit possible
- Optimum – on flank
- Alternatives
  > Thigh or Arm
- Avoid Buttock placement
- Remove pads carefully to prevent shearing
Where to avoid pad placement…

- Boney prominences
- Scar tissue – including Tattoos
- Skin/Scars over an implanted metal prosthesis
- Hairy surfaces – clip if necessary
- Lotions or oils on skin

Note: If the patient’s skin is excessively oily or dry, prepping the skin prior to pad placement may be warranted.
Electrosurgical Considerations for Clinical Safety Fire Prevention

Components of the Fire Triangle – Heat, Fuel, Oxygen

- Is an alcohol-based prep agent or other volatile chemical being used preoperatively? Y or N.
- Is the procedure being performed above the xiphoid process? Y or N.
- Is open oxygen or nitrous oxide being administered? Y or N.
- Is an ESU, laser, or fiber-optic light cord being used? Y or N.
- Are there any other possible contributing combustion factors? Y or N.
Electrosurgical Considerations for Clinical Safety Fire Prevention

Oxygen Management

- Preventative measures to avoid combustion in oxygen enriched environments:
  - Conscious Sedation Patient
    Supplemental nasal cannula $O_2$ at 3 L/M or LOWER.
  - Mask delivery is considered high.
  - Intubated Vent Patient
    Supplemental $O_2$ Concentration should be reduced to 40% or less.
  - Activate during the patient’s exhalation phase or apnea.

Combustion requires heat source, fuel, and oxygen
Electrosurgical Considerations for Clinical Safety Fire Prevention

**Bowel Explosions**

- Patients should be fully prepped any time electrosurgery is used.
- Incomplete Preps or enema-only preps for Flexible Sigmoidoscopy increases the risk for bowel explosions due to the presence of combustible gases.
- Three things are needed for a bowel explosion to occur:
  - Presence of combustible gases - Hydrogen and/or Methane gas.
  - Presence of Oxygen.
  - Spark created by application of monopolar electrosurgery (Snare Polypectomy, Hot Biopsy, APC, etc.).
Some produce more Hydrogen and Methane gas than others…
Electrosurgical Considerations for Clinical Safety

Jewelry Removal

• AORN recommends the removal of ALL pierced and non-pierced jewelry, if within the electrical circuit.

• Removal helps to:
  − Avoid Burns
  − Avoid accidental injury
  − Lower staff liability
Electrosurgical Considerations for Clinical Safety

Trans-dermal and micro-dermal implants

Sub-dermal implants

Additional risks are posed due to:
- Patient positioning
- Patient transfers
- Electrosurgery use and pad placement
Electrosurgical Considerations for Clinical Safety

- EMI (Electromagnetic Interference) in healthcare:
  - Electrosurgery units
  - Defibrillators
  - MRI
  - PET
  - Radiation Therapy

- Electrosurgery involves high-voltage, high frequency (>100,000 kHz) current for cutting or coagulation of tissue.

- Electrosurgery remains the most common source of pacemaker EMI and is the principal intraoperative issue for the patient with an IED, due to the possibility of current demodulation.
Implanted Electronic Devices (IEDs) are battery operated devices placed within a patient’s body to treat a physiological defect or to replace a sensory function:

- **Cardiac**
  - Pacemakers
  - Internal Cardiac Defibrillators (ICDs)
  - Ventricular Assistive Devices (VADs)

- **Neurostimulators**
  - Deep brain stimulators
  - Spinal cord stimulators
  - Vagal nerve stimulators
  - Programmable ventricular shunts

- **Implantable Hearing Devices**
  - Cochlear Implants
  - Auditory Brainstem Implant (ABI)
  - Bone-conduction stimulators

- **Implanted Infusion Pumps**
- **Osteogenic (Bone-growth) Stimulators**
- **Gastric Electronic Pumps**
Electrosurgical Considerations for Clinical Safety Pacemakers, ICDs, IEDs

“AORN Guidance Statement: Care of the Perioperative Patient With an Implanted Electronic Device”

AORN offers guidelines for Implanted Electronic Devices

Implanted electronic devices are widely used in a variety of diagnostic and therapeutic applications. These devices, which include pacemakers, defibrillators, and other implanted medical devices, are essential for managing various medical conditions. However, these devices can also pose risks during electrosurgical procedures. To ensure patient safety, it is crucial to understand the specific risks and precautions associated with each type of implanted device.

Introduction

This document is intended to serve as a guide for perioperative nurses involved in the care of patients with implanted electronic devices. It provides guidelines for the safe management of these devices during electrosurgical procedures. The document also includes case studies to illustrate the importance of adhering to the guidelines.

Definitions

For the purposes of this document, the following definitions apply:

- **Implanted Electronic Device (IED)**: Any device that is placed under the skin, such as a pacemaker, defibrillator, or implantable cardioverter-defibrillator (ICD).
- **Perioperative Nurse (PON)**: A nurse who provides direct patient care during the perioperative period.
- **Electrosurgical Procedure**: A procedure that uses high-frequency electrical energy to destroy tissue.

The goal of this document is to provide guidance to PONs on how to safely manage patients with IEDs during electrosurgical procedures. The guidelines include recommendations for patient assessment, preoperative planning, and intraoperative management. By following these guidelines, PONs can help ensure the safety of patients with IEDs during electrosurgical procedures.

AORN offers guidelines for Implanted Electronic Devices

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Pre-planning is crucial…

- Pre-procedure knowledge of IED patients allows time for adequate planning:
  - Determine the type and location of the device.
  - Contact the implanting physician to determine -
    - Last device evaluation.
    - Any specific pre-op/post-op orders for the device.

- Consider having a policy in place specific to IED patients:
  - Utilize anesthesia and manufacturer device-specific guidelines as warranted to assist with establishing facility protocols and guidelines for care of IED patients.
  - Contact appropriate device representatives and arrange presence during procedures, based on protocols.
  - Notify the physician, anesthesia and other team members in advance of an IED patient.
Electrosurgical Considerations for Clinical Safety Pacemakers, ICDs, IEDs

Electrosurgical Safety for Patients with IED’s

- Use Bipolar when possible.
- Keep 15 cm between the active electrode and any EKG electrode.
- Have resuscitation equipment at the ready – DOCUMENT.
- Have the device clinical support line available.
- Contact the IED manufacturer for specific deactivation recommendations.
Electrosurgical Considerations for Clinical Safety Pacemakers, ICDs, IEDs

Electrosurgical Safety for Patients with IED’s

If the physician must use Monopolar current:

- Place the dispersive electrode close to the operative site, but as far away from the IED as possible.
- Use the lowest settings possible.
- Use the shortest possible activations.
- If the ICD is deactivated, re-establish integrity of the device post-procedure.
Electrosurgical Considerations for Clinical Safety Pacemakers, ICDs, IEDs

Contact Information – ICD’s/Pacemakers

<table>
<thead>
<tr>
<th>Table 4. TELEPHONE NUMBERS OF TECHNICAL SERVICE DEPARTMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Pacemaker Corporation (Intermedics, Inc.)</td>
</tr>
<tr>
<td>Angelson Corporation</td>
</tr>
<tr>
<td>ARCO Medical Products (Intermedics, Inc.)</td>
</tr>
<tr>
<td>Biotronik, Inc.</td>
</tr>
<tr>
<td>Cardiac Control Systems</td>
</tr>
<tr>
<td>CPI/Guidant</td>
</tr>
<tr>
<td>Cardio-Pace Medical, Inc.</td>
</tr>
<tr>
<td>Cook Pacemaker Corporation</td>
</tr>
<tr>
<td>Coratonic (Biocontrol Technology)</td>
</tr>
<tr>
<td>Cordis (Teletronics Pacing Systems)</td>
</tr>
<tr>
<td>Daig/Medicor</td>
</tr>
<tr>
<td>Edwards Pacemaker Systems (Medtronic, Inc.)</td>
</tr>
<tr>
<td>ELA Medical</td>
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<tr>
<td>Intermedics, Inc.</td>
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<td>Novacor</td>
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<td>Oscar</td>
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<tr>
<td>Pace Medical</td>
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<tr>
<td>Pacesetter, Inc.</td>
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<tr>
<td>Siemens-Electra</td>
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<tr>
<td>TCI</td>
</tr>
<tr>
<td>Teletronics Pacing Systems</td>
</tr>
<tr>
<td>Ventritex</td>
</tr>
<tr>
<td>Vitatron (Medtronic, Inc.)</td>
</tr>
</tbody>
</table>
In summary…

• Endoscopic resection has certainly evolved since the first colonic electrosurgical snare polypectomy was performed in 1969 by Dr. Shinya.

• From basic polypectomy, to EMR and ESD, understanding the art and science of electrosurgery and the various endoscopic interventional tools and approaches allows us to offer optimal, individualized patient care.

• Furthermore, keeping abreast of emerging trends and evidenced based practices, along with position statements and guidelines established by our governing bodies (i.e. SGNA, ASGE, AORN) enhances our ability to make critical decisions, while promoting positive patient outcomes and safety.