Electrosurgery and Argon Plasma Coagulation in Endoscopy: An Art and Science

CSGNA
2018

erbe
Perfection for Life

Objectives

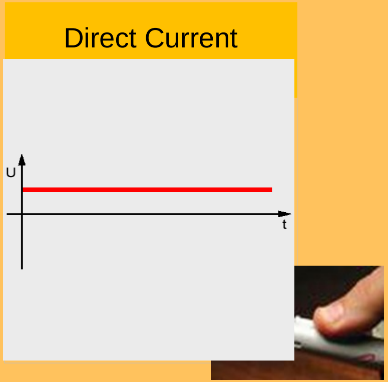
1. Discuss the basics of electricity and how it’s adapted for use in the human body.

2. Describe how Electrosurgery is used therapeutically and the variables that affect it.

3. Discuss how to provide safe electrosurgical care to patients.

4. Describe the basic principles and components of Argon Plasma Coagulation (APC) and how it’s applied safely in clinical applications.

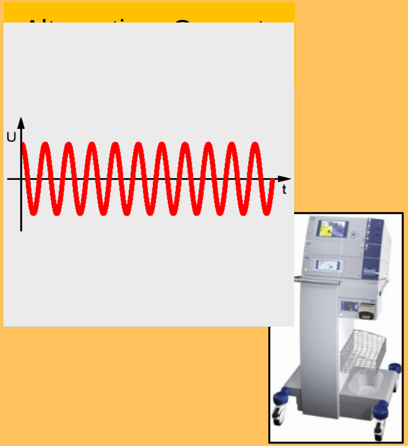
Electrocautery vs. Electrosurgery…



…there is a difference

Electrocautery:

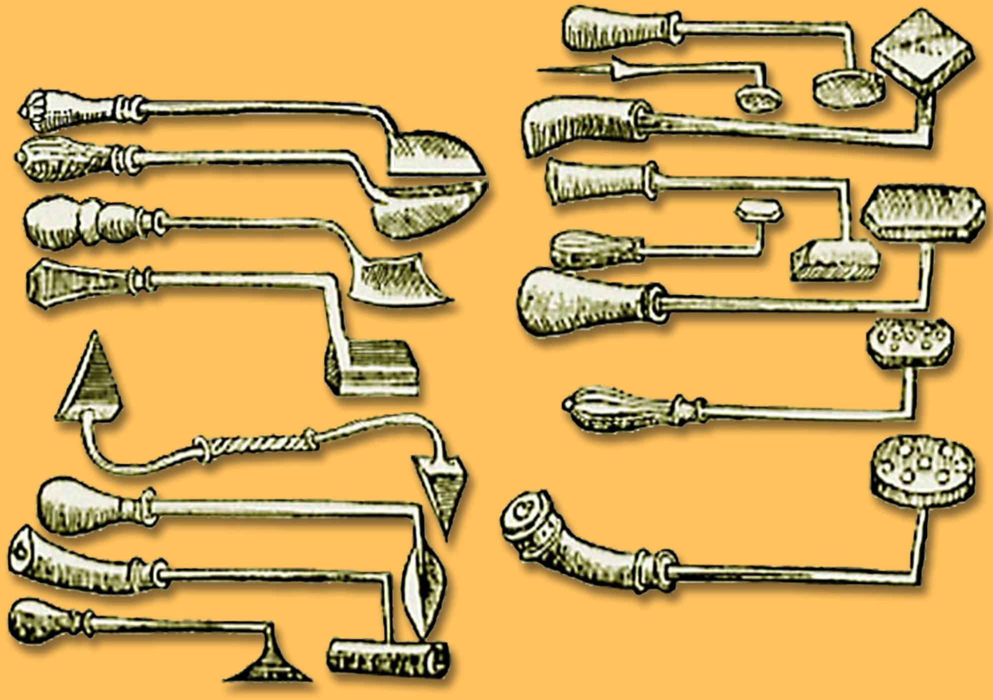
- Uses direct current.
- Often used inaccurately to describe "Electrosurgery".
- Current does not enter the patient's body – only the heated wire tip comes in contact with tissue.



Electrosurgery:

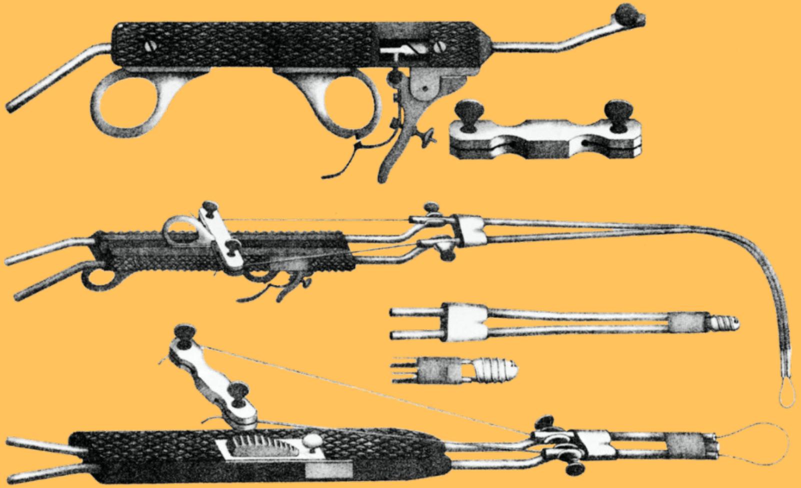
- Uses High-Frequency Alternating Current (AC).
- The AC Circuit must be completed: includes the electrosurgical generator, active electrode, the patient and return electrode.

How cauterization all started...



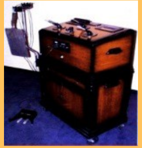
Various tools were heated with fire -17th century.

History - Hemostasis by cauterization



These devices were comprised of a metal wire, heated by means of an electrical galvanic (direct) current - used for coagulation and separation of biological tissue and was referred to as ***galvanocautery***.

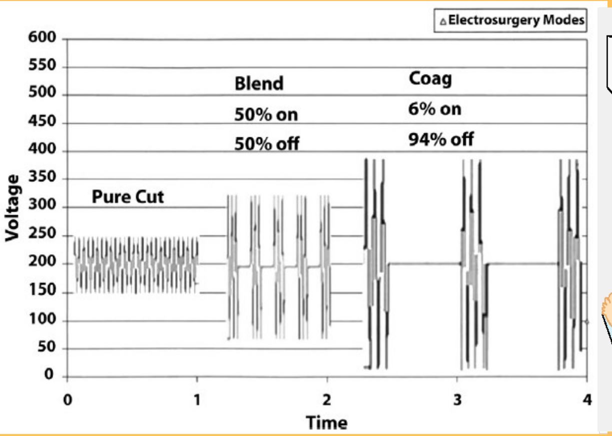
History of Electrosurgery – Hemostasis

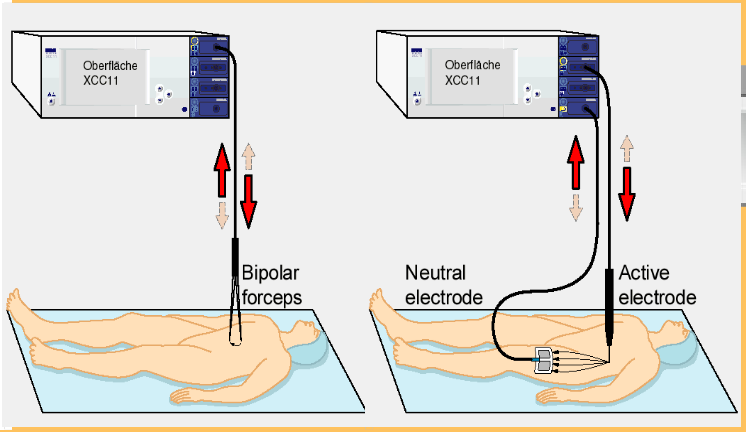


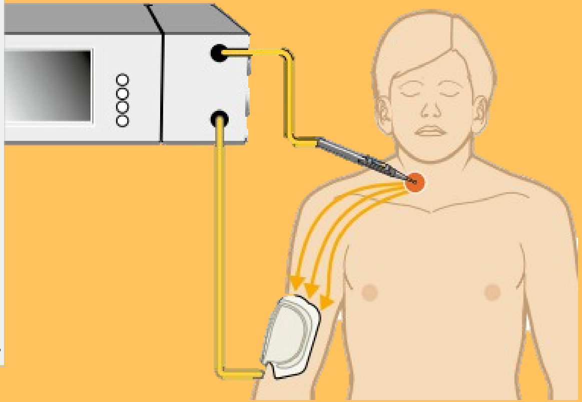
In 1978, Dr. Glover published an article on the use of thermal knives in comparison to other modalities and stated, *“There is no group of instruments in the surgical armamentarium that is used as frequently and understood as poorly as Electrosurgery units….”*

Basics of Electrosurgery

- Uses an alternating courant ≈350kHz
- Efficient ESUs convert 60Hz to a clean/pure 350kHz
  - - Friction caused by the oscillating electrons results in the desired thermal energy
  - - Which passes between two electrodes (poles)





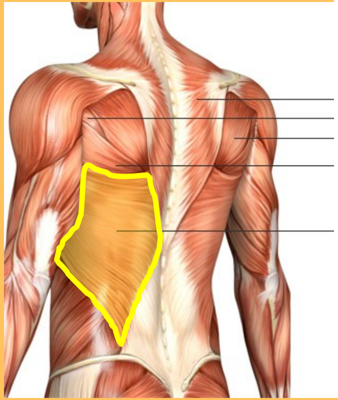


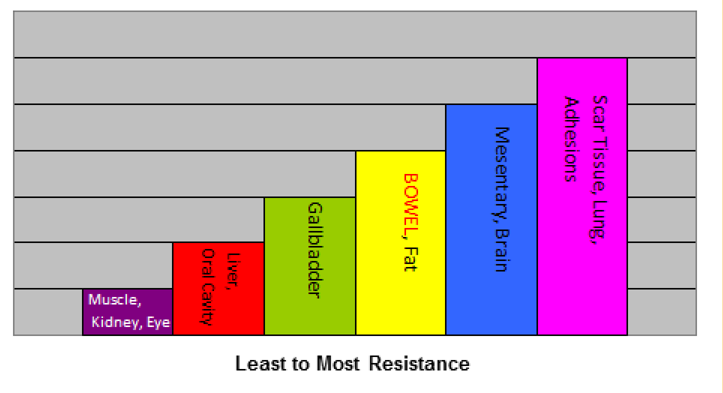
Electrosurgery Basics - Electrical Circuit - Pad Placement

How the circuit impacts target tissue effect

Impedance = Resistance

- *As the electrons encounter impedance, the electrical energy is converted into heat, resulting in tissue effect*
- *Tissue Impedance varies with water content*





Electrosurgery Basics - Electrosurgery Variables & Thermal/Tissue Effect

CURRENT (I = Amps) - Flow rate of electrons through the electrical circuit, measured in amps (I).

- The diameter (x-sectional area) of the hose impacts the amount of water that can fit through. Larger diameter = lower resistance, lower pressure = higher flow rate (I).

VOLTAGE (V = Volts) - Pressure or Force applied to the current

- Amount of pressure controlled by faucet/pump

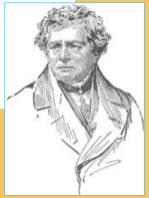
RESISTANCE (R = Impedance) - opposition to flow of electrons (current)

- Narrower diameter = higher resistance (R) = higher pressure (V)

POWER (P = Watts) - the rate at which electrical energy is transferred by a circuit in a given time

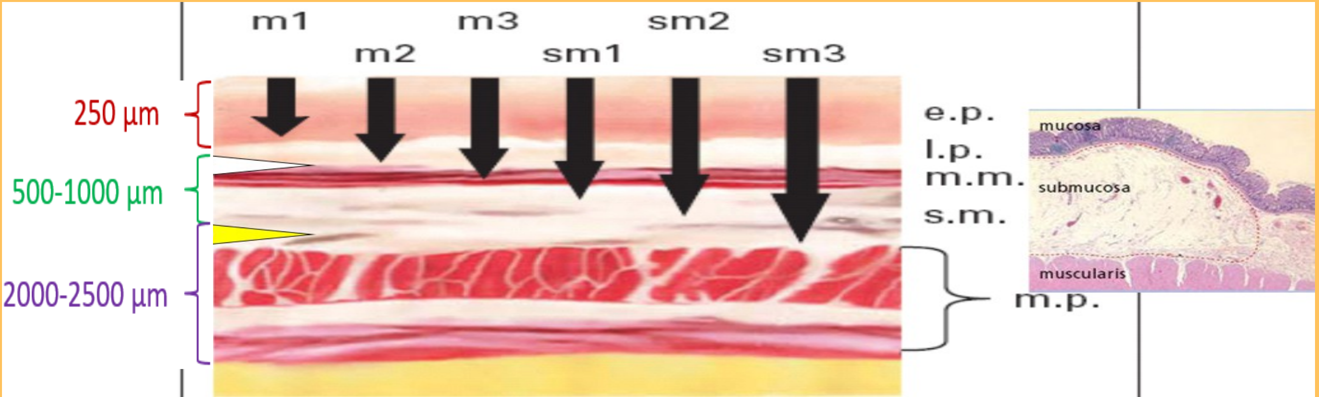
- Depends on Current (amount of water) and Voltage (the pressure of water)… A by product of V & I
- P = V x I

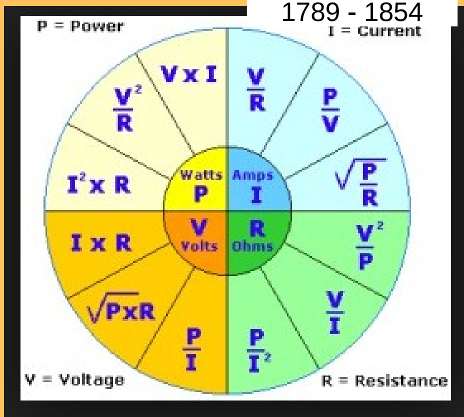
Energy (J = Joules) - the ability to do work (or transfer energy) ***Clinically we want to dose the least amount of energy into the patient.***



Ohm's Law: V = I x R

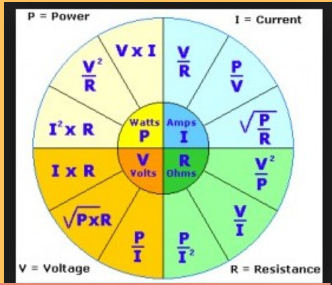
German physicist - Georg Simon Ohm 1789 - 1854





Thermal Effect on tissue

- when High Frequency Current is applied



The heat created (Q) as per Joules law (Q = P x t)

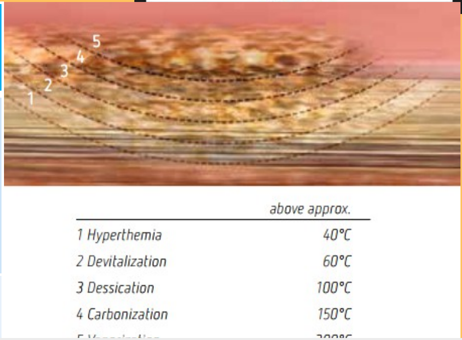
Q = I2 x R x t = (V2/R) x t

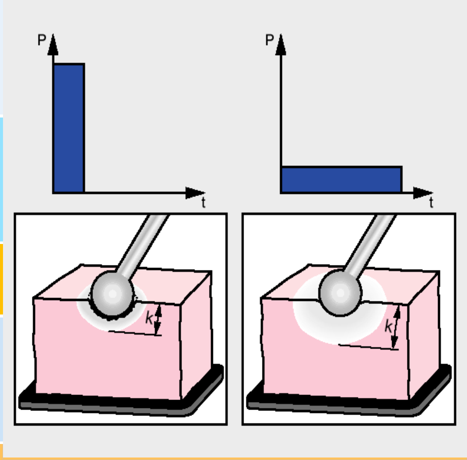
I = V/R ; V is directly related to I

Time (t), V & R has a direct effect on thermal tissue effect.

The heat created (Q) = Current (I) travels in/through a conductor with a resistance (R) over a period of time (t)

Temp	Tissue Effect
104°F:	Reversible cellular trauma
120°F:	Irreversible cellular trauma
158°F:	*Coagulation (Desiccation)*
212°F:	*Cutting*
392°F:	Carbonization





Thermal Effect on tissue

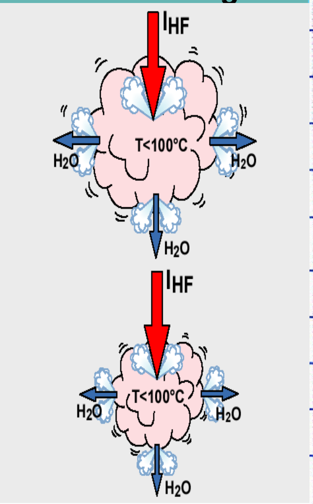
- Coagulation vs Cut @ the cellular level

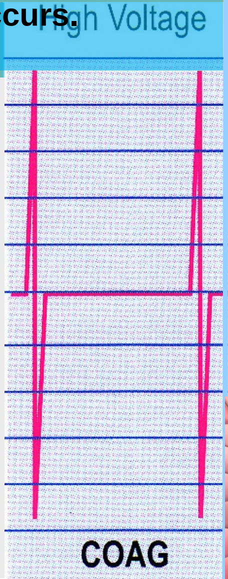
- Amplitude modulated Waveform with spikes of high voltage, followed by rest periods.

- This allows the cellular proteins to slowly denature (dehydrate).

- Coagulation occurs.

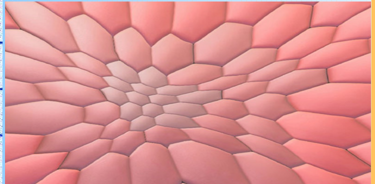
Hemostasis due to shrinking



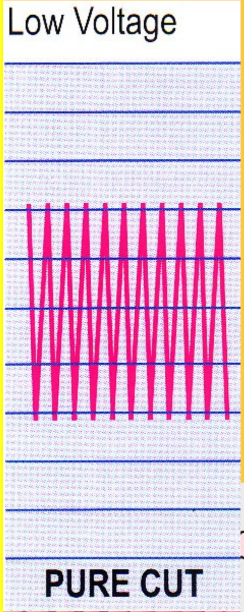


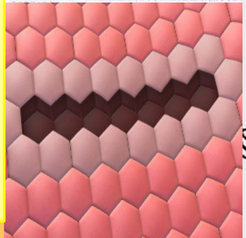
Voltage = the driving force that pushes current forward.

- Higher voltages increase the depth of thermal injury, OR can facilitate the desired endoscopic effect (particularly hemostasis).
- Inadvertent thermal complications are minimized by



- Cutting requires a spark – a minimum of 200 volts needed for spark
- Efficient Cutting requires a 100% duty cycle; means no stalling
- Maximize current density (finer tipped instruments), ↑es resistance/heat
  - The extremely rapid vaporization of the intracellular liquid leads to the rupturing of the cell membrane



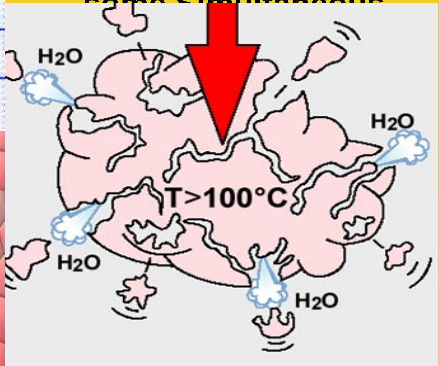


- Voltage quickly raises cell water temperature to the boiling point.

- Cell water turns to steam.

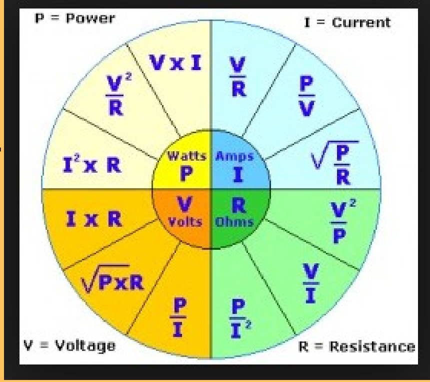
- Cell explodes, separating from adjoining cells.

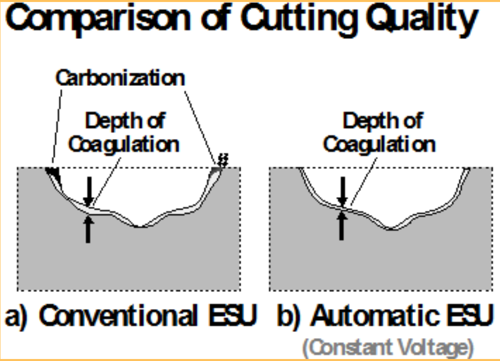
- Cleavage plane is created = clinical “CUT”, with NO mechanical force



Electrosurgical Unit (ESU) – microprocessor controlled

Constant Voltage (Power Adjusts) vs. Constant Power (Voltage Var





Electrosurgical Unit (ESU)

Constant Voltage = Homogeneous, Reproducible Tissue Effects

Communication from the ASGE Technology Committee

TECHNOLOGY STATUS EVALUATION REPORT

ASGE — American Society for Gastrointestinal Endoscopy

Electrosurgical generators

Volume 78, No. 2 : 2013 GASTROINTESTINAL ENDOSCOPY

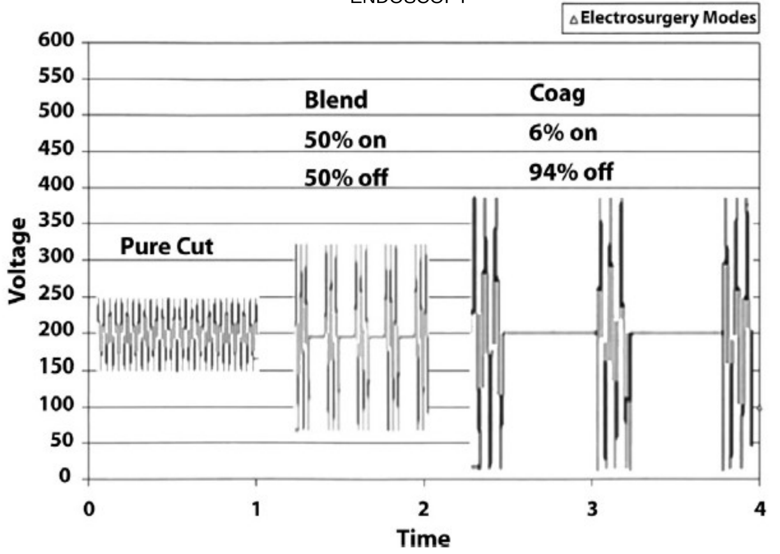
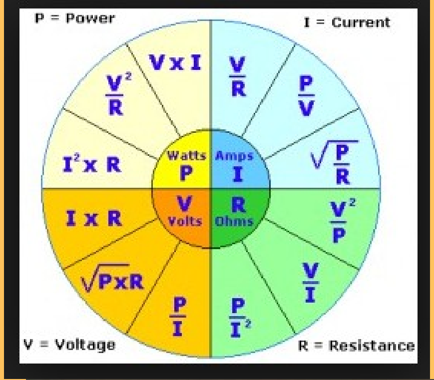


Figure 1. The electrosurgical current modes commonly used in GI endoscopy are represented graphically. Current delivered continuously at 100% duty cycle at more than 200 V is referred to as pure cut. Intermittent current pulsed at a 6% duty cycle is referred to as pure coagulation. Blended current is a mode that uses preset duty cycles ranging from 12% to 80%. To maintain a fixed power setting, lower duty cycles require progressively higher voltage.

What feature may be most important in Endoscopic electrosurgery…Constant Power or Variable Power Dosing (constant V)?

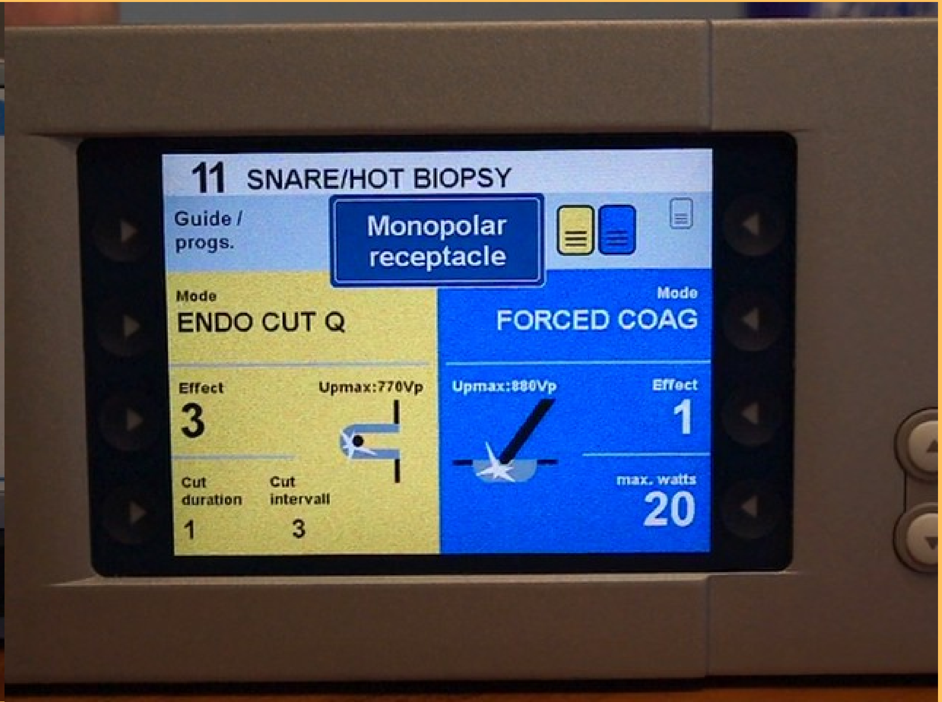
During polypectomy, tissue resistance is initially low and current flows easily into the tissue. However, progressive tissue desiccation increases the resistance (impedance) to current flow. ***Conventional Constant Power ESUs maintain constant power output, but as tissue changes occur, there can be significant fluctuations in voltage.***

Some modern ESUs are capable of monitoring changes in voltage, during the delivery of electrosurgical energy. ***Some ESUs are capable of <u>keeping voltage constant while power more efficiently fluctuates to the lowest effective output, based on impedance within the circuit. This results in the most reproducible and consistent target tissue effects</u> during electrosurgery.***



Electrosurgical Unit (ESU)

‘92 Coag Constant Power (Voltage Varies) vs. ‘04 Coag Constant Voltage (Power Adjusts)

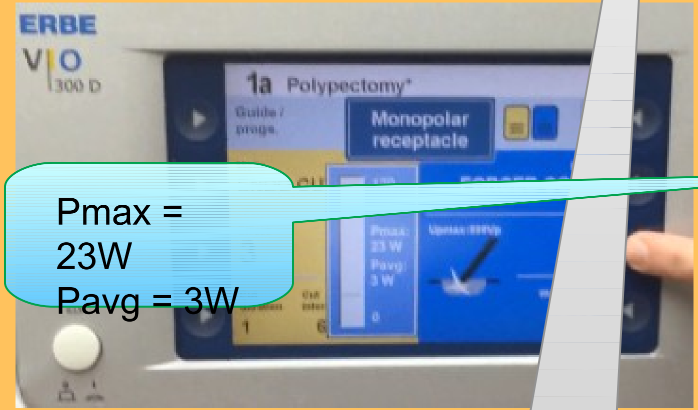


Technology

Cut & Coag modes with Voltage Regulation (Power Dosing)

- The voltage remains constant and controlled, so that the tissue effect is consistent, regardless of changes in tissue resistance (muscle, fatty tissue).

- With voltage regulation, the power automatically adjusts based on the impedance and conductivity of the tissue, as well as other influencing circuit variables in order to achieve the desired reproducible tissue effect.



Pmax = 23W
Pavg = 3W

Max watts = 25

Electrosurgical Unit (ESU) – Old vs. New Technology

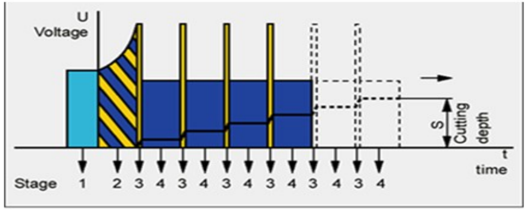
World's first automatically regulated Electrosurgery unit ERBOTOM TUR (1985). The successful ICC line (here with APC 300) followed in 1992 with "Intelligent Cut and

ICC w lower Amps… leads to a longer desiccation period (TIME) before spark

Note VIO dynamic initial Cut

The VIO System is the first modular-built electrosurgery unit (introduced in 2002).
There are new modes and upgrades for cutting, coagulating and devitalizing tissue.

ERBEJet is now available in Canada with HybridKnife & HybridAPC



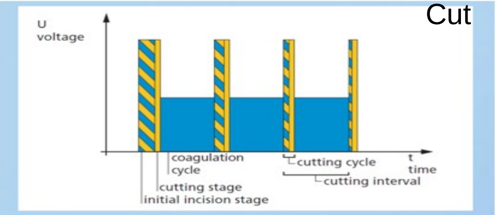


Fig. 2: Cutting cycle with ENDO CUT Q: initial incision phase (yellow/blue), cutting phase (yellow) and coagulation cycle (blue).

Spark Recognition—only in first cutting

Amperage is 1.4

Produces Dessication until able to start a spark

Spark Recognition ---All Cuts

Amperage in VIO® is 3 plus

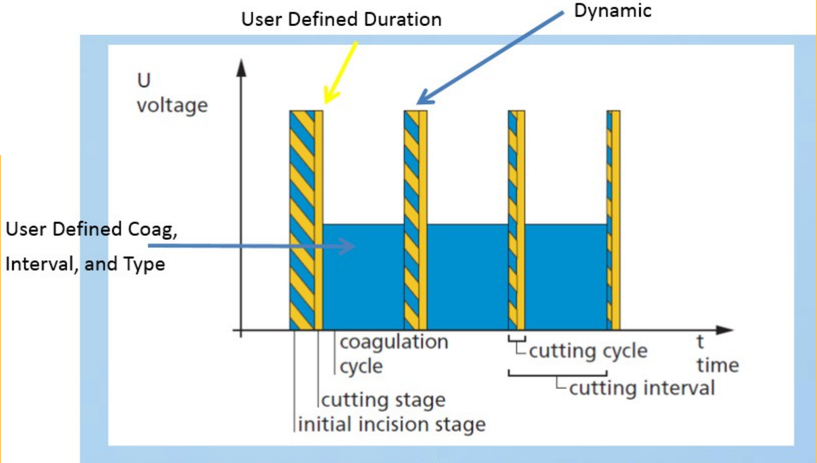


Fig. 2: Cutting cycle with ENDO CUT Q: initial incision phase (yellow/blue), cutting phase (yellow) and coagulation cycle (blue).

ERBE VIO dynamic initial Cut based on desiccation/impedance level (ability for current (3 amps) to create a spark), using **either 700Vp or 500Vp**. With VIO you can adjust **Cut length to 4 different options** (Cut duration = 1-4) & **Coag length to 10 different options** (Cut Interval = 1-10) Vs. ICC has one high ~ 650Vp:

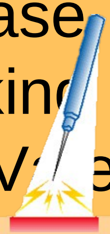
- 650Vp might be too high in delicate ERCP or Advanced Submucosal microsurgery
- 650Vp might be too low in f brous/sessile polyps

VIO platform has 4 different Cut length options (Cut duration = 1-4) & Coag length to 10 different options (Cut Interval = 1-10)

Technology – Spark Regulation

Spark Regulation – « Peak Power System » (PPS)

- patented spark generation (increases Peak Power) and recognition
- calculates in real-time when micro-electric arcs become present and determines the intensity of the arcs. With the introduction of the VIO® 300 D (2004), the "spark on" can be limited to a few milliseconds, depending upon the duration chosen.
- Rapid spark production with limited 'on' time can decrease thermal spread, which is extremely important while working in delicate areas such as the right colon or the ampulla of Vater.

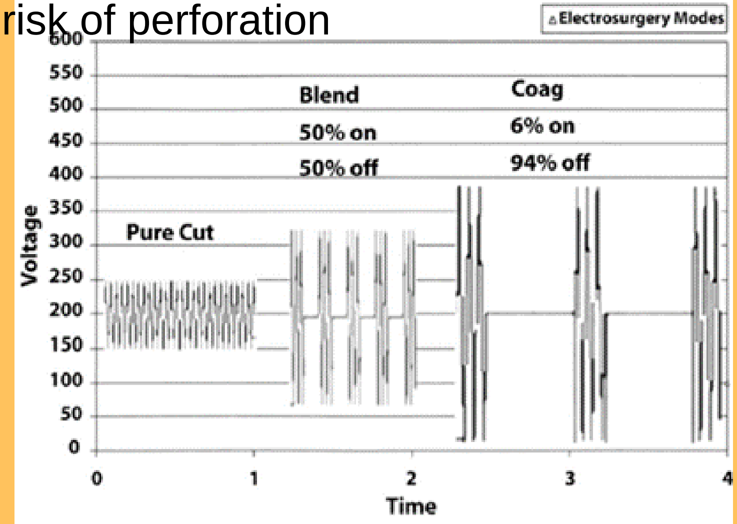


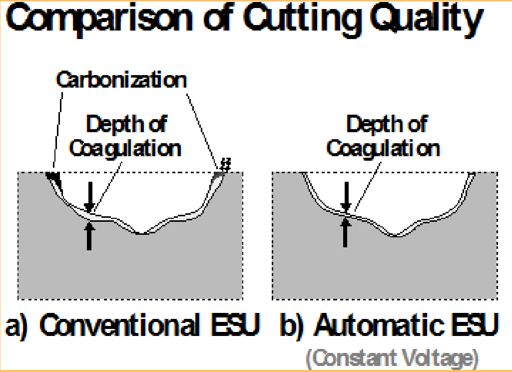
Technology

a continuous 100% Hf duty cycle = True Pure Cut

*A pure-cut current, allows effective electrosurgical cutting at the cellular level during flexible endoscopy (**no sticking**).*

Lower duty cycles might require higher voltages, which could increase the risk of perforation

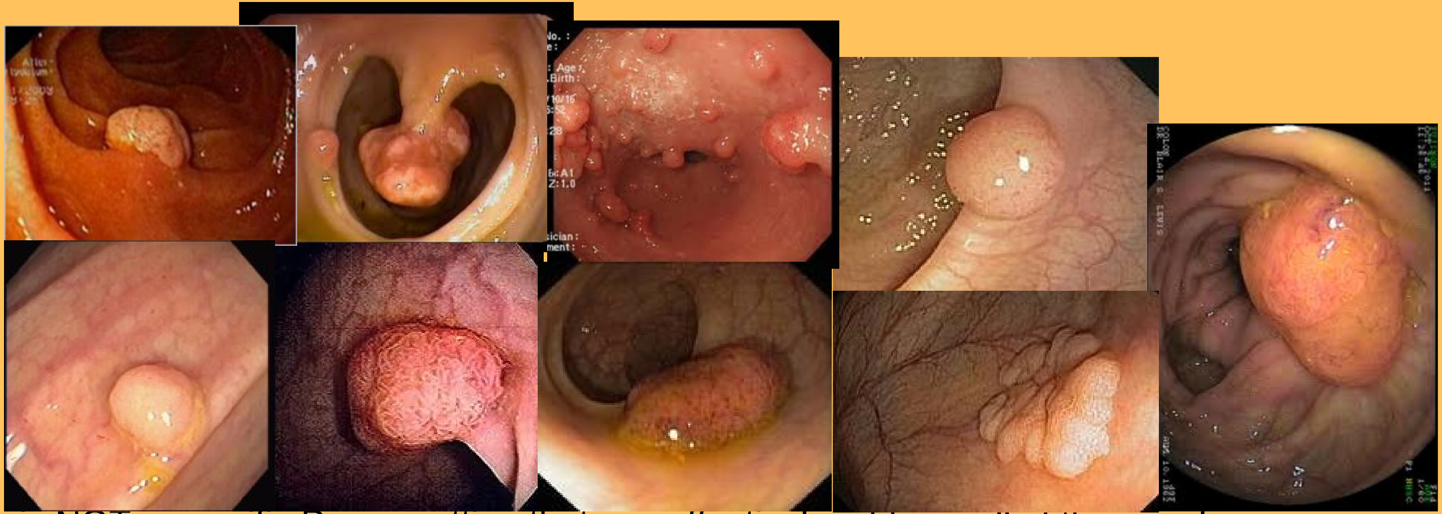




Electrosurgical Unit (ESU)
- Choose a Power Setting or Tissue Effect in Cut/Coag?

Therapeutic Relevance—Settings/Waveform Choice

- Depends partially on your clinical goals… Where (wall thickness).



- There is NOT a specific Power setting that can effectively address all of these polyps
  - Need to select a specific tissue effect (thermal spread)
- What are your treatment goals?

TECHNICAL BACKGROUND

- Current Density & Thermal/Tissue Effect

What is the impact of Current Density

↑Contact Surface Area (↓Resistance / ↓Heat / ↓Current Density)
= ↑Power needed to create the same amount of heat for a desired tissue effect

In Micro-Surgery, Current Density is your friend!
↓Contact Surface Area (↑Resistance/↑Heat / ↑Current Density

= ↓Power (Energy) dosed through the tissue (to the return electrode)

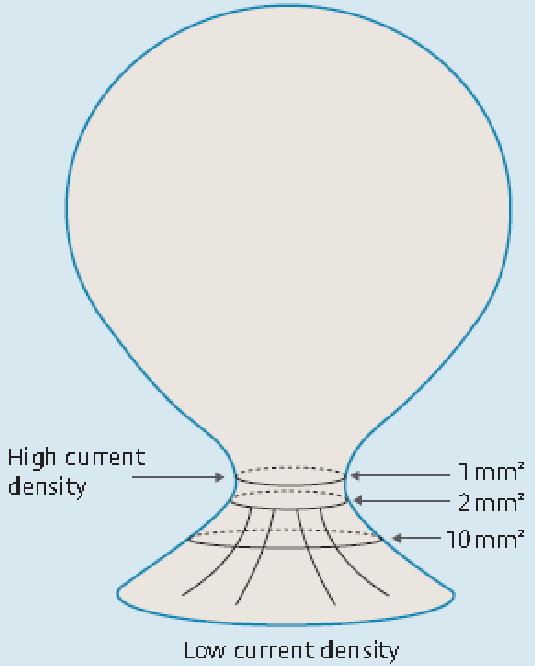
= ↑Safety for the patient

The increase in tissue temperature is directly related to the amount of electrical energy absorbed by the tissue (QE). This amount (QE) can be expressed by the equation:

- Q = I2 x R x t = heat created
- **QE = (Current2 x Resistance)/ tissue contact Surface Area**

TECHNICAL BACKGROUND

- Current Density & Thermal/Tissue Effect



The increase in tissue temperature is directly related to the amount of electrical energy absorbed by the tissue.

Current densities during polypectomy at various levels of a polyp stalk. The density of the monopolar current administered through the snare (and, hence, the rise in temperature) varies according to cross-sectional areas.

- Narrower cross-sectional area = Quicker cutting response
  - Means less energy is dosed through the muscularis
  - After adequate hemostasis is achieved consider making the snare as tight as possible; to decrease the cross-sectional area (increasing current density)

Clinical Principles

- Variables Affecting Electrosurgical Effect

TIME & MD
technique

CSPEB

Clinically Significant Post-endoscopic Mucosal Resection Bleeding (CSPEB)

Risk Factors for Intraprocedural and Clinically Significant Delayed Bleeding After Wide-field Endoscopic Mucosal Resection of Large Colonic Lesions

Nicholas G. Burgess,* Andrew J. Metz,* Stephen J. Williams,* Rajvinder Singh,‡ William Tam,‡ Luke F. Hourigan,§,‖ Simon A. Zanati,¶,# Gregor J. Brown,¶,** Rebecca Sonson,* and Michael J. Bourke*

The use of a microprocessor-controlled current was associated with significantly fewer delayed bleeding events.

Modern electrosurgical units with microprocessor control alternate cycles of short cutting bursts with prolonged periods of coagulation and limit peak voltage on the basis of impedance feedback, which may result in a less marked coagulating effect than the use of a non–microprocessor-controlled blended or pure coagulating current. Pure cutting current has been shown to be associated with immediate bleeding,[20,24] whereas pure

coagulating current results in a deeper thermal injury[25] and is associated with late bleeding.[26] Our study has shown that microprocessor control is associated with the lowest CSPEB rates (5.8%) compared with use of a blended (8.5%) or pure coagulation (15.2%) current. The trade-off for less coagulating effect is a potential increase in IPB. Rates of IPB were not significantly different be-

What clinical situation is preferred?

a) *Intra-procedure bleeding?*

b) *Post procedure bleeding?*

The elegance of an effective electrosurgical cut is achieved by dosing the least possible amount of power/energy into the patient, as quickly (shortest time) as possible with the minimal mechanical force (less chance of distorting cutting plane).

Halsted's Principles of Surgery

William S Halsted of John Hopkins University put forward a set of principles in the 1890’s for achieving the best results in surgery. Now, more than 100 years later, they still form the basis of modern surgical craftsmanship. As the “Tenets of Halsted”:

Gentle handling of tissues;

Strict aseptic technique;

Sharp anatomic dissection of tissues;

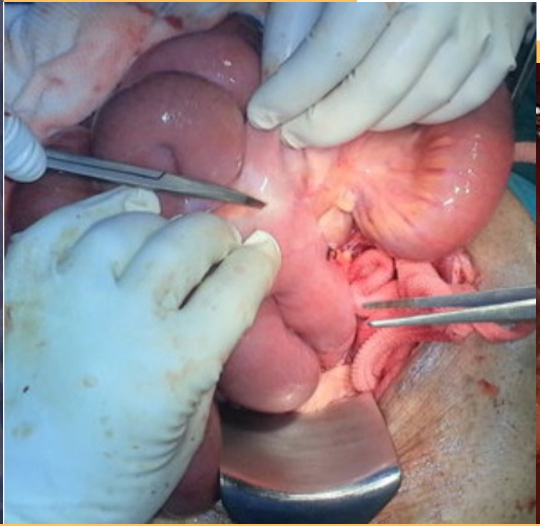
Careful hemostasis, using fine, non-irritating suture material in minimal amounts

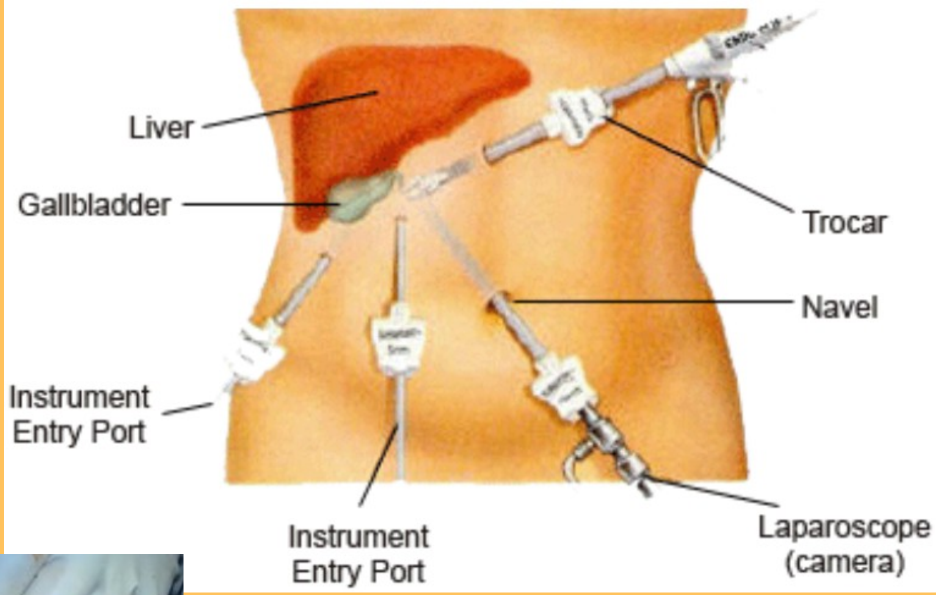
The obliteration of dead space in the wound; and

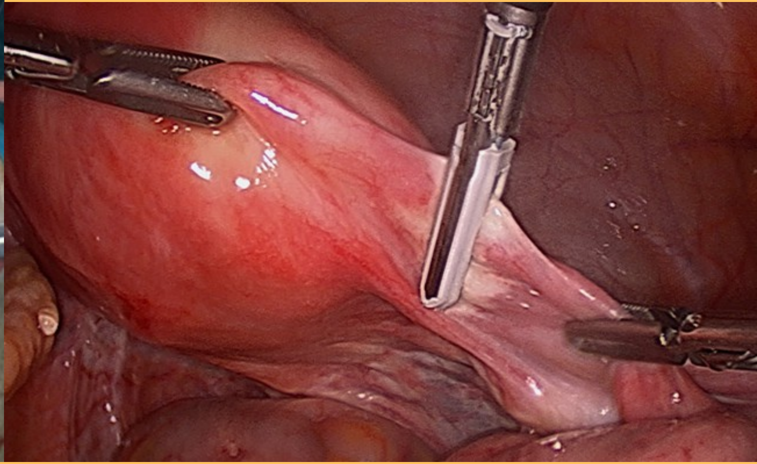
Avoidance of tension

Surgical Environment

- Open & Laparoscopic Procedures

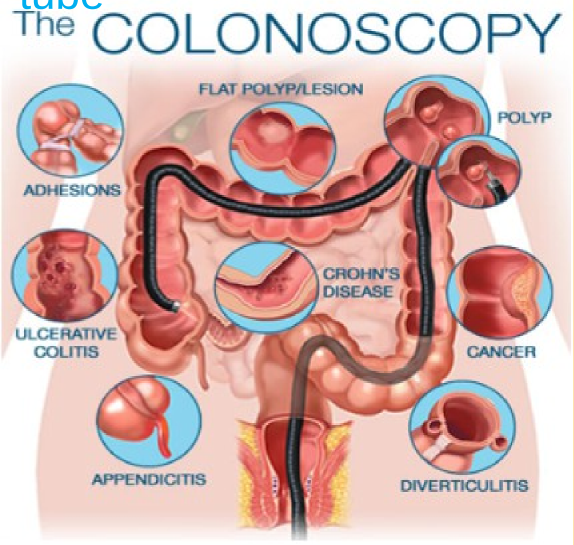


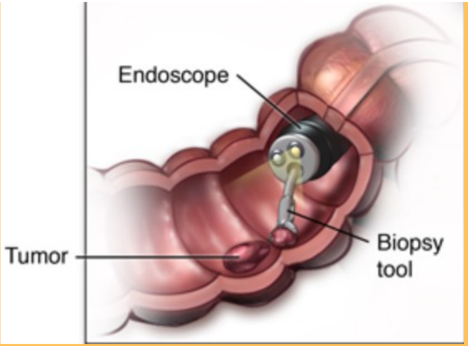




Surgical Environment

- Endoscopic Procedures - Thickness of cutting plane (several mm), within loose tube





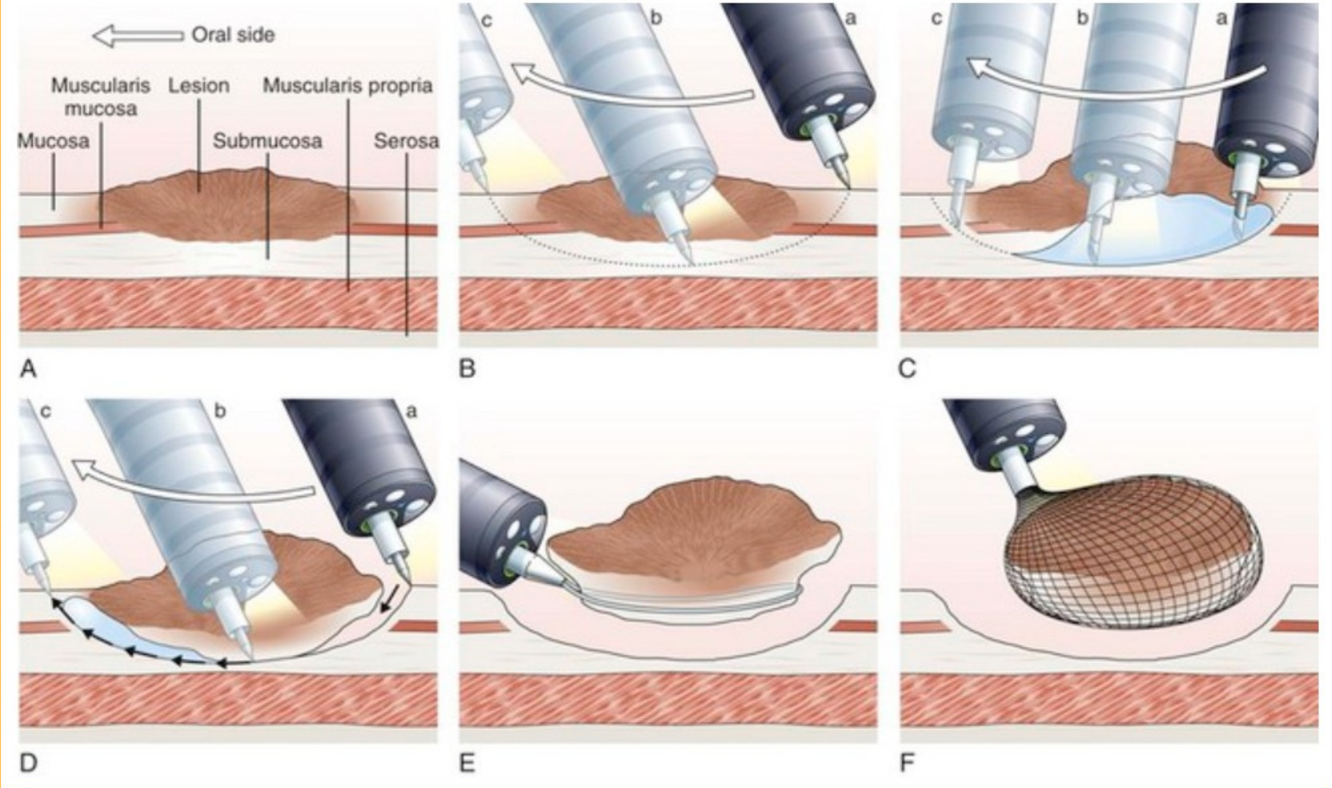


Fig. 33.5 En bloc endoscopic mucosal resection (EMR). **A,** Lesion involving the mucosal layer. **B,** Marking of incision around the lesion with a needle-knife from the distal to proximal edge. **C,** Submucosal injection of sodium hyaluronate below the lesion and around the lesion from the distal to proximal edge. **D,** Incision of marked area around the lesion with a needle-knife from the distal to proximal edge of lesion. **E,** Snare excision of entire lesion. **F,** Retrieval of lesion with Roth net.

Surgical Environment - Endoscopic Procedures - How many hands?

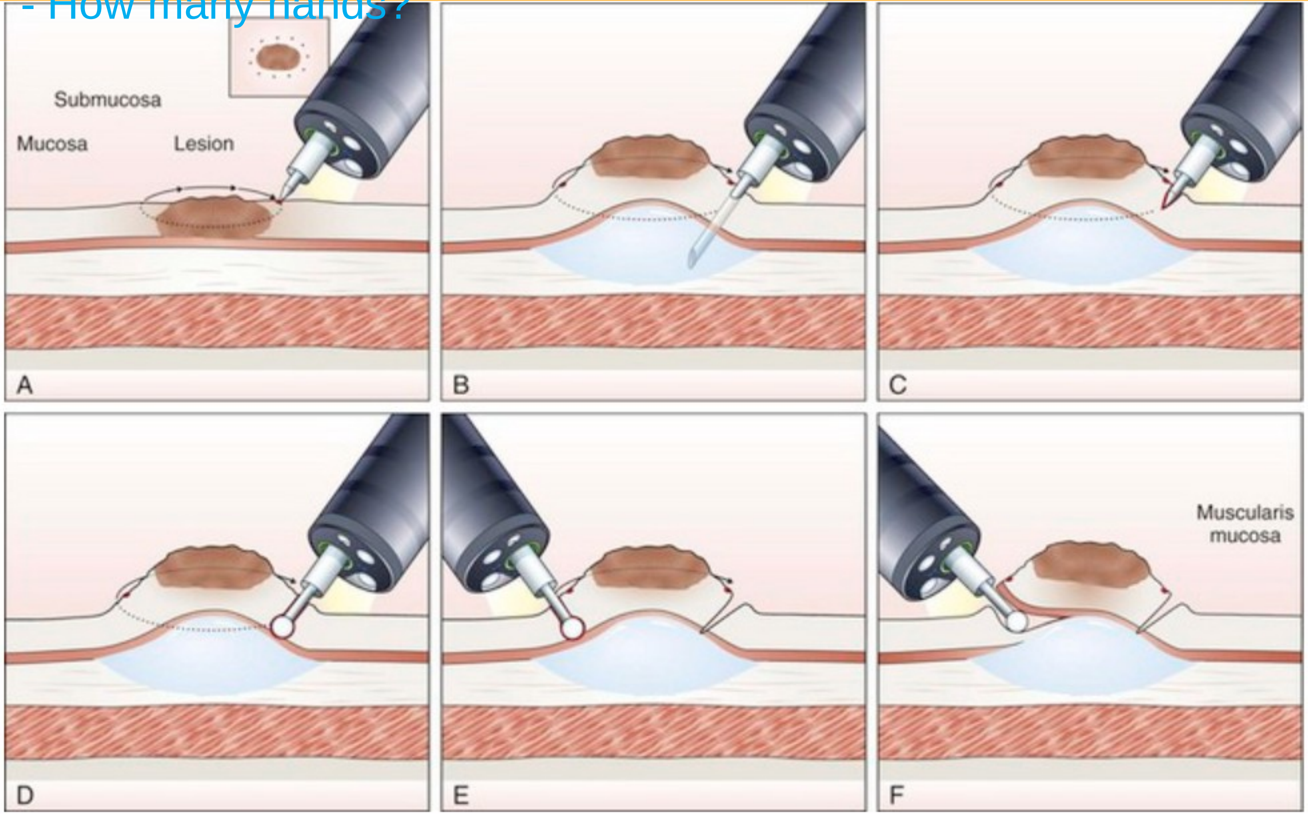
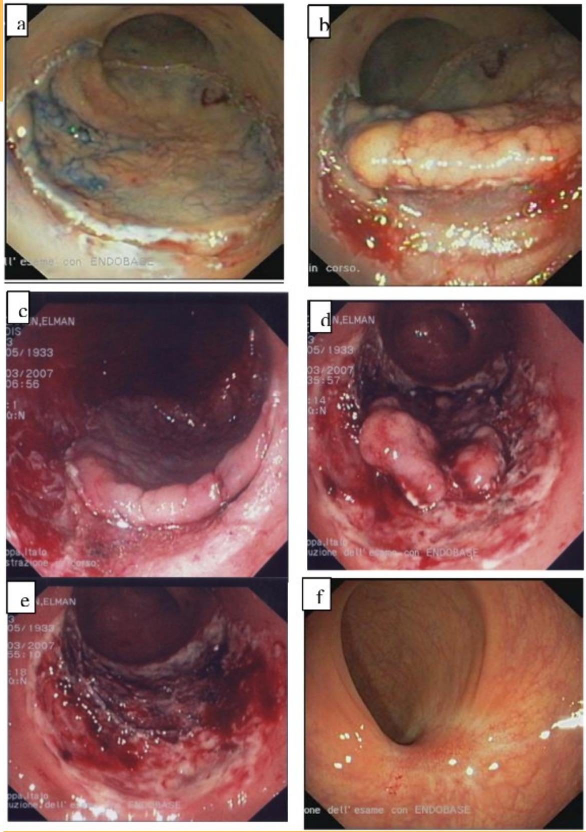


Fig. 33.10 Endoscopic submucosal dissection (ESD). **A,** Markings with knife or argon plasma coagulation (APC) probe around the edge of the lesions. **B,** Submucosal injection around the edge of the lesions. **C,** Incision hole with a needle-knife or hook knife. **D,** Margin cutting with insulated-tip (IT) knife at the incision hole. **E,** Circumferential margin cutting. **F,** Submucosal dissection with IT knife beneath the muscularis mucosa.



a *Spraying with 1% indigo carmine and lesion marking with Flex-Knife.* b *Infiltration of submucosa and removal of the anterior part of the lesion with Hook-Knife.* c *Anterior and lateral excision.* d *Removal of a large flap of lesion.* e *Complete polyp removal.* f

Clinical Principles - Special Surgical Situations
- Polypectomy or EMR

Endoscopic challenge…

To effectively/elegantly cut something your not holding in place.

How do you effectively apply the Tenets of Halsted Endoscopically?...

- Gentle Counter traction in a hollow lumen.

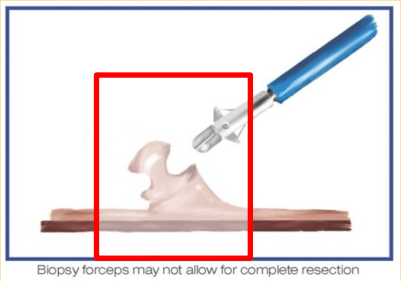
Traction is achieved using:
- injection (elevation)
- gravity
- water (floating mucosa)

- **while maintaining the plane of your cut/not distorting the anatomical structure**
- **By not using mechanical force to cut.**
  - **Let the electrosurgical CUT wave form do the cutting**

Clinical Principles - Polypectomy Techniques - ASGE Guidelines

A polyp needs to be removed and sent to the lab for evaluation.

- Did you get it all?
- Don't just ablate the surface!
  - Worry about buried glands/cells that can mutate below the surface
- Is there a margin?


Biopsy forceps may not allow for complete resection

The type of current used has the potential to affect the quality of histological interpretation. GI pathologists blinded to the polypectomy technique evaluated 148 polypectomy specimens (78 blended current, 70 ENDO CUT current) and concluded that polyps resected with <u>ENDO CUT had better overall quality, primarily because of improved ability to evaluate the margin of the specimen</u> (75.7% vs 60.3%, P Z . 046)

… Fry LC, Lazenby AJ, Mikolaenko I, et al. **Diagnostic quality of: polyps resected by snare polypectomy: does the type of electrosurgical current used matter?** Am J Gastroenterol 2006;101:2123-7.

Residual lesion rates can be as high as 46%, primarily due to piecemeal resection…

Woodward T, Crook J, et al: ***Improving Complete Endoscopic Mucosal Resection of Large Sessile Colorectal Neoplasia: a Randomized Trial Comparing Snares & Injectate***

Clinical Principles - Colorectal Cancer

- What we know

Diagnosed when neoplastic cells cross into the muscularis mucosa.

Normal Epithelium can take ten years to mutate into a carcinoma; but, has also been found to mutate in as little as 2-3 yrs.

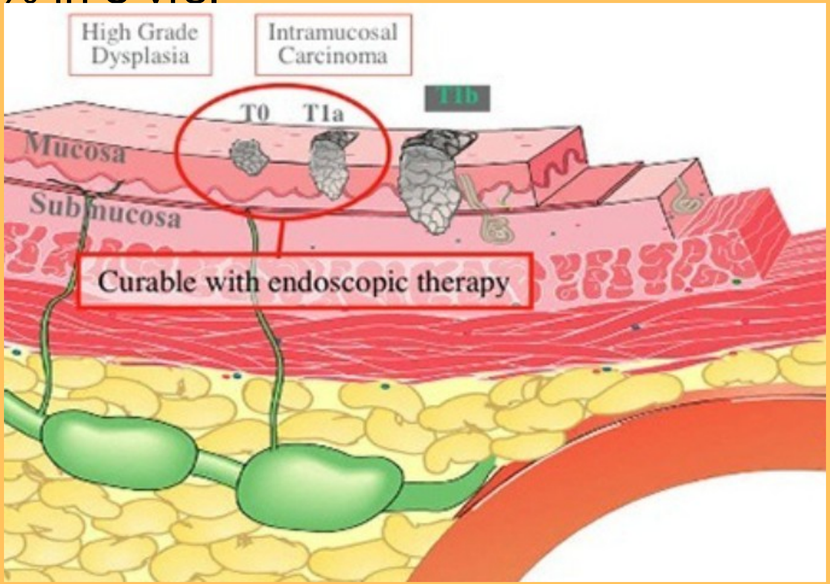
- Interval cancer rate post polypectomy of 20-40% in 3 yrs.

3-4 mm

250 µm

500-1000 µm

2000-2500 µm



Clinical - Tips for basic Polypectomy or EMR

- Adjust settings according to particular conditions (e. g. low power settings for small bowel and cecum).
- If polypectomy snare sticks in a polyp, increase cutting intensity & current density.
- Do not touch metal parts, such as clips, with snare when applying current.
- Do not touch the scope with metal parts of endotherapy instruments.
- Watch out that snare tip does not accidentally touch the bowel wall opposite to mucosectomy.
- Avoid deep coagulation of muscle layer (risk of late perforation).
- Before applying current, make sure that the muscularis propria is not entrapped in the snare loop.

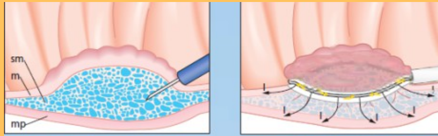
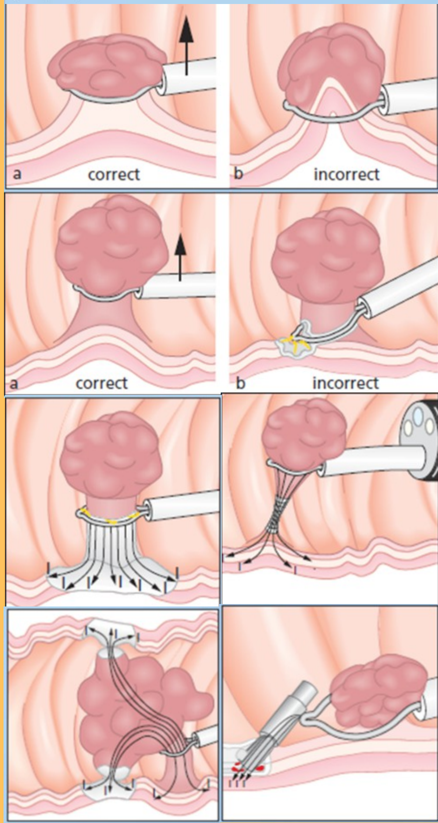


Fig. 16: Submucosal (sm) injection. The distance between mucosa (m) and muscularis (mp) is increased after submucosal injection of liquid (blue).

Fig. 17: With the submucosal injection the risk of selective thermal heating by the electrosurgical current (black arrows) is reduced.



Argon Plasma Coagulation (APC)

APC is a non-contact monopolar application for hemostasis and thermal destruction

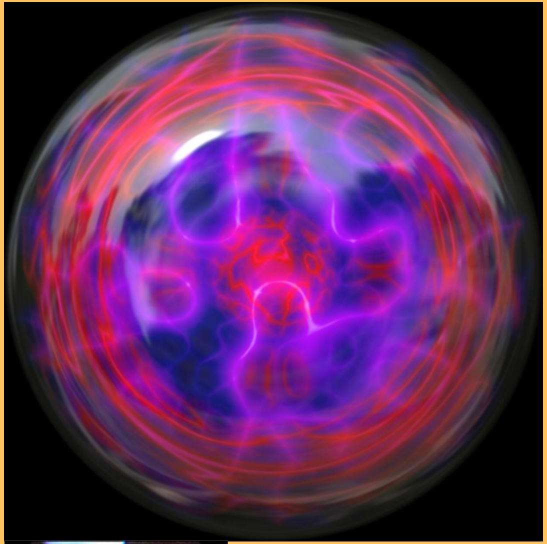
What is Argon Plasma?

Argon

- Nobel gas
- Present in air (≈ 1%)
- Non-flammable
- Non-toxic
- Ionizes easily
- Heavier than air

Plasma

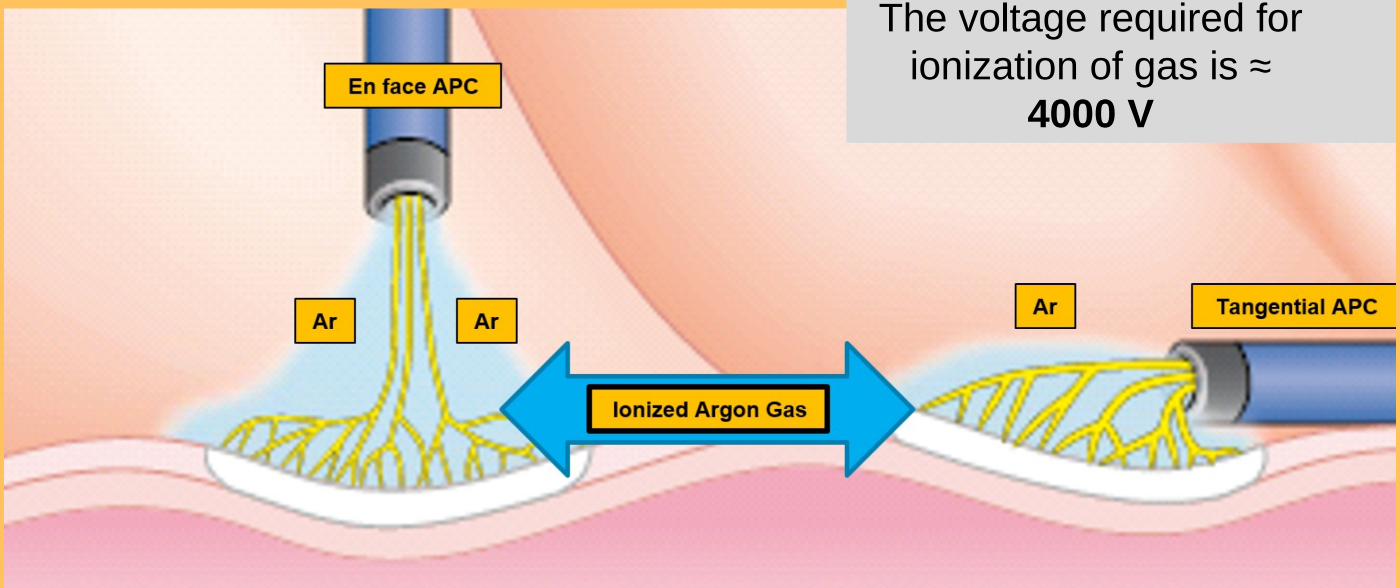
- Ionized, electrically conductive gas
- Ionization by way of high voltages



Argon Plasma Coagulation - APC

Argon Plasma Coagulation (monopolar) offers particular advantages for non-contact, endoscopic applications as it can be applied enface or tangentially, enabling less accessible areas to be easily treated.

The voltage required for ionization of gas is ≈ **4000 V**



Argon Plasma Coagulation – APC Advantages

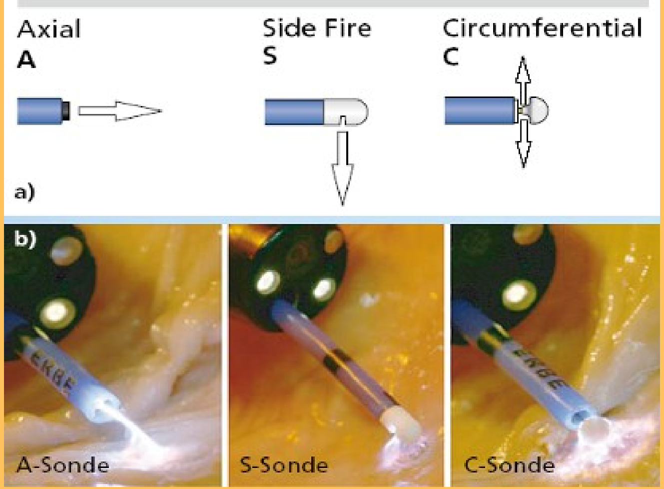
Non-contact application - *No sticking to delicate tissue.*

Varied probe Diameter & Length – for Bronchoscopic, colonic & enteroscopic applica

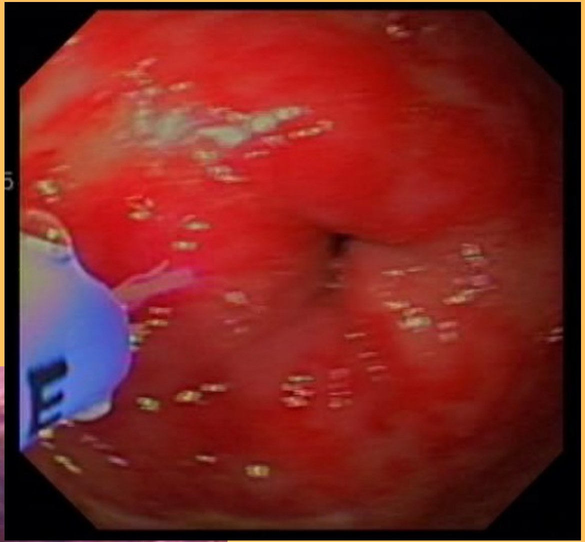
Thinner, more flexible eschar.

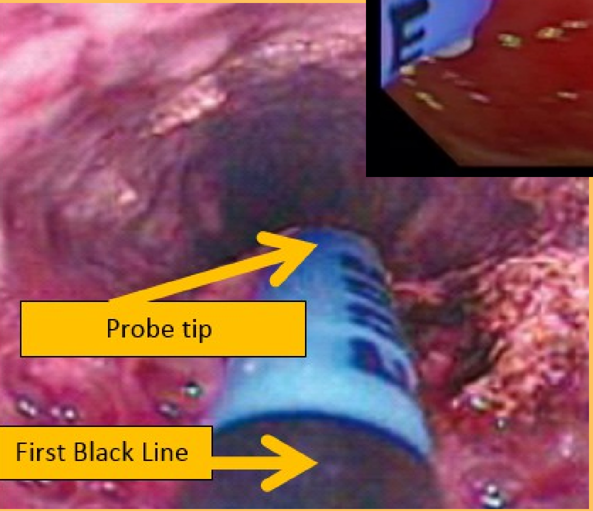
Widespread areas can be treated.

- Applications can be –
  - Axial
  - Radial
  - Retroflexed
  - Circumferential



Argon Plasma Coagulation – APC Use





Purge probe at least twice before placing in the scope channel.

Advance the tip of the probe until one "E" is visible on the monitor - depth perception; at this point, use scope articulation and movement for APC treatment.

- Leave the probe stationary within scope – move the SCOPE.

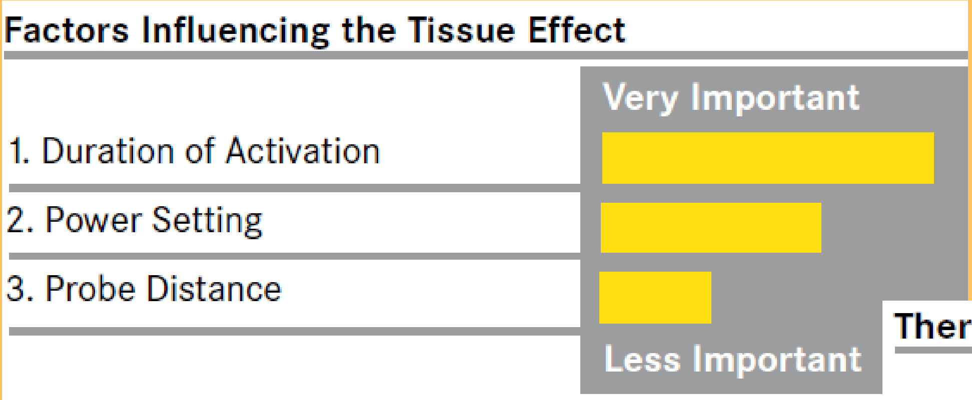
APC probe tip must always remain in the clinicians field of vision.

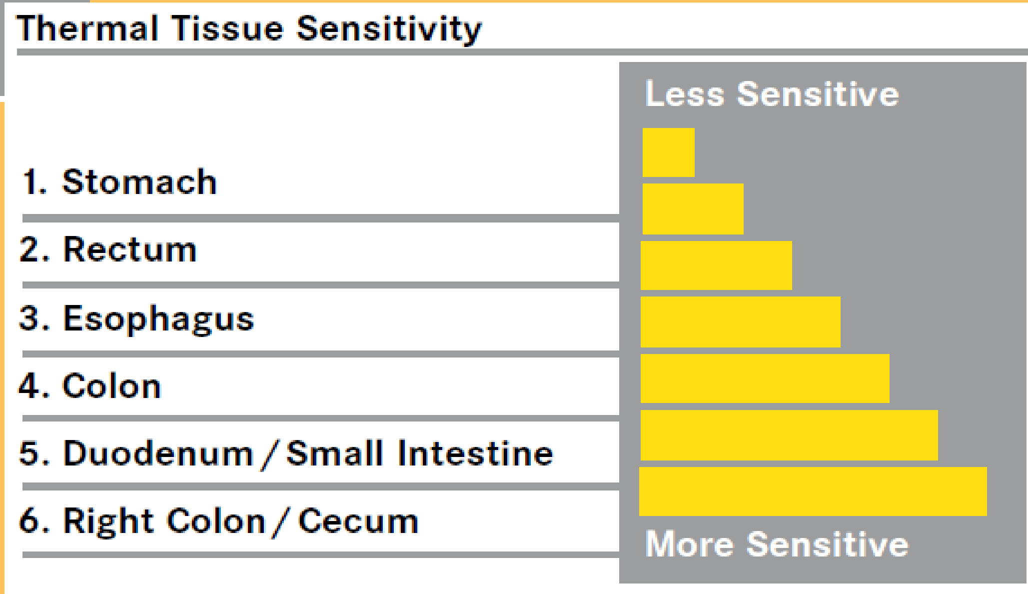
Activate only when the tissue being treated is within the field of view.

Proximity to tissue: 1 - 5 mm.

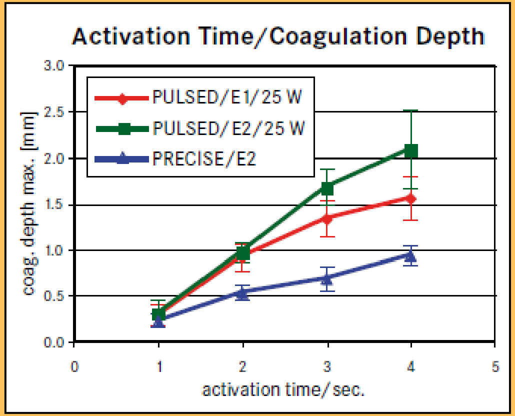
Argon Plasma Coagulation – Application techniques

Argon Plasma Coagulation – thermal tissue effect - Considérations





Argon Plasma Coagulation – Duration of Activation



Depth effect depending on the duration of activation with the APC modes in a bovine liver. Testing was performed with an ESU (VIO® 300 D Model)/APC (APC™ 2 Model) System along with an A-type (Straight Fire) APC probe, O.D. 2.3 mm. Also, the application was vertical and the probe distance was 5 mm.

- When the application time over the same area is increased, the depth of the tissue being affected will increase.
- The physician should treat with an activation time to correspond with the desired thermal effect and anatomical location.

Argon Plasma Coagulation – Power or Effect Setting

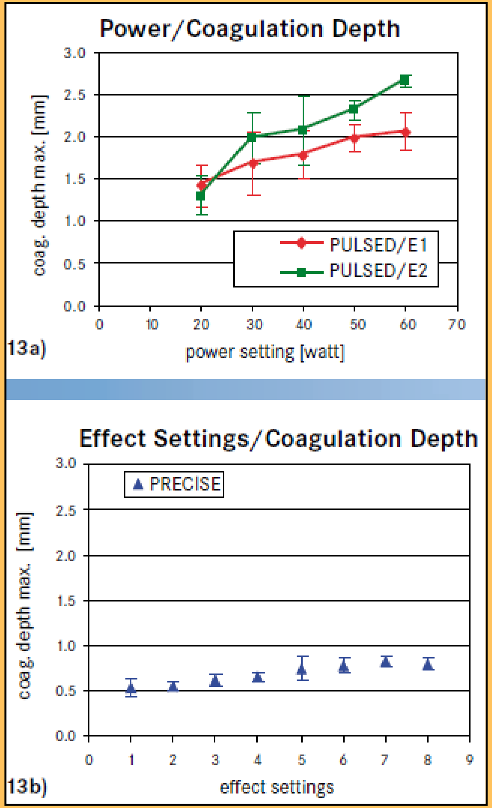


Fig. 13a: Depth of penetration on bovine liver depending on the power setting when using PULSED APC mode with an A-type (StraightFire) APC™ probe, O.D. 2.3 mm; Fig. 13b: Depth of penetration on bovine liver depending on the Effect setting when using PRECISE APC with an A-type (StraightFire) APC probe, O.D. 1.5 mm. Testing was performed with an ESU (VIO® 300 D Model)/APC (APC 2 Model) System. Also, the application was vertical, the probe distance was 5 mm, and the application duration was 3 seconds.

In general:

- *Lower output settings –*
  are used for treatment of very small superficial areas, or in applications with very thin-walled tissue structures.

- *Higher output settings –*
  are used for treatment when devitalization is required, or for the reduction of tissue.

Argon Plasma Coagulation – Probe Distance

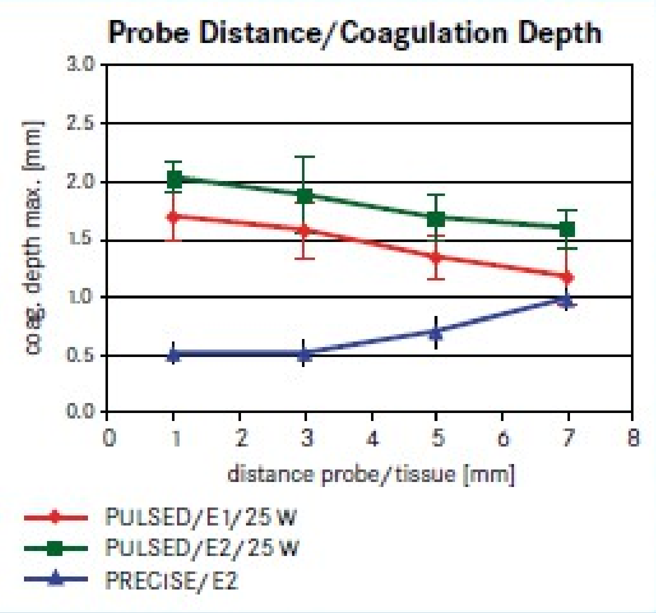


Fig. 14: Depth of effect depending on the distance of the probe to the bovine liver, using an ESU (VIO® 300 D Model)/APC (APC 2 Model) System with an A-type (StraightFire) APC probe, O.D. 2.3 mm. Also, the application was vertical, and the application duration was 3 seconds.

Probe distance can influence thermal tissue effect based on the mode chosen:

- *FORCED APC*
- *PULSED APC*
  - *Effect 1*
  - *Effect 2*
- *PRECISE APC*

Argon Plasma Coagulation – APC Modes

Forced - continuous application of energy

Precise - automatic adjustment control which adjusts the argon plasma regardless of the impedance. Superficial coagulation effect using a low-energy output per unit of time. Time-out feature.

Pulsed Effect 1 – 1 pulse per second

Pulsed Effect 2 - 16 pulses per second

Argon Plasma Coagulation – An important factor affecting thermal effect - Mode Chosen… Modulation/Algorithm

Argon Plasma Coagulation – Modes - PRECISE ® APC

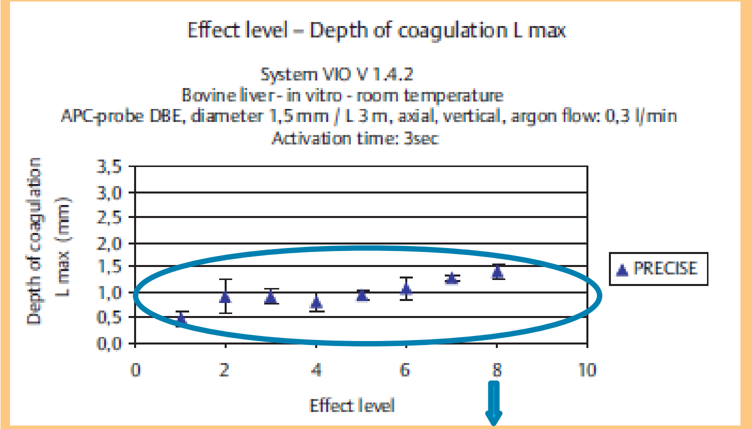
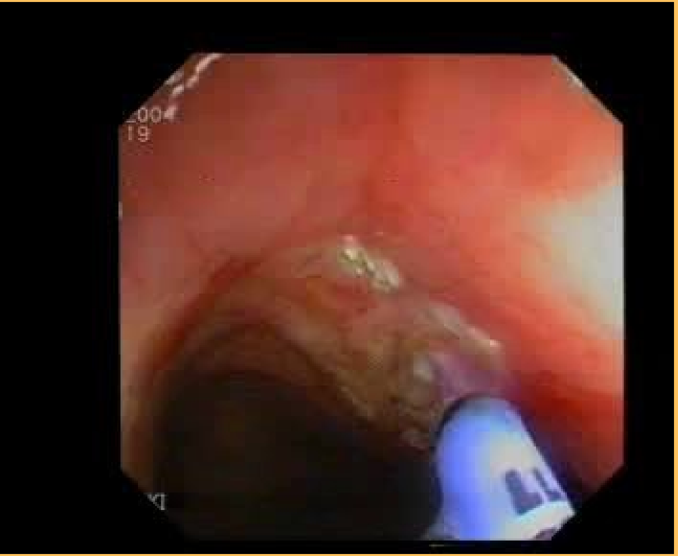


Fig. 1 Tissue effect and depth of infiltration of PRECISE APC.

Eickoff A. et al. Effectiveness and Safety of PRECISE APC for the Treatment of Bleeding Gastrointestinal Angiodysplasia - a Retrospective Evaluation. *Z Gastroenterol* 2011; 49:195–200.

Argon Plasma Coagulation – Modes - PRECISE ® APC



Angiodysplasia
PRECISE APC Effect 5

Areas of Application:

- Superficial hemostasis.
- Thermosensitive areas and/or within thin-walled structures.
- Devitalization and reduction of lesions or tissue remnants that are superficial in nature.
- In situations where maintaining the probe distance from the tissue is difficult, e.g., enteroscopic intervention.

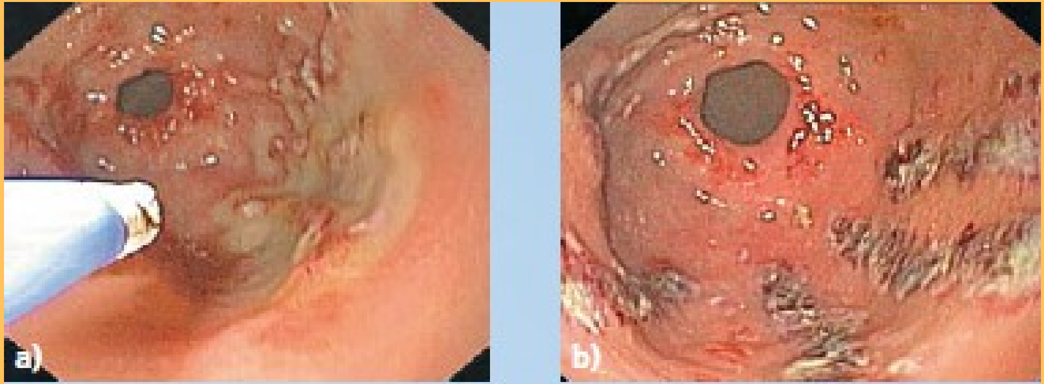
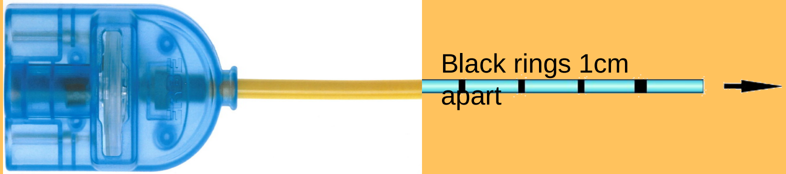


Fig. 28: GAVE syndrome before (a) and after (b) treatment.

Argon Plasma Coagulation – Probe Design

<ins>**FiAPC Probes**</ins> (filter integrated APC probes) – A filter is built into every disposable APC probe. This filter prevents the backflow of contaminants into the system from the patient and conversely prevents the flow of contaminants into the patient. This feature is patented.



Black rings 1cm apart

Connector with integrated filter

Old APC probes have a cable adapter that needs to be reprocessed (brushed through (manually cleaned/disinfected) & Sterilized between uses. Not simply a wipe down between cases.

Argon Plasma Coagulation – Clinical Applications

Gastroenterology Uses reported in Clinical Literature

- Radiation Induced Proctopathy
- Watermelon Stomach (GAVE)
- Treatment (Ablation) of Residual Adenomatous Tissue
- Stent Shortening (e.g. migrated stents)
- Strictures
- Exophytic Benign or Malignant Tumors
- Oozing from Vascular Lesions (e.g. Angiodysplasias,
- Arteriovenous Malformations (AVMs), Telangiectasias)

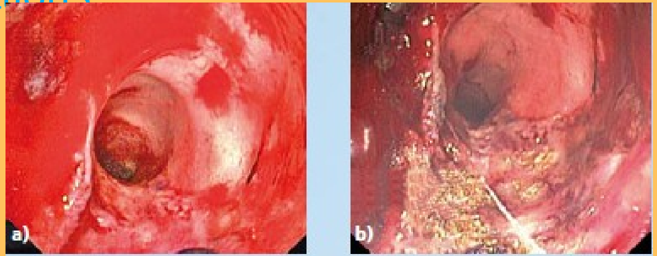


Fig. 25: Bleeding over a larger surface area due to radiation proctitis (a) and after hemostasis with APC (b).

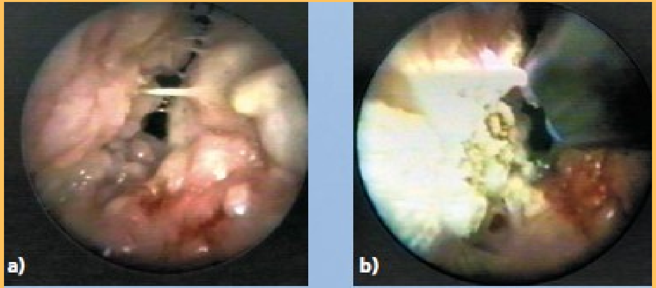


Fig. 34: Stent in- and over-growth: a) initial state; b) treatment with APC; c) postoperative appearance.

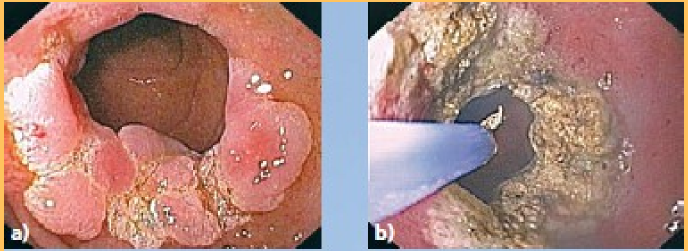


Fig. 29: Large duodenal adenoma before (a) and after (b) ablation using APC.

Argon Plasma Coagulation

– Clinical Applications – Residual Tumour Ablation


Adenoma of Cecum


Adenoma Injected


Adenoma Snared (piecemeal)


APC Ablation of Residual Islands & Margin

Long term clinical study results show 50% reduction in re-growth of adenomatous polyps after tissue treatment with APC.

Brooker J, Saunders B, et al. Treatment with argon plasma coagulation reduces recurrence after piecemeal resection of large sessile colonic polyps: A randomized trial and recommendations. *Gastrointestinal Endoscopy* 2002; 55:371-375.

Regula, J. Argon Plasma Coagulation after Piecemeal Polypectomy of Sessile Colorectal Adenomas: Long-Term Follow Up Study. Endoscopy, 2003.

STSC – Snare Tip Soft Coag

- may miss several residual areas doing STSC on a polyp (not validated for ablation)

- Risk of inflammatory response due to energy dosed with circumferential contact coagulation.

Sa1580

Argon Plasma Coagulation Compared With snare Tip Soft Coagulation in an In-Vivo Porcine Model of Endoscopic Mucosal Resection

Nicholas G. Burgess*[1,2], Farzan F. Bahin[1,2], Maria Pellise[1], Rebecca Sonson[1], Rafael Perez-Dye[3], Shahrir Kabir[4], Vishnu Subramanian[5], Hema Mahajan[5], Duncan J. Mcleod[5], Michael J. Bourke[1,2]

[1]Department of Gastroenterology and Hepatology, Westmead Hospital, Sydney, NSW, Australia; [2]Faculty of Medicine, University of Sydney, Sydney, NSW, Australia; [3]Department of Animal Care, Westmead Hospital, Sydney, NSW, Australia; [4]Department of General Surgery, Westmead Hospital, Sydney, NSW, Australia; [5]Department of Tissue Pathology, Westmead Hospital Institute of Clinical Pathology and Medical Research, Sydney, NSW, Australia

Introduction: Endoscopic Mucosal Resection (EMR) is now a well-established and effective method for the management of sessile polyps and laterally spreading tumours (LSTs). There are few studies of adjunctive thermal therapies such as argon plasma coagulation (APC) and snare tip soft coagulation (STSC) for the ablation of marginal defect tissue. Small studies examining APC have shown that recurrence may be variably reduced, but criticisms of APC include that it is poorly controllable, that the ablation depth varies, and that it may leave patchy areas of residual mucosa explaining the recurrence that occurs despite treatment. STSC has not been studied in clinical settings to reduce recurrence, but it may have advantages as it is endoscopically easier to control and may provide a more consistent ablative effect. Aims To examine depth of injury and ablation consistency associated with adjunctive thermal therapies for the prevention of marginal recurrence (APC or STSC). Methods: Standardised EMR of porcine mucosa was performed by a single operator. Submucosal injection of a solution of succinylated gelatin (Gelofusine) and indigo carmine was followed by two intersecting 15mm snare resections. Resections were randomised to Erbe VIO 300D EndoCut Q (Effect 3) or Erbe 100C forced coagulation current (25W). The lateral margins of each defect were treated with APC or STSC. Porcine colons were surgically removed at 72 hours post EMR. Pathological resection specimens and porcine colonic defects were assessed by 2 expert gastrointestinal pathologists blinded to the treatment modalities. Study size was calculated based on based on previous porcine studies suggesting a 20% difference in muscularis propria involvement by inflammation or necrosis. Ethical approval was obtained from the Western Sydney Local Health District animal ethics review board. Results: 88 resection defects were created in 12 Landroc-Duroc cross pigs (mean weight 60kg). 2 defects were incorrectly sectioned so were not analysed. 174 tissue sections were assessed comparing APC (87) with STSC (87) ablation. APC treatment did not differ from STSC treatment for deep involvement of the colon wall by acute inflammation (6.9% vs 9.2%, p=0.58) or chronic inflammatory infiltrate (62.1% vs 64.4%, p=0.75) although there was a trend towards greater depth of deep necrosis with STSC (4.6% vs 12.6%, p=0.059). A non-viable necrotic margin was present in 36.8% treated with APC versus 47.1% treated with STSC p=0.17.. Conclusion: Depth of thermal injury did not differ between APC and STSC in an in-vivo porcine model of EMR however there was a trend toward deeper necrosis with STSC.

"There was a trend toward deeper necrosis with STSC"

Clinical Applications – APC – Gastroenterology Uses found in Clinical Literature

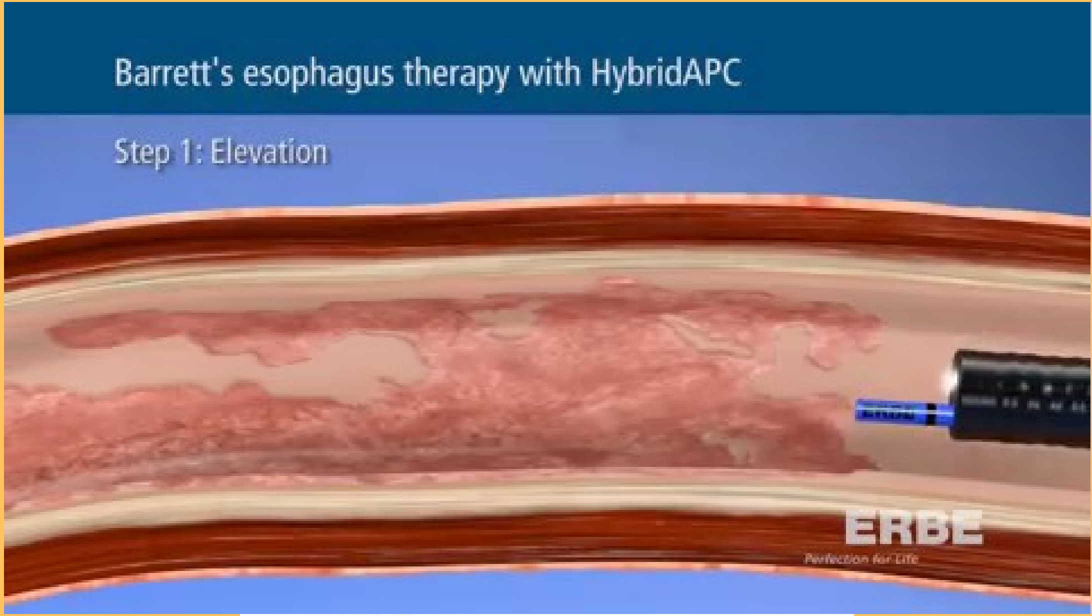
References:

1. "The role of endoscopy in ampullary and duodenal adenomas". Gastrointestinal Endoscopy; 2006: Vol. 64, No 6.
2. Brooker, J. Treatment with APC reduces recurrence after piecemeal resection of large sessile colonic polyps: a randomized trial and recommendations. Gastrointestinal Endoscopy, 2002.
3. Buyukberber, Mehmet. APC in the treatment of hemorrhagic radiation proctitis. Turk J Gastroenterol, 2005.
4. Dulai, Gareth. Treatment of Water Melon Stomach. Current Treatment Options in Gastroenterology, 2006.
5. Eickhoff, A, et al. Prospective nonrandomized comparison of two modes of argon beamer (APC) tumor desobstruction: effectiveness of the new pulsed APC versus forced APC. Endoscopy 2007: 39: 637-642. Ferreira, L, et al. Post-Sphincterotomy Bleeding: Who, What, When, and How. American Journal of Gastroenterology. 2007.
6. Eickhoff, A, et al. Pain sensation and neuromuscular stimulation during argon plasma coagulation in gastrointestinal endoscopy. Surg Endosc. 2007.
7. Fujishiro, M. Safety of Argon Plasma Coagulation for Hemostasis During Endoscopic Mucosal Resection. Surg Laparosc Endosc Percutan Tech; 2006.
8. Fukami, N. Endoscopic treatment of large sessile and flat colorectal lesions. Current Opinions in Gastroenterology. 2006:22:54-59.
9. Fukatsu, H, et al. Evaluation of needle-knife precut papillotomy after unsuccessful biliary cannulation, especially with regard to postoperative anatomic factors. Surg Endosc. 2008;22:717-23.
10. Garcia, A, et al. Safety and efficacy of argon plasma coagulator ablation therapy for flat colorectal adenomas. Rev Esp Enferm Dig. 2004:96:315-321.
11. Herrera S, et al. The beneficial effects of argon plasma coagulation in the management of different types of gastric vascular ectasia lesions in patients admitted for GI hemorrhage. Gastrointestinal Endoscopy 2008.
12. Horiuchi, A, et al. Effect of precut sphincterotomy on biliary cannulation based on the characteristics of the major duodenal papilla. Clin Gastroenterol Hepatol. 2007;5:1113-8.
13. Ifadhli A, et al. Efficacy of argon plasma coagulation compared with topical formalin application for chronic radiation proctopathy. Can J Gastroenterol 2008;22:129-132.
14. Kitamura, Tadashi. Argon plasma coagulation for early gastric cancer: technique and outcome. Gastrointestinal Endoscopy, 2006.
15. Kwan, V. APC in the Management of Symptomatic GI Vascular Lesions. American Journal of Gastroenterology. 2006.
16. Lecleire, S, et al. Bleeding gastric vascular ectasia treated by argon plasma coagulation: a comparison between patients with and without cirrhosis. Gastrointestinal Endoscopy. 2008:67.
17. Manner, H, et al. Safety and efficacy of a new high power argon plasma coagulation system (hp-APC) in lesions of the upper gastrointestinal tract. Digestive and Liver Disease. 2006.
18. Norton, I, et al. A Randomized Trial of Endoscopic Biliary Sphincterotomy Using Pure-Cut Versus Combined Cut and Coagulation Waveforms. Clinical Gastroenterology and Hepatology. 2005; 3:1029-1033.
19. Norton, I, et al. Efficacy of colonic submucosal saline solution injection for the reduction of iatrogenic thermal injury. Gastrointestinal Endoscopy. 2002:Vol 56, No 1.
20. Olmos, Jorge. APC for prevention of recurrent bleeding from GI angiodysplasias. Gastrointestinal Endoscopy, 2004.
21. Ortner, M, et al. Endoscopic Interventions for Preneoplastic and Neoplastic Lesions: Mucosectomy, Argon Plasma Coagulation, and Photodynamic Therapy. Digestive Diseases. 2002;20 :167-172.
22. Perini, Rafael. Post-sphincterotomy bleeding after microprocessor-controlled electrosurgery. Gastrointestinal Endoscopy. 2005.
23. Regula, J. Argon Plasma Coagulation after Piecemeal Polypectomy of Sessile Colorectal Adenomas: Long-Term Follow-Up Study. Endoscopy, 2003.
24. Repici, A. Endoscopic polypectomy: techniques, complications and follow-up. Tech Coloproctol. 2004; 8: S283-S290.
25. Rerknimitr, R. Trimming a Metallic Biliary Stent Using an Argon Plasma Coagulator. Cardio Vascular and Interventional Radiology, 2006.
26. Ross, A. Flat and Depressed Neoplasms of the Colon in the Western World. American Journal of Gastroenterology. 2006.
27. Schubert, D. Endoscopic treatment of benign gastrointestinal anastomotic strictures using argon plasma coagulation in combination with diathermy. Surg Endosc; 2003:17:1579-1582.
28. Soctikno, R, et al. Prevalence of Nonpolypoid (Flat and Depressed) Colorectal Neoplasms in Asymptomatic and Symptomatic Adults. JAMA. 2008: Vol 299, No 9.
29. Vargo, John. Clinical Applications of APC. Gastrointestinal Endoscopy, 2004.
30. Zlatanic, J, et al. Large sessile colonic adenomas: use of argon plasma coagulator to supplement piecemeal snare polypectomy. Gastrointestinal Endoscopy; 1999: Vol. 49, No. 6.

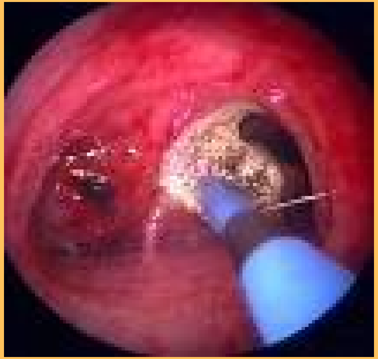
ERBE - HybridAPC

HybridAPC is a multifunctional probe that uses a high pressure water system (ERBEJET2) and the ERBE Argon APC system.
With this 2-in-1 probe, it possible to elevate and ablate the targeted mucosa without having to change the instrument.

- Especially useful for the treatment of Barrett's esophagus.



Clinical Applications – Pulmonary APC Uses reported in Clinical Literature

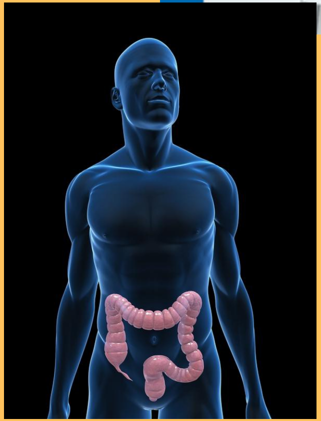


- Granulation Tissue
- Bleeding/Hemoptysis
- Exophytic Tumors
- Stent Over-growth/In-growth

1. Bergler, Wolfgang, Treatment of recurrent respiratory papillomatosis with argon Plasma coagulation. Journal of Laryngology and Otology. 1997.
2. Bolligner, CT, et al. Therapeutic bronchoscopy with immediate effect: laser, electrocautery, argon plasma coagulation and stents. European Respirartory Journal. 2006: 27:1258-1271.
3. Capaccio, P, et al. Flexible Argon Coagulation Treatment of Obstructive Tracheal Metastatic Melanoma. American Journal of Otolarynogology. 2002: Vol 23, No 4.
4. Crosta, C et al. Endoscopic argon plasma for palliative treatment of malignant airway obstructions: early results in 47 cases. Lung Cancer. 2001: 33: 75-80.
5. Lee, P, et al. Advances in Bronchoscopy-Therapeutic Bronchoscopy. JAPI. 2004: Vol 52.
6. Morice, Roldofo. Endobronchial Argon Plasma Coagulation for Treatment of Hemoptysis and Neoplastic Airway Obstruction. Chest. 2001.
7. Orino, K, et al. Bronchoscopic Treatment with Argon Plasma Coagulation for Recurrent Typical Carcinoids: Report of a Case. Anticancer Research. 2004: 24:4073-4078.
8. Sheski, F. Endobronchial Electrosurgery. Seminars in Respiratory and Critical Care Medicine. 2004: Vol, 25, No 4.
9. Sohrab, S. Management of Central Airway Obstruction. Clinical Lung Cancer. 2007.
10. Sutedja, G. Endobronchial Electrocautery and Argon Plasma Coagulation.   Prog Respir. 2000: Vol 30.
11. Tremblay, A. Endobronchial electrocautery and Argon Plasma Coagulation: A Practical Approach. Can Respir. 2004.

Clinical Safety Considerations…

Clinical Safety – Important Considerations for Endoscopy



- Use the lowest possible output settings, as well as the shortest activation times.
- Confirm gas flow (with APC use) and settings prior to activation.
- Continuously monitor for signs of over-distention.
  - Brief and repeated aspirations should be routinely performed throughout the procedure.

Clinical Safety – Important Considerations for Endoscopy

APC is a non-contact modality

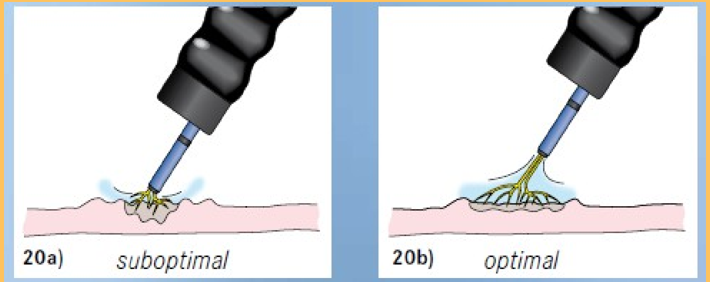


Fig. 20a: *The probe is too close to the tissue, which may result in an undesirable thermal effect and/or submucosal emphysema;* ***Fig. 20b:*** *The distance of the probe is sufficient, leading to a more even distribution of current.*

If an 'Axial' probe is too close to the tissue, an undesirable thermal effect or submucosal emphysema may occur.

Clinical Safety – Important Considerations for Endoscopy

Avoid APC activation in close proximity of metal objects

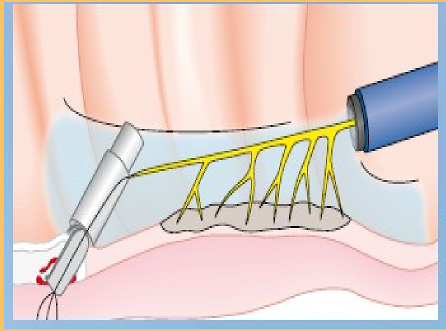
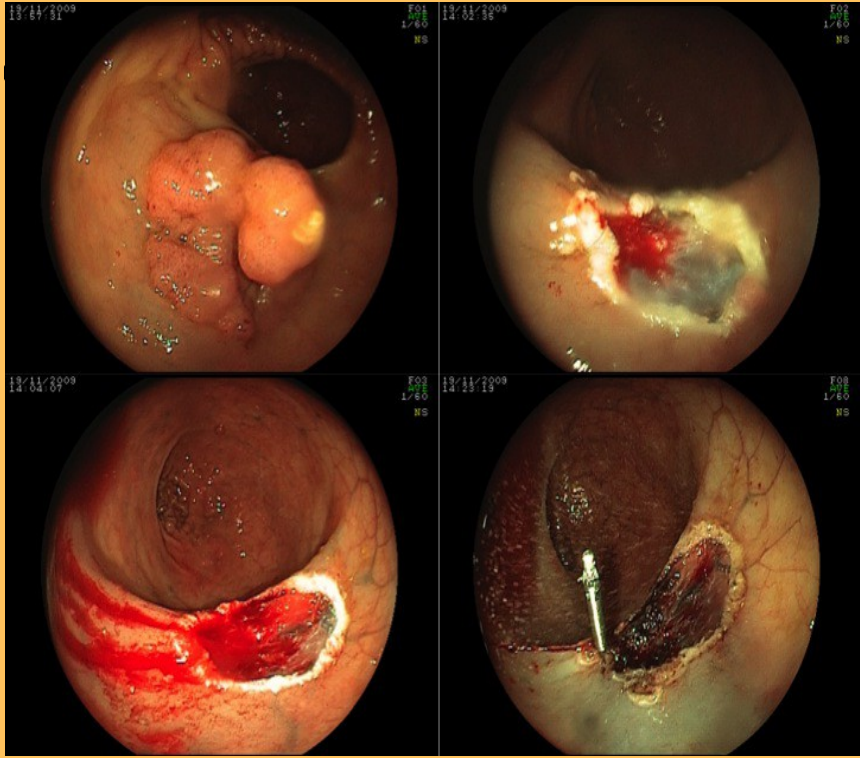


Fig. 21: Unintended flashover of electric arcing from the APC probe to a metal clip.

- The APC probe should not be activated if the tip is in close proximity to metal objects.
- Unintended thermal injury of the surrounding tissue may occur.
- Metal objects may receive unintentional damage.
- Exceptions - “trimming” o migrated metal stents.

Potential Complications

- Risk of Bleedin



1.5-2% all polypectomies (Ginsberg, 2008)

Increased risk if polyp >1cm, multiple polyps, large defect, NSAIDs, cecum/ascending (Bourke 2011)

Intervention

Epinephrine solution, clips, thermal (APC – for superfical, Bipolar Probe, Coag Grasper). Extreme cases angiographic embolization, surgery.

Ginsberg, G. Risks of Colonoscopy and Polypectomy. Techniques in Gastrointestinal
Endoscopy, 2008;10:7-13.
Bourke, M. Advances in Endoscopy. Gastroenterology & Hepatology,2011;(7)12:814-17.

Potential Complications

- Perforation

EMR reported perforation rate 0.3-0.5% (ASGE, 2008)

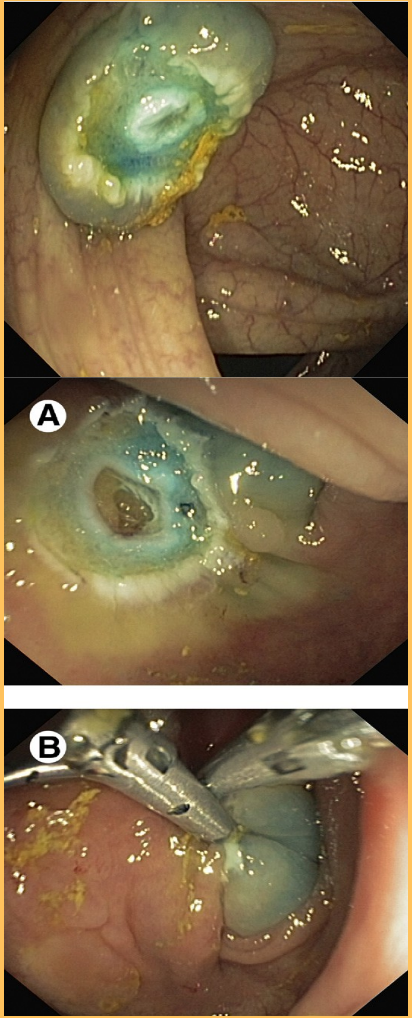
Disruption in the dyed SM plane post resection often indicates thermal damage to muscularis propria. Can inspect specimens and defect for firm white discs (Target Sign) (Bourke, 2011)

Intervention

Small….clip (Boston, Cook, Olympus, Vantage), Ovesco OTSC,   OvertStitch Apollo

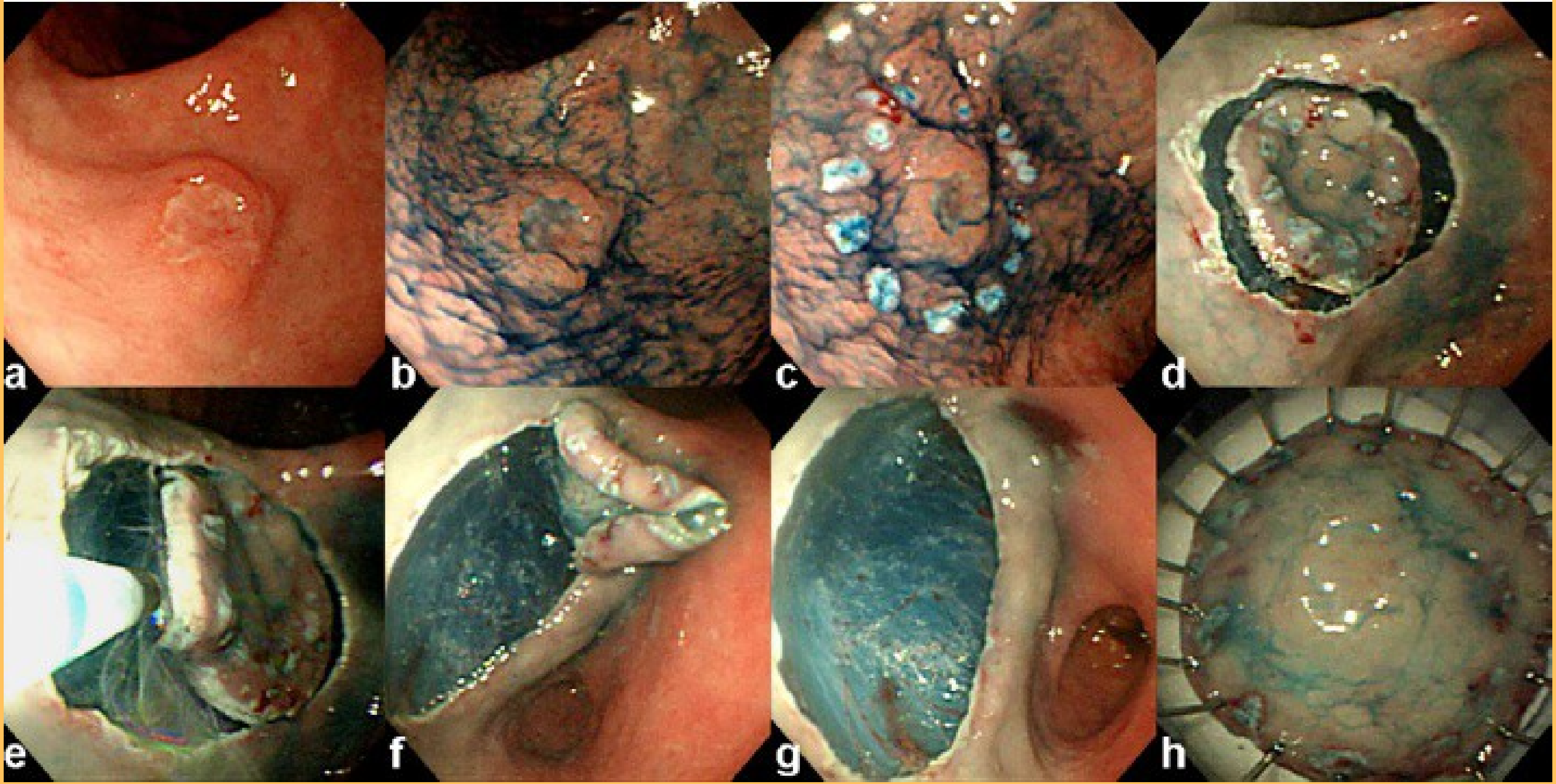
Large….surgery to prevent peritonitis

"Although surgery has been the standard practice to manage perforations, application of clips and loops has emerged as a useful option to close lesions less than 10–15 mm in size." (Monkemuller 2009)



Clinical

- Gastric ESD



Gastric ESD (B.H. Min- Dig. Endos.)

Clinical

– The Future Now

IR/endoscopic submucosal dissection.
ing ERBE HybridKnife


Communication from the ASGE Standards of Practice Committee

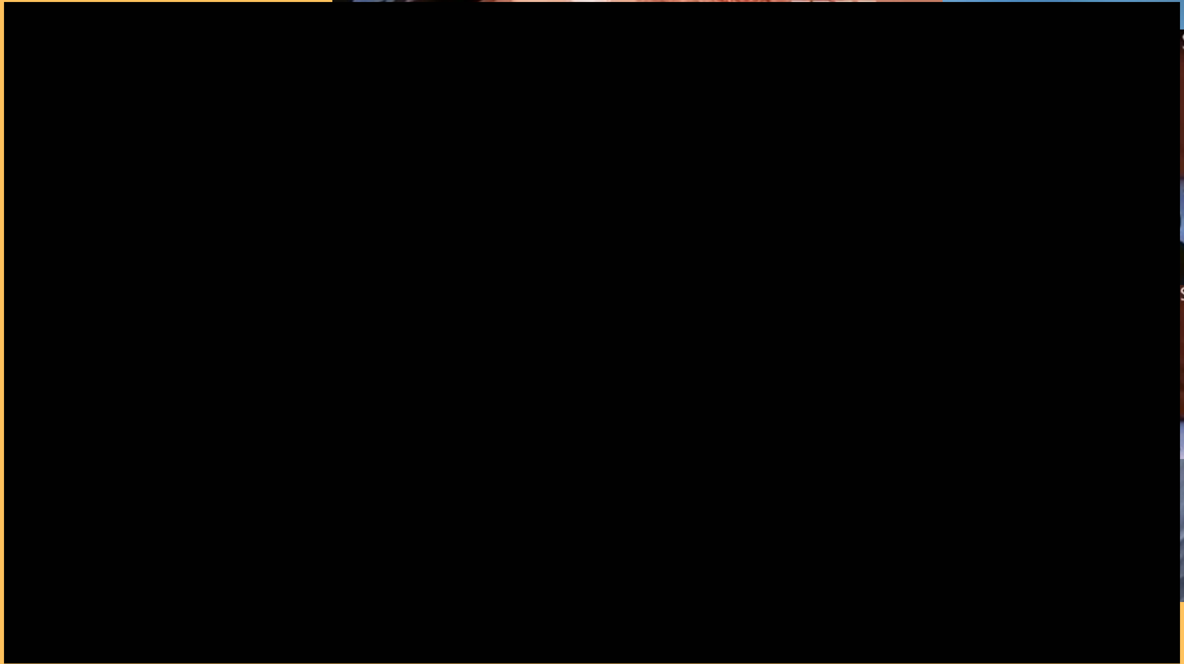
GUIDELINE

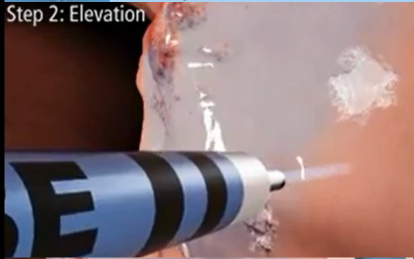
ASGE

The role of endoscopy in Barrett's esophagus and other premalignant conditions of the esophagu

Volume 76, No. 6 : 2012 GASTROINTESTINAL ENDOSCOPY


Elevation of the mucosa before endoscopic submucosal dissection

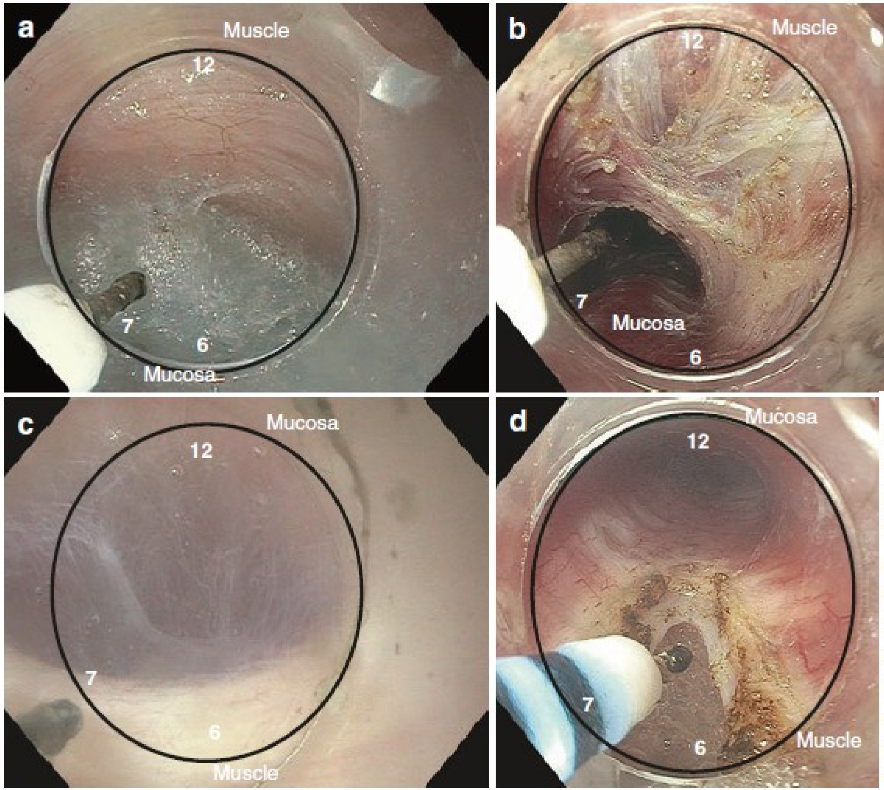




Clinical

- Video ESDH (Endoscopic Submucosal dissection with Hy

POEM



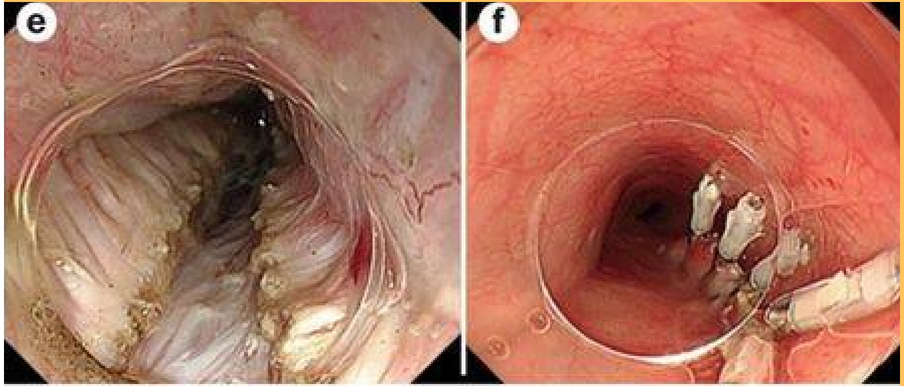


Fig. 7.14 (**a**, **b**) Illustration of knife position relative to the mucosa and muscularis in an anterior POEM during tunnel dissection (**a**) and myotomy (**b**). (**c**, **d**) Illustration of knife position relative to the mucosal and muscularis in a posterior POEM during tunnel dissection (**c**) and myotomy (**d**). The knife is much closer to the mucosa in anterior POEM (possibly resulting in higher rates of mucosal injury). In posterior POEM, the myotomy is on the same side of the tunnel as the knife and endoscope, possibly resulting in faster myotomy by forward advancement of endoscope and knife and minimal if any lateral movement of the knife. In contrast, in anterior POEM, incising the muscle at 2 o' clock position, the diametrically opposed position to that of the endoscope and knife (exiting the endoscope at 7 o' clock position) can only be done by interrupted lateral cuts hooking and cutting individual muscle bundles which result in large lateral swings of the knife from the muscle at 2 o' clock position to the knife's neutral position at 7 o' clock, very close to the mucosa which may suffer "countercoup" injuries

Applications in hybrid technology:

Submucosal tunneling and endoscopic resection (STER)

- - for therapy of submucosal benign tumors with HybridKnife T-Type, I-Type

Per Oral Endoscopic Myotomy (POEM)

- - for therapy of achalasia with HybridKnife T-Type, O-Type, I-Type

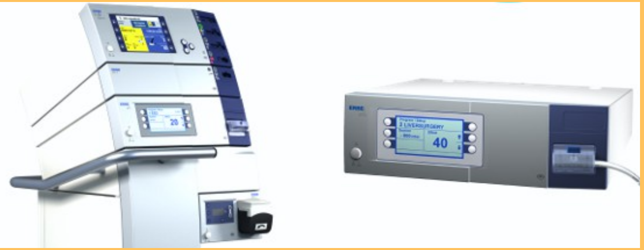
Endoscopic mucosal resection (EMR) or ESD

- - for therapy of early-stage carcinoma in the gastrointestinal tract using the flexible probe

Who is ERBE – The Gold Standard everybody tries to compare too… we're just like ERBE? – Not Really

World's first automatically regulated Electrosurgery unit ERBOTOM TUR (1985). The successful ICC line (here with APC 300) followed in 1992 with "Intelligent Cut and Coagulation".

5th generation - Christian Otto Erbe



The VIO System is the first modular-built electrosurgery unit (introduced in 2002). There are new modes and upgrades for cutting, coagulating and devitalizing tissue.

ERBEJet is now available in Canada with HybridKnife & HybridAPC

"Imitation is the sincerest form of flattery that mediocracy can pay to greatness." - *Oscar Wilde*

Thank You!