

Principles of Electrocautery

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Electrocautery

- Radiofrequency Generator:
 - Generates high-frequency currents (100 K-Hz to 4 M-Hz) which induces ionic vibration but no movement.
 - Ionic vibration generates intracellular heat but no muscle/nerve depolarization.
 - Power settings are in Watts (amps x volts).
 - Intracellular heat can cause:
 - boiling + explosion (CUT), and/or
 - dehydration (desiccation), and/or
 - fire sparks (fulguration).
- } COAGULATION

Electrocautery

- **BLUE SIDE**
 - **COAGULATION**
 - Activation: Blue Pedal
 - Settings: blue side ONLY
 - Modes:
 - Monopolar
 - APC
 - Bipolar
 - Outlets: separate for monopolar & bipolar
- **YELLOW SIDE**
 - **CUT**
 - Activation: Yellow Pedal
 - Settings: yellow side ONLY
 - Modes:
 - Pure-cut
 - Blend-Cut with several “modes” with different “on”/”off” ratios.
 - Outlet usually single.

Basic Physics Terminology

- Voltage (volts): force that pushes the current (“Potential Energy”).
 - **More force = more destruction**
- Resistance (ohm): quality of tissue that impedes flow of current.
 - **More resistance = less current flow.**
 - **Resistance of skin > bone > fat > muscle > bowel wall (326 ohms) > blood.**
- Intensity (amps): amount of electricity crossing an area (wire), per second.
- Current Density (amp/cm²): amount of current flowing through a cross sectional area = Current Intensity(amps)/area(cm²)

Point to Remember

- The amount of Energy delivered to the “active” device (snare, hot forceps, sphincterotome, etc) is the same than the delivered to the “indifferent plate”, but the “current density” is very different due to the small “active” end compared with the large “indifferent plate”.

Basic Physics Terminology

- **Generated heat**: is proportional to the square of the current density: $(\text{Intensity/area})^2$.
 - **Small area of lesion/stalk causes disproportional high heat.**
- **Power output**: Is given in Watts = amps x volts. Voltage is constant, hence higher output increases the intensity of current (amps).
 - **Higher output = higher current density = much higher heat**
- **Delivered Energy**: Is given in Joules.
Energy (watts) x time (seconds)

Types of Electrocautery

- **Monopolar** (Needs separate “return electrode”)
 - **Coagulation** (6% “on” duty cycle)
 - Argon Plasma (non-contact coagulation)
 - Contact coagulation
 - **Cut**
 - Pure (100% “on” duty cycle)
 - Blend (12-80% “on” duty cycle); usually 25-50%
- **Bipolar** (active and return electrode are side-to-side)

ERBE Electrocautery



Indifferent
electrode

MONOPOLAR
CUT or COAG

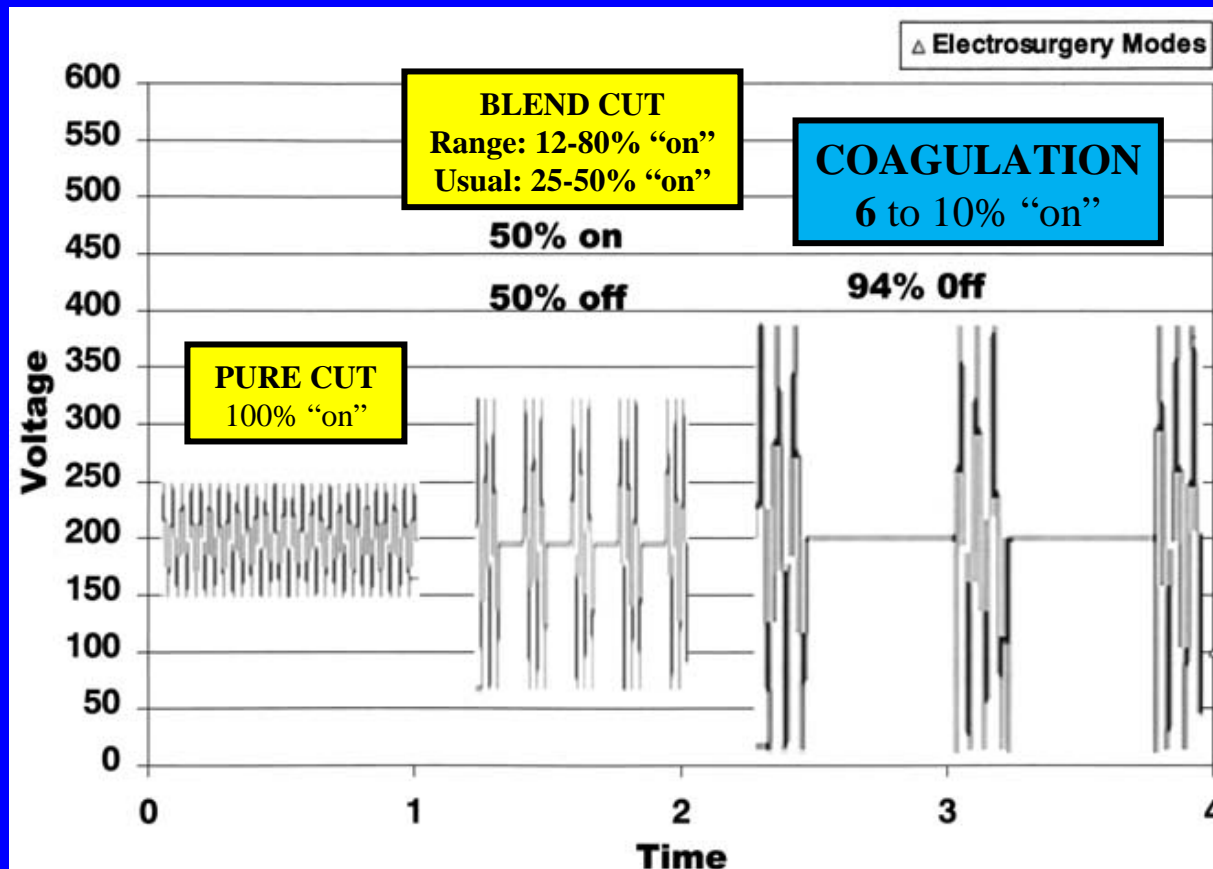
BIPOLAR
COAG

Electrocautery Waveforms

COAGULATION

CUT

Electrocautery Modes

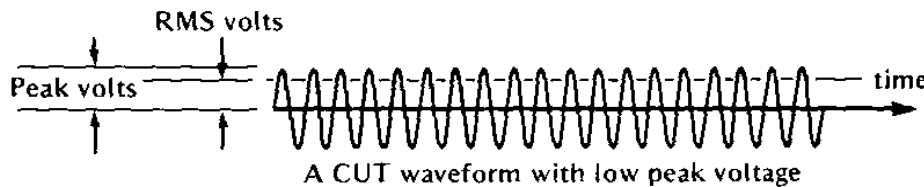


Same energy (W): CUT vs COAGULATION

“peak voltage”: $Cut \lll Coagulation$

CREST: [peak/root mean square] voltage

CUT



A CUT waveform with low peak voltage

COAG

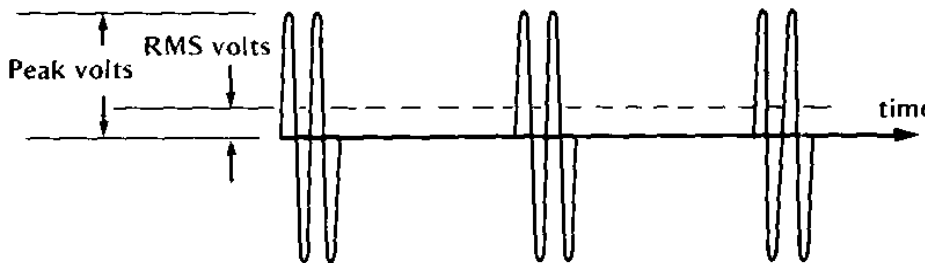


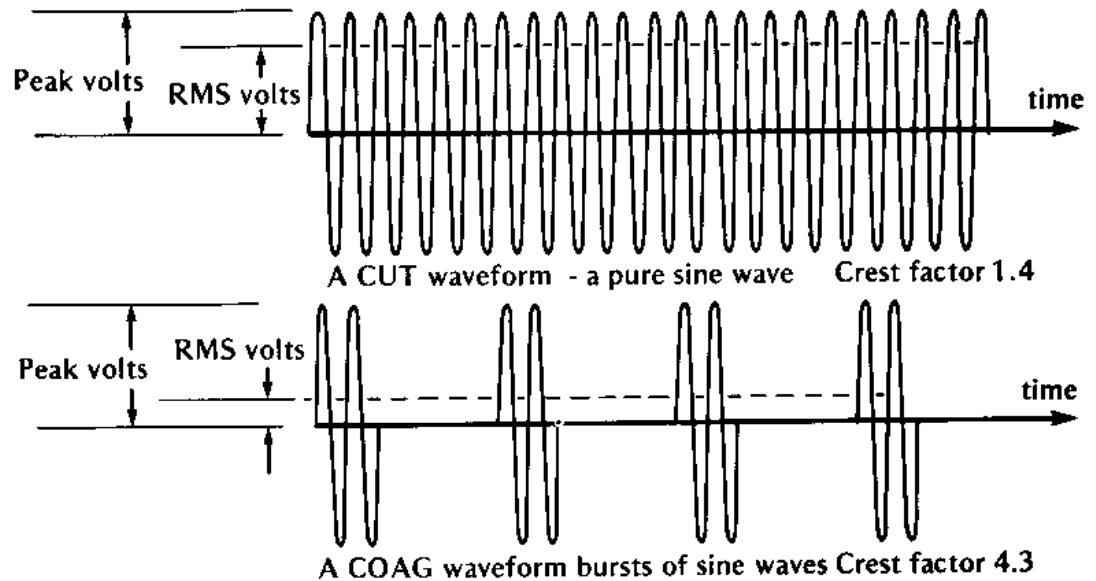
FIGURE 7-7. The COAG waveform (bottom) with equal power (energy per second) to that of the CUT waveform (top). COAG peak voltage is about three times higher in this example than in in Figure 7-6. Note that RMS (average) voltages are equal in both waveforms.

Usual CREST: Coag = 7-8, Pure-Cut < 2, Blend-Cut = 2.2-5

High CREST = longer cooling time/higher peak = more desiccation/fulguration & less cut

Same “peak voltage”: CUT vs COAG Energy (W): CUT >>> COAGULATION

FIGURE 7-6. In this diagram peak voltages of CUT (*top*) and COAG (*bottom*) waveforms are the same, but power is about one third less in the COAG waveform.



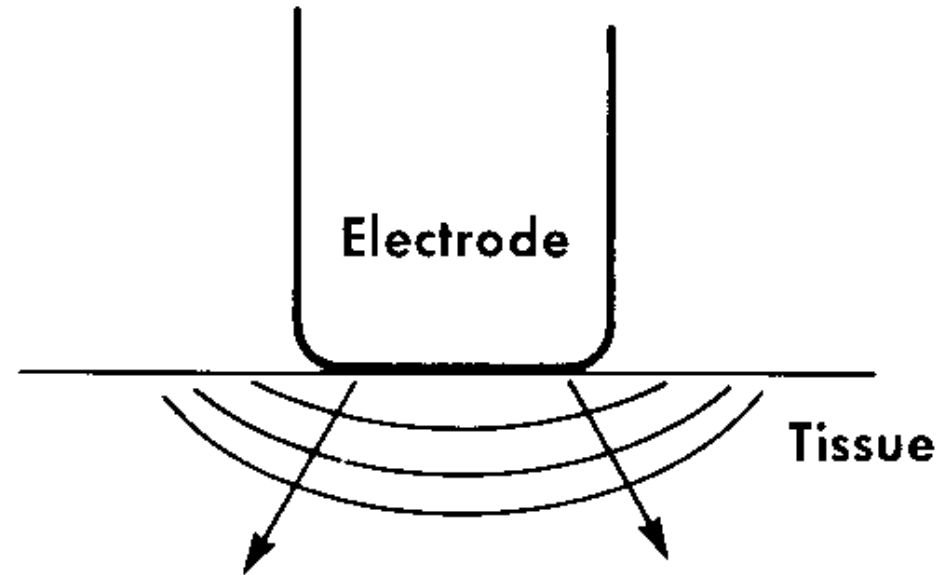
Physical Process for Electrocoagulation

Physical Process

Desiccation (Coagulation)

- Slow heating of tissue in **close contact**, then **fluid loss with bubbling**, then **steam release with cooling**, then restarts, **slow heating** of tissue in close contact, then ...
- Main Effect: Desiccation/Coagulation, with preemptive HEMOSTASIS.
- Best Instrument:
 - Microbipolar (no fulguration).
- Alternatives:
 - Monopolar coagulation @ 20-30 W, or
 - Blend-cut with high-CREST (3 or more) or low % duty @ 20-40W
- CONSIDERATIONS:
 - If setting is too low, may desiccate too deep; difficult to cut.
 - If too high and monopolar, may give deep fulguration.
 - Pressing on wall increases burn depth (**pull in Hot Bx.**)

Desiccation (Coagulation)



TYPICAL CURRENT=0.5 AMP RMS

FIGURE 7-3. Diagrammatic representation of electro-surgical desiccation. The electrode is in good contact with tissue. Deep coagulation spreads radially. Relatively soft, light brown eschar will result. RMS = root mean square (effective average).

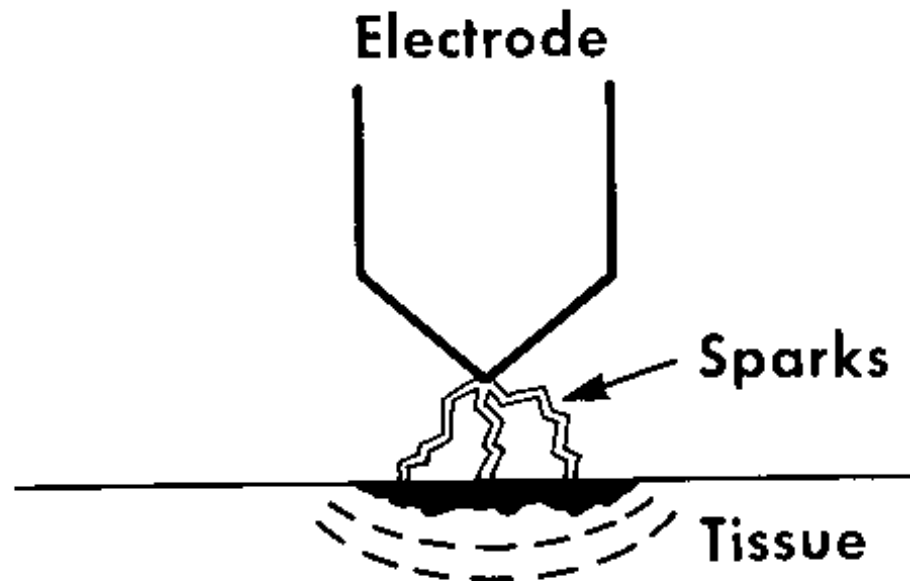
Desiccation needs long cooling time/high CREST & close contact

Physical Process

Fulguration

- Electrode **not in contact** with tissue (or insulated by desiccated tissue): **ionization** of surrounding air, then **long spark** with high current density, then **superficial coagulation**, then (if you continue) **deep necrosis with black eschar**.
- Effect: Tissue ablation.
- Best instrument:
 - Argon Plasma Coagulator @ 40-60 W.
- Alternative:
 - Monopolar coagulation, or
 - Blend-cut with high-CREST at high setting.
- High risk of transmural necrosis with prolonged burn (continuous “painting” in APC); use “saline pillow”.

Fulguration



TYPICAL CURRENT= 0.1 AMP RMS

FIGURE 7-5. Diagrammatic representation of electro-surgical fulguration. The electrode is free from tissue. Long sparks to tissue result in superficial coagulation first, then deeper necrosis as fulguration continues. Eschar is hard and black.

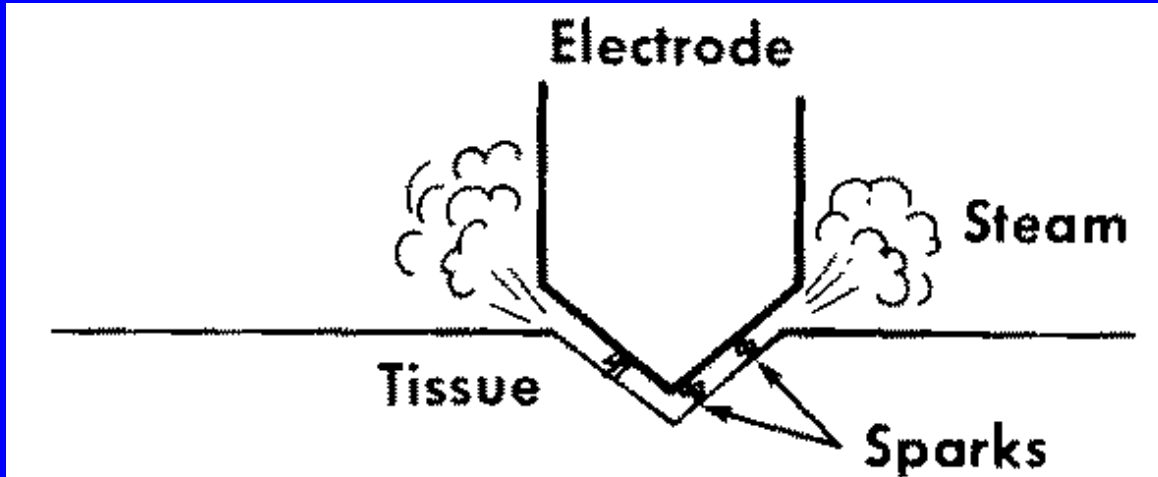
Fulguration needs high “peak” voltage and very loose contact

Physical Process

Cutting

- In low resistant tissue (GI mucosa): Initial **desiccation**, then **increased tissue resistance**, then **short spark**, then very rapid **tissue heating**, then intracellular **boiling**, then **cell explosion**, then **steam release**, then **desiccation**, then increased tissue resistance, then, ...
- Effect: Cut
- Best instrument:
 - Monopolar “pure” Cut @ high energy
 - Monopolar Blend-Cut with high % “on” duty, or low CREST.
- **CONSIDERATIONS:**
 - Needs water in tissue (not completely desiccated) and **loose contact** (short sparks).
 - Works better with high-continuous energy 60-100 Watts.

Cutting



TYPICAL CURRENT=0.1 AMP RMS

FIGURE 7-4. Diagrammatic representation of electro-surgical cutting. The electrode is separated from tissue by a thin layer of steam. Short, intense sparks flash cells into steam. Hemostasis can be minimal and the process mimics the scalpel.

Cutting needs short cooling time/low CREST & mildly loose contact

MONOPOLAR ELECTROCOAGULATION

Monopolar Electrocautery

- Has a large “Indifferent Plate” for electricity return and a small “active electrode”;
 - causes high current density and very high heat at active electrode.
- CAUTIONS:
 - Causes deeper injury, hence is bad choice to control active bleeding (high perforation risk except with non-contact technique like APC).
 - There must be absence of flammable gases (bowel lavage) to avoid explosion.

Monopolar Electrocautery

- Indifferent plate should:
 - A) be near to site of active electrode, to decrease resistance from other tissues,
 - B) have conductive gel to decrease skin resistance,
 - C) remain in complete contact all the time (dual plate w monitoring circuit confirms contact) to maximize energy in active electrode.
- Examples: hot snare, hot biopsy, Argon Plasma Coagulator, sphincterotome, needle knife.

MONOPOLAR COAGULATION

Monopolar Modes

Contact Coagulation

- Very short “active” sinus wave (6-10% of cycle) with long cooling period (off, or inactive 90-94% of cycle).
- Long “cooling” facilitates desiccation, high “peak voltage” facilitates fulguration (CREST 7-8).
- Causes slow heating (excellent desiccation) followed with spark and superficial fulguration, after desiccation is complete.
 - Deep fulguration can give transmural necrosis
- Close contact gives more desiccation, but loose contact or complete desiccation of surrounding tissue causes more fulguration/necrosis (keep continuous close contact).
- Complication: Post-polypectomy bleed after 2-8 days.

Argon Plasma Coagulation

(Non-Contact Electrocoagulation)

Argon Plasma Coagulation

- Argon gas flowing inside hollow catheter and ionized by monopolar current in wire inside catheter.
- Needs “indifferent plate” and absence of flammable gases.
- Causes coagulation at point of nearest conductive (non desiccated) tissue: “around the corner” coagulation.
- Distance of probe to tissue, and length of therapy:
 - 2-8 mm (2-3 mm at lower setting) x 0.5-2 sec.
- Depth of injury is decreased by “saline pillow” (from 86% to 21% deep).

Argon Plasma Coagulation

- Power:
 - For ablation, best setting is 70-90 W @ 1 LPM.
 - For hemostasis , best setting is 40-50 @ 0.5 LPM; Poor hemostasis in active bleeding (dissipation).
- PRECAUTIONS:
 - Injury can be deep; give short bursts (tap) or continuous movement “painting”.
 - Use lower setting if in contact with metal stents.
 - Avoid contact (gas injection and monopolar transmural burn),
 - Avoid fluid pool (energy dissipation),
 - Suction between treatments to decrease gas distention/perforation risk.

Argon Plasma Coagulation

SITE	Esoph/Stomach/ Rectum	Cecum & Rt. Colon	Tr. Colon to Sigm Small Bowel
FLOW	1.4 LPM	0.5 LPM	1-1.4 LPM
COAG	A 60 W Blue Pedal	A 40 W Blue Pedal Tap	A 50 W Blue Pedal
TIME to DEPTH	1 sec = 1.5 mm 5 sec = 2 mm 10 sec = 3 mm	1 sec = 1 mm 8 sec = 2 mm 15 sec = 3 mm	1 sec = 1.5 mm 7 sec = 2 mm 12 sec = 3 mm

APC Settings per Clinical Indication

Vargo J. Gastrointest Endosc 59(1):81-88; 2004

	Energy	Flow
Ablation polyp residue	40-65 W	0.8-2 LPM
Radiation Proctopathy	40-60 W	0.6-3 LPM
GAVE	40-100 W	2 LPM
Angioectasia	40-60 W	2 LPM
Ablation of Barrett's	30-90 W	0.5-2 LPM
Bleeding Ulcer	40-70 W	1.5-3 LPM
Palliation GI Cancer	40-100 W	0.8-2.5 LPM
Post variceal ablation	50-60 W	1.5-2 LPM

MONOPOLAR CUT

Monopolar Modes

Pure Cut

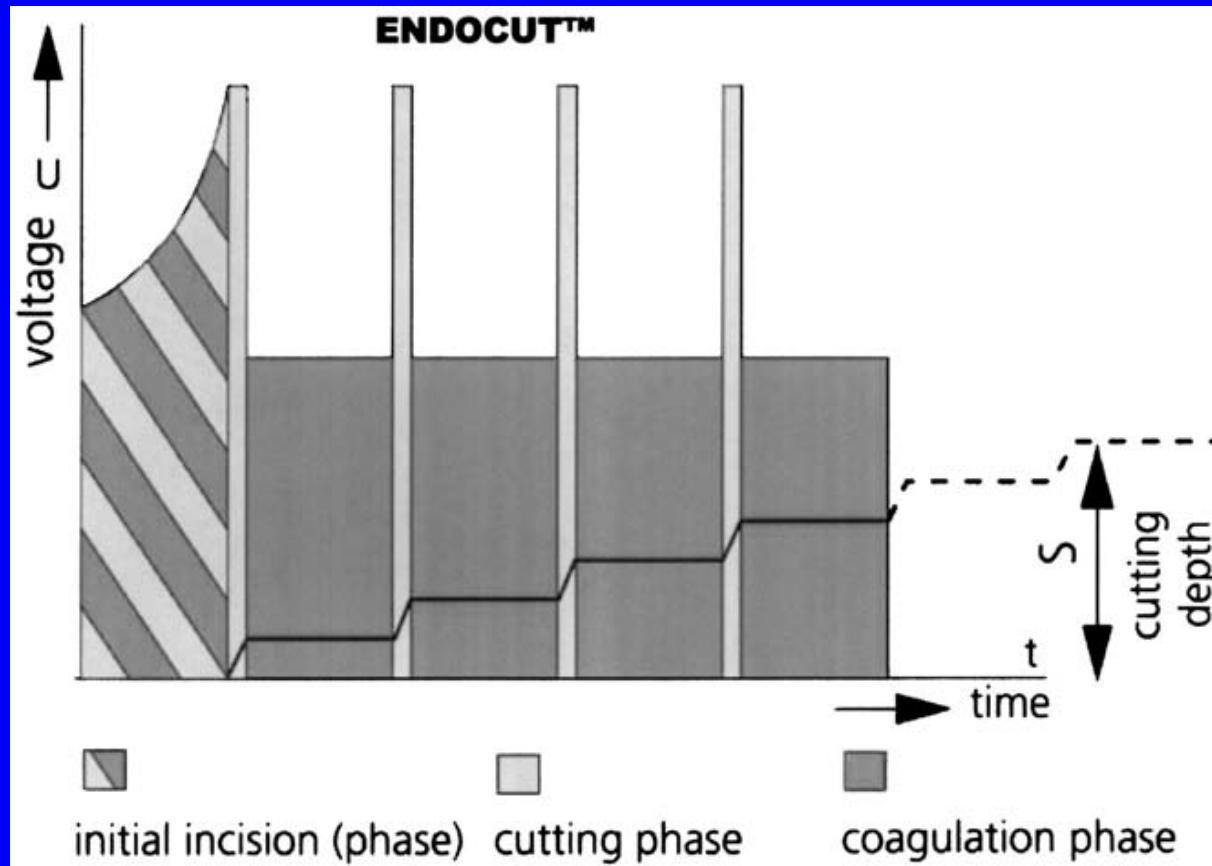
- **Pure Cut:** 100% on continuous sinusoidal wave without cooling-off period.
- Causes very rapid heating with cell explosion and formation of steam and sparks.
 - Gives little coagulation (no desiccation)
 - Current has a very low “peak voltage”/”root of mean square voltage” ratio (low CREST < 2)
 - Not used in endoscopy, unless some coagulation was given first.
 - Complication: immediate bleed.

Monopolar Modes

Blend-Cut

- **Blend-Cut:** Sinus wave duty cycle is “on” 25-50% of the time; allows for some cooling-off period (50-75% of time)
 - Gives less cell explosion (cut) than pure-cut, and moderate desiccation + fulguration (coagulation)
 - Has higher CREST than pure-cut (2.2-5)
 - At same energy setting has higher peak voltage, hence can fulgurate more.
 - Different levels of “blend” are set by the manufacturer.
 - In ERBE: Effect-1= minimal coag; Effect-4 = maximal coag; ENDO-CUT uses Effect-3 (high coag alternating with blend-cut)
 - Responds only to “CUT setting”
 - Loose contact facilitates “blend” process.
 - Complication: Post-polypectomy bleed within 12 hours.

EndoCut



Point to Remember

- In general, at identical Power Setting (watts):
 - COAGULATION currents cause deeper tissue injury than CUT (pure or blend) currents.
 - HOT FORCEPS cause deeper tissue injury than HOT SNARES.

REMEMBER

Yellow + Blue *IS NOT* Green

- COAGULATION (Blue) unit is completely independent of CUT (Yellow) unit;
 - Power setting in COAG side does not affect the CUT side.
- BLEND-CUT current is a feature of the CUT (Yellow) unit.
 - The degree of “blending” depends on the chosen mode (Endo-Cut, vs blend-1, vs blend-2, etc.)

Endoscopic Electrocoagulation Techniques

Snare Polypectomy

- **VARIABLES**

- Energy
- Wave: coag vs blend-c
- Stalk diameter
- Wire tension (>1.5cm)
- Wire diamet(.3-.4mm)

- **PHASES**

- Desiccation
- Cut: mechanical vs electrosurg. vs mixed
 - Sequential
 - Combined

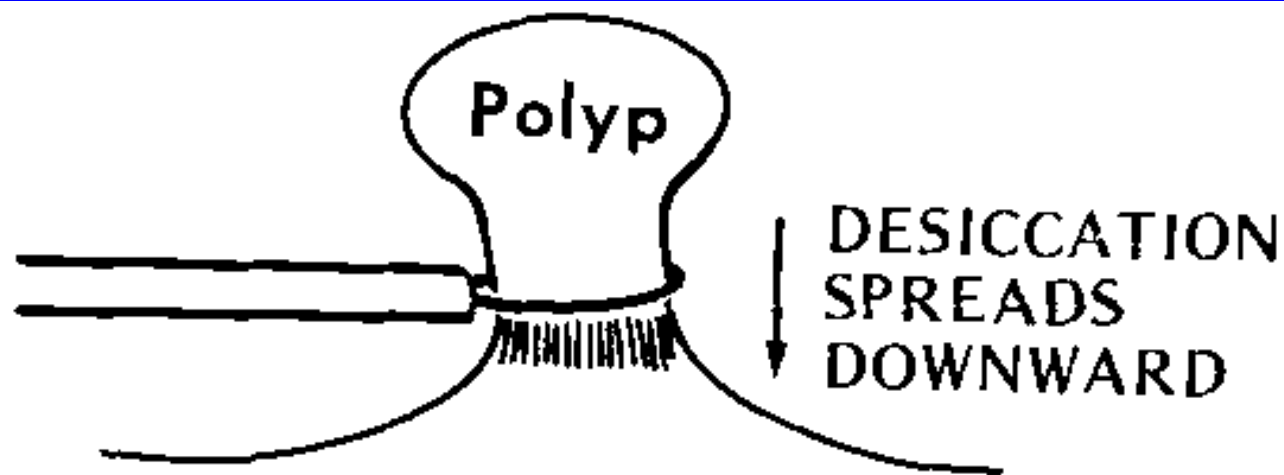
Snare Polypectomy

- **Desiccation:**

- COAG @ 20-30 (25)W, or Blend Cut 2 @ 20-30 W, or Endo-Cut-3@ 200 W;
- Lower energy on Rt colon. Higher in thick stalk.
- Saline “pillow” in sessile lesions.
- Avoid:
 - Too much desiccation: difficult to cut; transmural necrosis
 - Polyp contact with other wall: burn (shake it)
 - Fluid pool: loss of energy.

Snare Polypectomy

- **Cutting:**
 - A) **Mechanical or Mixed:** close snare with *constant mild-moderate pressure* during or after COAGULATION.
 - B) **Electrosurgical:** Close snare with *very light hold* during Blend-Cut or Endo-Cut.
- If snare gets stuck after excessive desiccation, change to pure-cut @ 100-150 W.(If tissue is too dry, will not cut)



DESICCATION FIRST FOR HEMOSTASIS

FIGURE 7-8. Diagrammatic representation of initial desiccation of polyp stalk prior to mechanical or electro-surgical cutting of stalk.

Current required is proportional to the square of the polyp diameter since current density should be the same.

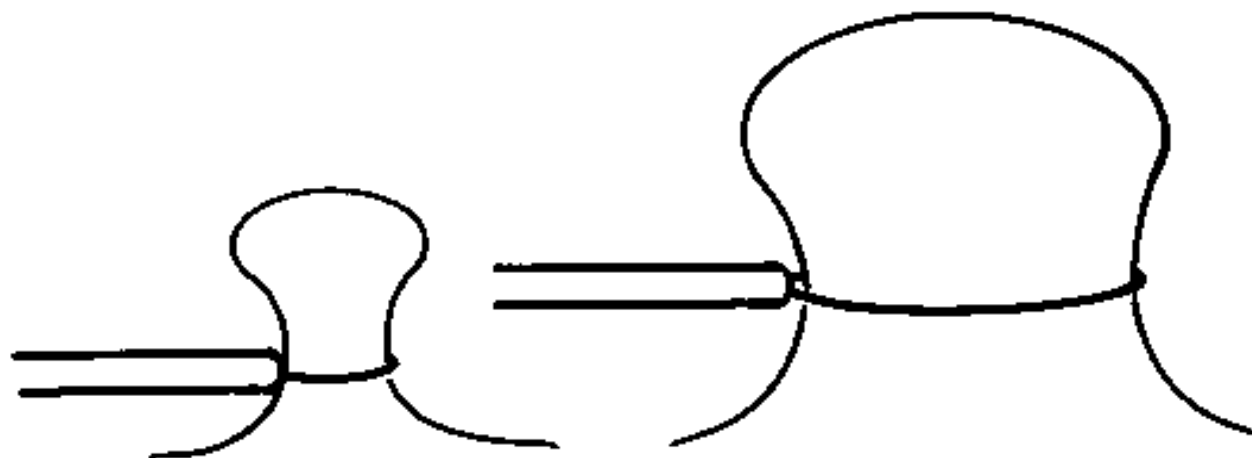
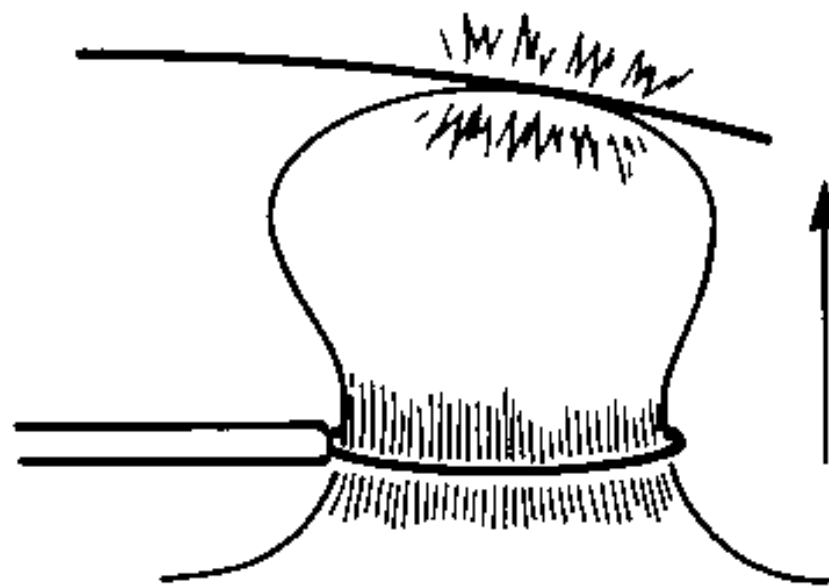


FIGURE 7-9. Current must be increased to achieve the same current density required for desiccation as with a small polyp.



If desiccation spreads upward, it means current is not leaving through stalk.

FIGURE 7-10. Clinical effect of electrosurgical current is altered by contact of the polyp with opposite wall of the bowel.

Hot Biopsy

- COAG (Fulgurate-COAG) @ 25 W, or ERBE Soft-COAG @ 60 W
 - Tent-pull tissue right & left, close & away, with short “tap” to coagulate all base; do not “overcook”; then pull to remove.
 - Adequate for lesions up to 5 mm (cold snare is preferred); used in difficult-to-snare position.
 - Residual polyp in Cold Bx = 30% of patients
 - Residual polyp in Hot Bx = 17% of patients
 - Residual polyp in cold snare = rare
 - Saline “pillow” has little effect in decreasing thermal injury in Hot Biopsy (“tenting” is important).

Sphincterotomy

- Endo-Cut-3 @ 200 W, or Blend-Cut 2 (medium CREST of 3) @ 40 W, or Pure-Cut @ 30 W.
 - At least 1/3 of wire outside the papillae to decrease over-coagulation and pancreatitis
 - Low wire tension to prevent “Zipper”
 - Blend-Cut / Endo-Cut causes less pancreatitis

Usual Electrocautery Settings

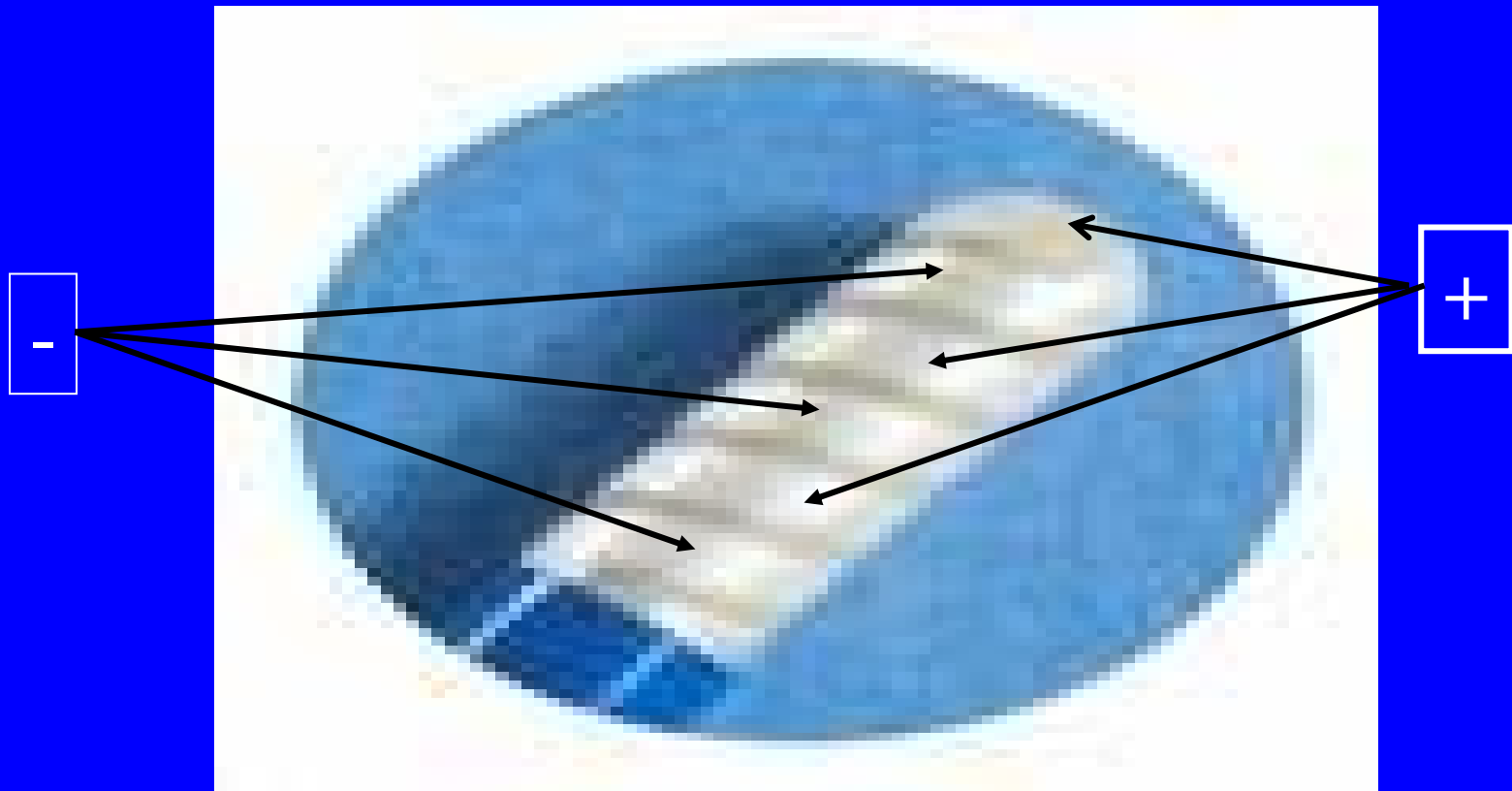
UNIT	Polypectomy/ Sphincteroto my bleed	Alternative Polypectomy	Hot Biopsy	Sphincteroto	Pre-cut Needle Knife
ERBE	COAG-Forced 25W COAG (blue) pedal (Tap in Hot Bx)	Endo CUT: ON Effect 3 200 W CUT (yellow) pedal	COAG – Soft 60 W COAG (blue) pedal	Endo CUT: ON Effect 3 200 W CUT (yellow) pedal	Endo CUT: OFF Effect 3 200 W – Tap CUT (yellow) pedal
ValleylabForce 2 Olympus (VA)	COAG 15-25 W COAG (blue) pedal	CUT Blend 2 20 W CUT (yellow) pedal	COAG 20 W COAG (blue) pedal	CUT Blend 2 40 W CUT (yellow) pedal	
Valleylab Force 40	COAG- Fulgurate 15-25 W COAG (blue) pedal	CUT Blend 1 25 W CUT (yellow) pedal	COAG- Fulgurate 20 W COAG (blue) pedal	CUT Blend 1 50 W CUT (yellow) pedal	

**BIPOLAR
ELECTROCOAGULATION**

Bipolar Electrocautery

- Usually gives low-energy or “micro-bipolar”. Has two or more small active electrodes very close to each other (active and return electrode)
- Does not use “indifferent plate”.
- Risk of explosion with flammable gases (needs colon prep)
- Less depth of injury. Saline pillow further decreases depth of injury (very important in colon & small bowel).
- Excellent desiccation and coagulation at low settings (15-20 W). Excellent for hemostasis.
- Example: BICAP, Gold-Probe.

BICAP Probe Tip



Micro-Bipolar Mode

- Used only for hemostasis (BICAP and Gold-Probe);
 - Tumor-Probe use was very limited.
- Depth of burn is limited and “saline pillow” can decrease it further.
- Better effect with large 10-Fr probes (needs “Therapeutic-channel” (T) Scope)
- Settings, pressure applied, and length of time have been standardized.

BICAP in Upper Endoscopy

(Inject “pillow” before SB burn)

Lesion	Probe	Pressure	Energy	Time/ Site
PUD/ Dieulafoy	10 Fr	Very Firm	20 W	10-14 sec
M-W Tear	7-10 Fr	Moderate	20 W	4 sec
Angiodys plasia	7-10 Fr	Light	15 W	2 sec

BICAP in Colonoscopy

(Inject “Pillow” before burn; tattoo after)

Lesion	Probe	Pressure	Energy	Time/ Site
Ulcer	10 Fr	Moderate	20 W	2 sec
Stalk	10 Fr	Moderate	20 W	2 sec
Diverticuli	10 Fr	Moderate	20 W	2 sec
Cancer	10 Fr	Moderate	20 W	2 sec
Angiodysplasia	7-10 Fr	Light	15 W	1 sec

Complications Of Electrocautery

Complications Of Electrocautery

- Indifferent-Plate & EKG-Pad: burn
- Fetal Stimulation
- Capacitive Coupling Discharge: burn
- Pacemaker: interference, burn, or device damage.
- Implantable Cardioverter Defibrillator: trigger, device damage, or asystole (dual system)
- Deep Brain stimulator and Gastric stimulator: “shock”, burn, or device damage.
- Bowel Explosion

Complications

Indifferent-Plate & EKG-Pad Burn

Fetal Stimulation

- Skin burn from Indifferent Plate (Return Electrode):
 - If partial detachment causes small contact area, and high current density, giving a burn.
- EKG electrode pad burn:
 - If indifferent plate is separated, and EKG pads acts as “indifferent plate”; EKG electrodes should be $> 0.3 \text{ cm}^2$ each
- Fetal Stimulation:
 - if electricity passes through the uterus to reach “indifferent-plate”
- Prevention:
 - Dual-Pad with “Return electrode Monitor” (REM) circuit, detects change in surface/resistance and “shuts-off” the unit.
 - During pregnancy, indifferent-plate should not be placed causing the uterus to be between electrode & plate.

Dual Electrode Monitoring



Independent
Pads

Complications

Capacitive Coupling Discharge

- Scope works as capacitor of currents induced by snare/hot-forceps;
 - important only with large scopes (Colon/ERCP).
- Scope can discharge current after contact with “frame-wires” (damaged external surface) or eye piece; can burn physician or inside of patient.
- Prevention:
 - S-cord connects “scope frame” to “indifferent plate” and unloads charge.
 - Risk: if indifferent plate gets off, scope acts as indifferent plate; should be used with “dual-pad”/REM.

Complications

Pacemaker Interference

- Electrocautery generates electromagnetic fields of up to 60 V/m
- Pacemakers are inhibited with electromagnetic fields > 0.1 V/m.
- Permanent protective circuit may be damaged or need reprogramming if current is delivered close to pacemaker or its leads.
- With poorly grounded or non-isolated electrocautery, pacemaker can work as “indifferent plate” and cause myocardial burn or arrhythmia (use “dual-pads”).

RECOMMENDATION

Pacemaker Interference

- **RECOMMENDATION:**
 - **“Pacemaker-dependent” for rhythm or hemodynamics (20%):** use magnet
 - pacemaker should be placed on “continuous asynchronous pacing” (VOO or DOO) with a “ring magnet”, only while electrocautery current is delivered.
 - after electrocoagulation, the pacemaker should be reactivated and assessed for normal function (telephonically).
 - **“No pacemaker-dependent”:** magnet use is optional
 - used mostly for prolonged electrocautery use, like in APC for GAVE or radiation proctitis.

Complications

Implantable Cardioverter Defibrillator

- Damage can occur as in case of pacemakers
- Electrocautery waves can be interpreted as “R waves” simulating arrhythmia or normal rhythm, and ICD will respond cardioverting, or inhibiting cardioversion or pacing.
- Most, but not all, ICDs respond to properly placed “magnet” by “suspension of tachycardia detection”, and/or “suspension of ICD therapy”, without affecting pacemaker function.

Complications

Implantable Cardioverter Defibrillator

- Patient with ICD who is “pacemaker dependent” will not have pacer changed to “asynchronous pacing” by the magnet:
 - risk of prolonged pacemaker inhibition by electrocautery, with asystole.
- Is difficult to ascertain if magnet is properly placed over ICD;
 - change in position may affect inhibition.
- Is difficult to know beforehand which effect magnet will have on the ICD.
 - **Example: ICDs made by “Guidant” may respond to magnet by:**
 - 1) Permanent disabling ICD therapy,
 - 2) Temporary disabling ICD therapy, or
 - 3) No change at all

Recommendations

Implanted Cardiac Defibrillators

(ASGE 2007)

- Determine:
 - 1) Cardiac device make/model/type,
 - 2) Indication for the device,
 - 3) Underlying cardiac rhythm,
 - 4) Degree of pacemaker-dependence.
 - 5) Frequency of VT and VF therapy
 - 6) Need for reprogramming for Procedure.
- **RECOMMENDATION:**
 - **1) Consult a hearth rhythm specialist.**
 - Optimal solution is ICD interrogation & reprogramming of ICD detection/therapy, before and after the procedure.
 - **2) If patient with ICD is “pacemaker-dependent” and device cannot be reprogrammed to “asynchronous mode”:**
 - strongly consider use of bipolar cautery.

Recommendations

Implanted Cardiac Defibrillators

(ASGE 2007)

- Monitor cardiac rhythm continuously.
- Have available external defibrillator with transcutaneous pacing capability.
- Place “Indifferent Return Electrode” in thigh or buttock (away from chest). Keep distance ≥ 15 cm away from device.

Recommendations

Implanted Cardiac Defibrillators

(ASGE 2007)

- Use “short & repetitive” bursts.
- Consider use of Bipolar electrocautery in:
 - **Patient with ICD who is “pacemaker dependent”**
 - If working in distal esophagus
 - If working in proximal stomach
 - If working in splenic colonic flexure

Complications

Non-Cardiac Devices

- Deep Brain Stimulators (DBS):
 - paresthesias and “shock” with monopolar electrocautery.
- Gastric (Enterra) and DBS:
 - 1) Temporary malfunction or reprogramming,
 - 2) Shock or “jolting” from induced currents,
 - 3) Electrode heating with tissue injury.
- Neurostimulators in spine, peripheral nerves, bladder or cochlea:
 - no complications if voltage reduced to zero and then “shut off”.

Recommendations

Non-Cardiac Devices

(ASGE 2007)

- Prefer non-cautery thermal probes or bipolar/multipolar probes.
- Use electrocautery at lowest effective power and for the briefest time
- Place return electrodes far away from the device generator and wire-leads
- Avoid electrocautery use near the device.
- In patients with DBS & GES:
 - consult with the specialist.
- Neurostimulators other than DBS & GES:
 - place voltage in zero, and turn-off the device.

Complications

Bowel Explosion

- Poorly prep bowel gas is combustible: swallowed O_2 + bacteria-produced H_2 and methane.
- Do not use preps with poorly absorbed carbohydrates (mannitol, sorbitol, lactulose); clear liquid diet decreases H_2 .
- If prep is sub-optimal:
 - “exchange air” or
 - use CO_2 , or
 - avoid electrocautery (heater probe is OK)

Non-Electrocautery Thermal Device

Thermocoagulation Heater Probe

- Can irrigate and tamponade + coagulate.
- Can be applied “en face” or “tangential”.
- 10 Fr probe is better, but needs “T-channel scope”.
- Is not electrocautery (no sparks); safe in unprepared bowel.
- Has an electrically heated coil inside a Teflon-covered insulated cylinder; heats to 110 °C degrees.
- Power setting in Joules (Watts x sec): HP unit decides time needed to deliver the requested energy.
- In ulcer; apply in 4 quadrants plus center.

Heater Probe in Upper Endoscopy

(Inject “pillow” before SB burn)

Lesion	Probe	Pressure	Energy	Pulses/ Site
PUD/ Dieulafoy	10 Fr	Very Firm	30 J	4
M-W Tear	7-10 Fr	Moderate	20 J	3
Angiodys plasia	7-10 Fr	Light	15 J	2

Heater Probe in Colonoscopy

(Inject “Pillow” before burn; tattoo after)

Lesion	Probe	Pressure	Energy	Pulses/ Site
Ulcer	10 Fr	Moderate	15 J	2
Stalk	10 Fr	Moderate	15-20 J	2
Diverticuli	10 Fr	Moderate	15 J	2
Cancer	10 Fr	Moderate	20 J	2
Angiodysplasia	7-10 Fr	Light	10 J	1