Surgical Energy in the 21st Century
(Didactic)

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Target Audience
This educational activity is developed to meet the needs of residents, fellows and new minimally invasive specialists in the field of gynecology.

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This course provides a review of the important principles that guide the surgeon in the safe use of surgical energy. This will include a comprehensive review of the guiding principles of electricity with a modern update surrounding such unique applications as single-site surgery. A review of modern monopolar, bipolar, and direct current devices will be undertaken. Additionally, an introduction to the Fundamental Use of Surgical Energy (FUSE) program, which may be important to those who are involved in surgical training, will be provided.

**Learning Objectives:** At the conclusion of this activity, the participant will be able to: 1) Apply the basic principles of electricity to the safe utilization of electrosurgical devices in surgery; 2) distinguish between monopolar and bipolar electrosurgical energy and review currently available devices; 3) apply strategies to avoid potential complications associated with the use of electrosurgical devices; 4) integrate plasma energy into appropriate gynecologic surgeries; 5) integrate LASER energy into appropriate gynecologic surgeries; and 6) articulate the potential benefits of integrating the FUSE program into the education of surgical trainees.

**Course Outline**

1:30 Welcome, Introductions and Course Overview C.J. Sobolewski
1:35 Sorry, But You’ve Gotta Start Here: A Review of Electrosurgical Principles C.J. Sobolewski
2:00 Bipolar Energy and the Modern Ways We Use It A. Setubal
2:25 Minimizing Complications with Surgical Energy M.G. Munro
2:50 Ultrasonic Energy: Maximizing Outcomes and Minimizing Complications S.D. McCarus
3:15 Questions & Answers All Faculty
3:25 Break
3:40 Plasma Energy and Direct Current Devices in Gynecologic Surgery R.P. Marvel
4:05 Managing Energy-Related Complications in Gynecologic Surgery M. Pansky
4:30 LASERs in Gynecologic Surgery L.R. Glazerman
4:55 An Introduction to the Fundamental Use of Surgical Energy (FUSE) Program M.G. Munro
5:20 Questions & Answers All Faculty
5:30 Course Evaluation/Adjourn
PLANNER DISCLOSURE
The following members of AAGL have been involved in the educational planning of this workshop and have no conflict of interest to disclose (in alphabetical order by last name).
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Consultant: Conceptus Incorporated
Kimberly A. Kho*
Frank D. Loffer, Executive Vice President/Medical Director, AAGL*
Linda Michels, Executive Director, AAGL*
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Other: Scientific Advisory Board: SurgiQuest
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Speakers Bureau: Bayer Healthcare Corp.
Richard P. Marvel
Consultant: Plasma Surgical
Speakers Bureau: Plasma Surgical
Steven D. McCarus
Speakers Bureau: Ethicon Endo-Surgery
Malcolm G. Munro
Inc., Channel Medical, Conceptus Incorporated, CooperSurgical, EndoSee Corp., Ethicon Women’s Health & Urology, Femasys, Gynesonics, Halt Medical, Hologic, Idoman Teoranta, Karl Storz Stock Ownership: Aegea Medical, Channel Medical, Gynesonics, Halt Medical
Moty Pansky*
Antonio Setubal*
Craig J. Sobolewski
Consultant: CareFusion, Covidien, TransEnterix, Teleflex
Stock Ownership: TransEnterix

Asterisk (*) denotes no financial relationships to disclose.
Objectives

- At the completion of this lecture, participants should:
  - Understand the various electrical waveforms used in electrosurgery and how they interact with cells and tissue
  - Understand the variables that affect tissue response during RF electrosurgery
  - Be aware of recent advances in ESU technology

History of Electrosurgery

- Late 19th Century
- 1926
  - Electrophysicist William Bovie and Neurosurgeon Harvey Cushing collaborate in the development of modern electrosurgery

Disclosures

- Consultant: CareFusion, Covidien, Teleflex, TransEnterix
- Stockholder: TransEnterix
Formalized Education and Training in Electrosurgery

Survey of 121 Surgeons at American College of Surgeons 2000

Variables That Impact Tissue Effect

- Type of waveform
- Electrode size and shape
- Contact vs. non-contact with tissue
- Duration of tissue exposure to activated electrode

Components

- RF Electrosurgical Generator or Unit (ESU)
- Electrosurgical RF Instruments
  - Active electrodes
  - Dispersive electrodes

Basic Principles of Electricity

Electricity always . . .
  - Seeks the path of least resistance

Electrosurgery

The passage of high frequency electric current through tissue to create a desired clinical effect.

Progression of Technology

1926 – Cushing uses radiofrequency ESU
1968 – Solid state circuitry
1981 – Return electrode monitoring
1995 – Tissue response technology
1999 – Tissue and vessel fusion
2006 – Tissue Sensing Energy
**Frequency Spectrum**

![Frequency Spectrum Image](image-url)

**Resistive Heating**

![Resistive Heating Image](image-url)

**Electrosurgical Instruments**

- Monopolar
- Bipolar

**Properties of Electricity**

- **Voltage**
  - The pressure force required to push electrons (volts)
- **Current**
  - The rate at which electrons flow (amperes)
- **Power**
  - The energy (amount of work) produced over time (watts)
- **Impedance**
  - Resistance to the flow of current (Ohms)

**Monopolar RF Instruments**

- Active electrode at surgical site
- Dispersive electrode at another site
  - Current flows through the body between the electrodes

**Properties of Electricity**

\[
\text{Power (W)} = \text{Volts} \times \text{Amps}
\]

- \( W \)= energy (amount of work) produced over time
- \( V \)= pressure force required to push electrons
- \( A \)= rate at which electrons flow
The Importance of Waveforms

- "Cutting" waveform
  - Low voltage, continuous
  - "Focused" with small surface area electrode to increases current concentration
  - Tissue temperature ≥ 100°C results in vaporization
  - Fulguration
    - Current arcs between electrode and tissue
    - High voltage "coagulation" waveform
    - Relatively large surface area electrode
    - Desiccation and carmelization (turns black)
- "Coagulation" waveform
  - High voltage, modulated
  - "Focused" with small surface area electrode to increases current concentration
  - Tissue temperature 60°C – 100°C results in desiccation and protein coagulation
- Variables That Impact Tissue Effect
  - Manipulation of Electrode
  - Waveform
  - Size of Electrode
  - Speed of Incision

Electrode Configuration

- Large surface area: Low current density
  - Desiccation
- Small surface area: High current density
  - Vegetative + Cutting

Electrode Manipulation

- Cutting:
  - Current arcs between electrode and tissue
  - "Focused" with small surface area electrode to increases current concentration
  - Tissue temperature ≥ 100°C results in vaporization
- Fulguration
  - Current arcs between electrode and tissue
  - High voltage "coagulation" waveform
  - Relatively large surface area electrode
  - Desiccation and carmelization (turns black)
- Desiccation
  - Current delivered to tissue by contact
  - Larger surface area electrode reduces current concentration
  - Tissue temperature 60°C – 100°C results in desiccation and protein coagulation
Properties of Electricity

• Power (W) = Volts X Amps

• Current (A) = Volts/Impedance

W = energy (amount of work) produced over time
V = pressure force required to push electrons
A = rate at which electrons flow

• As you increase impedance (R), current (A) decreases

• Current (A) = Volts/Impedance

• As you decrease current (A), power (W) decreases

• Power (W) = Volts X Amps

Power Impedance Curves

Power vs. Impedance

Tissue Response Technologies 1995

• Monitors and adjusts the energy output (200x per second)
  – “Cut” waveform monopolar instruments
  – Only waveform (“cut”) for bipolar instruments
  – NOT coagulation side of ESU

Tissue Sensing Technology 2006

An extremely fast computer program that senses tissue impedance and adjusts the energy to achieve the desired tissue effect
V-mode

- The “coag” button modulates the voltage of cut waveform
- The V-mode button modulates the voltage of the coagulation waveform

Summary

- There are several variables that impact the tissue effect of electrosurgery
- Cut and coagulation waveforms differ primarily in terms of voltage
- There are a variety of safety variables which the surgical team can control to limit risk of injury
- Impedance response technologies are the latest advances in electrosurgical instrumentation

Thank You
Bipolar Energy and the Modern Ways We Use It

Objectives

How far we became since the beginning?
**Bipolar energy**

**Introduction**

- First described in Gynie surgery in 1973 by Rioux
- Described as an evolution in comparison to monopolar energy: safer and with less thermal spread


**Advantages**
- Superior desiccation at low voltage
- NO alternate site burns
- Less direct and capacitive coupling

**Disadvantages**
- Minimal cutting effect
- Capacity of thermal damage spread

**Bipolar energy**

**Introduction**

- Principles:
  - Closed system with active electrode and passive electrode
  - Interrupted frequency of about 500 KHz
  - Low voltage interrupted current
  - Specific instrumentation: graspers or forceps

**ROBi bipolar**

**Advantages**
- Excellent dissection tool
- Grasping forceps
- Cheap
- Re-usable

**Disadvantages**
- Important lateral spread of heat
- Possible to touch by accident other tissues (not covered tip)
- Does not measure tissue impedance or temperature
“Never stop to push on the pedal before open your forceps”

New devices: everyone wants...

Bipolar energy

Ligasure™

Advantages
- Fast and efficient (up to 7mm) coagulation and cut
- Measure tissue impedance
- Minimal thermal spread (2mm)
- Cut function

Disadvantages
- Capacity of thermal damage spread
- Dissection limited

Bipolar energy

Enseal®

Advantages
- Fast and efficient (up to 7mm) coagulation and cut
- Measure tissue impedance and temperature
- Minimal thermal spread

Disadvantages
- Capacity of thermal damage spread
- Dissection limited
- Similar to Ligasure®
Bipolar energy

**Advantages**
- Combines ultrasonic energy to bipolar
- Better cutting
- Strong pressure distributed to tissue
- Minimal thermal damage

**Disadvantages**
- To control tip of the instrument after activation
- To know how to use two different types of energy

PKS Plasma SORD
PK Bipolar morcellator

**Advantages**
- Reduced time
- Continuous bipolar morcellation: no blunt blades
- Less fatigue for operating surgeon

**Disadvantages**
- Possible thermal lesion to patient

Comparison

The most important is to know how to use them and why we need them

A good man can make you feel strong, full of energy, and able to take on the world!

No, sorry, that's coffee. Coffee does that.
Goal: to increase efficiency
Minimizing Complications with Monopolar Instrumentation:  
**...what every surgeon should know**

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Professor, Department of Obstetrics & Gynecology  
David Geffen School of Medicine at UCLA  
Director of Gynecologic Services  
Kaiser Permanente, Los Angeles Medical Center  
Los Angeles, CA, USA

Disclosures
Stockholder: Aegea Medical, Channel Medical, Gynesonics, Halt Medical

Fundamentals of Radiofrequency Electrosurgery

All RF electrosurgery is bipolar…

…what differentiates systems is the location of the second electrode

Minimizing Complications with Monopolar RF Instrumentation

**Items**
1. “Active” electrode related injury  
   a. Accidental activation  
   b. Lateral spread  
   c. Residual heat  
2. Dispersive electrode injury  
3. Current diversion  
   a. Insulation defects  
   b. Direct coupling  
   c. Capacitative coupling  
4. Issues related to single port access  
5. Issues related to resectoscopic surgery  
6. RF electricity-related OR fires

Minimizing Complications with Monopolar RF Instrumentation

**Items**
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Accidental Activation: Avoiding the consequences

- Always holster active electrodes when not in use
- Be careful of floor pedals

Lateral Spread Trauma: Minimizing risk

Desiccation/Coagulation:
Factors affecting lateral propagation of thermal injury

<table>
<thead>
<tr>
<th>Variable</th>
<th>Increased</th>
<th>Decreased</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>Continuous</td>
<td>Pulsed</td>
</tr>
<tr>
<td>Voltage</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Tissue Compression</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>

Variable Increased Decreased
Current Continuous Pulsed
Voltage High Low
Tissue Compression Low High

WHAT IS RESIDUAL HEAT?

Residual Heat = Heat retained by the instrument after activation completed.

ACTIVATIONS (5 seconds each)

Contacting Tissue after Interval Waiting Times

<table>
<thead>
<tr>
<th>Change in Tissue Temp. (°C)</th>
<th>Time (seconds)</th>
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<tbody>
<tr>
<td>60</td>
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</tbody>
</table>


Temperature safety profile of laparoscopic devices: Harmonic ACE (ACE), Ligasure V (LV), and plasma trisector (PT)

Post Activation Residual Instrument Temperature

RESIDUAL HEAT - COMPARISON

Change in Tissue Temp. (°C)

<table>
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<tr>
<th>Time (seconds)</th>
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<td>0</td>
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</tbody>
</table>

Ultrasonic Device
Bipolar Device

Minimizing Complications with Monopolar RF Instrumentation

Items
1. "Active" electrode related injury
   a. Accidental activation
   b. Lateral spread
   c. Residual heat
2. Dispersive electrode injury
3. Current diversion
   a. Insulation defects
   b. Direct coupling
   c. Capacitative coupling
4. Issues related to single port access
5. Issues related to resectoscopic surgery
6. RF electricity-related OR fires

Fundamentals of Radiofrequency Electrosurgery

Electrosurgery is achieved with control of power density

Dispersive Electrodes

Create a chart
Minimizing Complications with Monopolar RF Instrumentation

Items
1. "Active" electrode related injury
   a. Accidental activation
   b. Lateral spread
   c. Residual heat
2. Dispersive electrode injury
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Safety: Current Diversion with Monopolar RF Instrumentation

Insulation Defects
- Minimize instrument "clashes"
- Check insulation integrity frequently
- Insulation testing program
- Maintain total view of operative field whenever possible
- Minimize interaction of monopolar instruments and bowel, ureter and bladder

Insulation Defects
- Don’t use uninsulated instruments in combination with monopolar instruments
- Care with the tissue adjacent to grasping instrument when activing monopolar instrument

Intentional direct coupling
Unintentional direct coupling

Bowel
- Don’t use uninsulated instruments in combination with monopolar instruments

Capacitative Coupling

Intentional direct coupling
Unintentional direct coupling with a clamp
Safety: Current Diversion with Monopolar RF Instrumentation

Capacitative Coupling
- Minimize use of high voltage (coagulation) waveform
- Don’t mix metal and plastic instrumentation
- Special care with single port systems

Insulated Anchor

Open circuit

High voltage output

Minimizing Complications with Monopolar RF Instrumentation

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1. "Active" electrode related injury
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Related Articles, Books
Genital tract electrical burns during hysteroscopic endometrial ablation: report of 13 cases in the United States and Canada.

We investigated 13 alleged thermal injuries to the genital tract of women undergoing hysteroscopic endometrial ablation. Possible mechanisms proposed to explain these injuries are hot-weighted speculum, povidone-iodine scrub solution, inadequate rinsing of Cidex sterilizing solution, and electrical burns. The history, nature, and distribution, as well as experimental evidence strongly support the hypothesis that these injuries are electrical due to capacitive coupled currents induced onto the sheath of the resectoscope, and/or stray currents generated by arcing or direct coupling from defective electrode insulation to the telescope, electrifying the entire resectoscope.
Background

Capacitive Coupling in a Radiofrequency Electrosurgical Resectoscope

Hypothesis

Mechanism of Injury to the Lower Genital Tract

Results

Uterovaginal Model

Results

Uterovaginal Model

Minimizing Complications with Monopolar RF Instrumentation

Items

1. "Active" electrode related injury
   a. Accidental activation
   b. Lateral spread
   c. Residual heat
2. Dispersive electrode injury
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   a. Insulation defects
   b. Direct coupling
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4. Issues related to single port access
5. Issues related to resectoscopic surgery
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OR Fire
Impact of O₂ and Drapes on Fire Risk

Managing OR Fire

- Stop flow of all airway gases to patient before disconnecting
- Remove burning and burned materials from the patient
- Extinguish the fire on burning materials (CO₂ extinguisher rarely necessary)
- Activate fire alarm
- Notify administration of event
- Sequester materials
  - Drapes
  - Mask
  - Tubing
  - ESU

Minimizing Complications with Monopolar Instrumentation: ...what every surgeon should know

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Los Angeles, CA, USA
Development of Ultrasonic Energy

Rationale
Cut and coagulate tissue with less destruction to surrounding and underlying tissues.

1980s
Hillman Medical Ventures develops an ultrasonic device for surgery based on the “Ultra Knife” used in industry to cut artificial transplants.

Ultrasonic Scalpel Clinical Abstract
- Ultrasonically vibrating knife used to cut skin and incise tissue

- "Ultrasonically vibrating knife produced less tissue injury and faster healing than electrosurgery or CO2 laser."

Early prototypes of the ultrasonically vibrating knife

Disclosure
Speakers Bureau: Ethicon Endo-Surgery

1st Laparoscopic Blade

- February 1991 — 1st prototype developed by Ultracision
- July 1991 — 1st human case performed by Dr. Joseph Amaral
- February 1992 — 1st Laparoscopic hook blade released
1st Laparoscopic Coagulating Shear

March 1991
- 1st laparoscopic coagulating shear prototype developed
- Rotating blade

1993
- 1st 10mm LCS was released

1995
- Ethicon Endo-Surgery acquires Ultracision
  - Innovation, research and development and the voice of the customer have helped make the Harmonic® franchise one of the most successful in Ethicon Endo-Surgery history
  - Used in over 6.5 million procedures worldwide

Technology: Mechanical Wave Energy

Energy is transported through a medium (solid, liquid or gas) by the propagation of waves.

Intrinsinc | Audible Range of Human Hearing | Ultrasound
---|---|---
| 20 - 20,000 Hz | > 20,000 Hz |

10 Hz (Earthquake) | 204 Hz (Vocal) | 55,000 Hz (HARMONIC®)

Diagnostic Imaging

Technology: Ultrasonic Hand Piece

The HARMONIC® System
- Electrical energy from the generator is converted to mechanical motion in the hand piece.

Technology: Path of Energy Flow

Transverse and Longitudinal Mechanical Waves

- Transverse Waves consist of oscillations occurring perpendicular to the direction of energy transfer
- Longitudinal Waves have vibrations along or parallel to their direction of travel
**Technology: Blade Expansion / Contraction**

**Amplitude vs. Power Level**

**Compression, Heat and Time**

**Ultrasonic Technology: The Generator**

Generator compensates for changes in impedance:
- Voltage will change to maintain the displacement
- Power will change to maintain the frequency based on impedance encountered at the blade tip

**Power Setting**
- Sets the current delivered by the generator
- Power Level 5 = 100% current set point = 100% displacement (i.e. 65 microns)
  - Increased cutting effect
- Power Level 1 = 50% current set point = 50% displacement (i.e. 33 microns)
  - Increased coagulative effect

**Tissue Dynamics: Coagulation Process**

**Depth of Injury - Liver**

Thermal effects of Harmonic compared to Monopolar Electro surgery
**Mean Time to 60°C**

**Time (sec)**

**ACE**
- LV
- PT

**Post Activation Residual Instrument Temperature**

**WHAT IS RESIDUAL HEAT?**

Residual Heat = Heat retained by the instrument after activation completed.

**ACTIVATIONS**
(5 seconds each)

---

**RESIDUAL HEAT - COMPARISON**

Touching Tissue after Interval Waiting Times

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<td>10</td>
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<tr>
<td>15</td>
<td>60</td>
</tr>
<tr>
<td>20</td>
<td>80</td>
</tr>
</tbody>
</table>

**Ultrasonic Device**

**Bipolar Device**

---

**What Is Adaptive Tissue Technology?**

- Exclusive to HARMONIC® devices, Adaptive Tissue Technology actively monitors the instrument during use, thus enabling the system to respond intelligently to varying tissue conditions.

- With the HARMONIC ACE® Shears, Adaptive Tissue Technology delivers greater precision by regulating energy delivery when needed, providing:
  1. a reduction in the power level
  2. enhanced feedback with a change to a second activation tone

- This typically occurs as tissue divides and the blade comes into contact with the tissue pad.

- With more precise energy delivery the HARMONIC ACE® Shears provide a 23% reduction in thermal spread, while offering 21% shorter transaction times and the same hemostasis you expect from the current HARMONIC ACE®.

---

**What does HARMONIC ACE®+?**

**Greater Precision**
- Delivers a 23% reduction in thermal spread, with 21% shorter transaction times and the same hemostasis you expect from HARMONIC ACE

**Intelligence**
- System monitors and adapts to varying tissue conditions

**Regulated Energy Delivery**
- Energy delivery is adjusted to improve temperature management

**Enhanced Audible Feedback**
- Tone change provides an additional cue to users to reduce unnecessary activation
The Impact of Adaptive Tissue Technology on HARMONIC A/C®+

- With any ultrasonic device, continued activation after tissue transection can result in increased blade temperatures.

Features & Benefits

- Available in 25cm and 30cm shaft lengths
- Refined blade design
  - For optimal performance
  - Provides a precise,atraumatic tissue transection

Audio/Visual Feedback
  - A visual change indicates need for active activation
  - Transsects tissue 2x faster than with a 200 watt laser in normal speed

Reduced Energy Output
  - Reduced temperatures allow for ease of use in deep tissues
  - 2x faster after activation

Adaptive Tissue Technology enables more precise and efficient delivery of energy.

Improved Temperature Management

Increased Efficiency
Plasma Energy in Gynecologic Surgery

Richard P. Marvel MD
Director, Minimally Invasive Gynecologic Surgery
Anne Arundel Medical Center,
Center for Pelvic Pain at Annapolis
Annapolis MD

Disclosures
• Consultant: Plasma Surgical
• Speakers Bureau: Plasma Surgical

Objectives
At the conclusion of this activity, the participant will be better able to:
• List types of energy produced by Plasmajet
• Identify benefits and disadvantages of plasma energy
• Select surgical procedures where plasma energy may be beneficial
• Summarize the current literature on tissue effects of plasma energy
• Implement plasma energy as a tool into surgical gynecologic surgical practice

Why Energy?
• With MIGS suturing is complex
• Energy allows for hemostasis without suture
• Energy can improve efficiency
• Energy can destroy abnormal tissue
• Energy can cut, coagulate, desiccate tissue with one instrument

Why Avoid Energy?
• Energy can lead to injury
  – Near
  – Far
  – Delayed
• Energy can lead to bleeding
• Energy can be expensive
• Energy can malfunction, Equipment can break, Hand pieces can fail

What is Plasma?
• One of the four fundamental states of matter
  – Solid, liquid, gas, plasma
• Heating a gas leads to ionization of particles to positive and negative ions of equal amounts
• Does not have a shape or volume
• Electrically Neutral
• Electrically Conductive
• Responds strongly to electromagnetic fields
Why is Plasma Helpful?

- Generates three types of energy
  - Light - Helps see area of interest
  - Kinetic Energy - Helps displace fluids
  - Heat - for cutting and coagulation
- Versatile - Cut, Vaporize, Coagulate
- Energy rapidly dissipates

Simplicity

- Easy to incorporate into clinical practice
- Simple to set up
  - Plug in, Turn on
  - Plug in hand piece
  - Open nozzle
- Simple to operate
  - Familiar settings
  - Energy controlled on hand piece

Clinical uses

Endometriosis

- Insert movie
- Peritoneal excision

Why Plasma in surgery?

- Benefits
  - Vary tissue effect by distance
  - Similar to Argon Beam Coagulator - fulguration
  - Similar to LASER, ablation, cutting
  - Similar to Monopolar Cautery — cutting, coagulation
  - Minimal Thermal Spread
  - Tissue Preservation
  - “What you see is what you get”
**Condyloma**
- Vaporization of condyloma
- Minimal lateral damage
- Quick Healing

**Myomectomy**
- Cut, coagulate, fulgurate
- Minimal Tissue damage
- Helps dissect planes
- Deal with Smoke

**Salpingostomy**
- Very Precise
- Minimal Tissue Damage
- Minimal Lateral thermal spread
- Cut pull back, coagulate

**Treatment of Endometriosis**
- Pilot study of 20 patients with endometriosis
- Lesions vaporized to complete eradication of lesion, then base biopsied for residual disease
- Some lesions primarily excised
- No residual endometriosis at base
- ≤1mm of lateral thermal injury
- No interference with interpretation


**Lateral Thermal Spread**
- 15 patients undergoing hysterectomy w/wo SO
- PJ used at 20 setting for 5 s at 0.5-1cm
- HTC low power similar time and distance
- Uterus p<0.001, ovary p<0.001, tube p<0.034


**Vaporization of Ovarian Endometrioma**
- Ablation of cyst lining followed by cystectomy
- Minimal damage to ovarian parenchyma
- Decreasing impairment of ovarian reserve

Affect on Fertility

- 55 women with endometrioma
- All underwent ablation of endometriotic cyst wall with Plasma energy
- Recurrence rate was 10.9% (12-39 months)
- 67% conceived, 59% spontaneously
- Probability of not conceiving in 24 months was 0.27 (0.12-0.44)

Plasma Ablation vs Ovarian cystectomy

Roman, H et al Postoperative recurrence and fertility after endometrioma ablation using plasma energy: retrospective assessment of a 3 year experience, JMIG, June 2013

Optimal Cytoreduction

- Epithelial ovarian cancer
- Optimal cytoreduction
- Vaporize bowel serosal lesions, diaphragmatic lesions,
- Able to vaporize large numbers of small lesions safely and efficiently to <1mm disease
- Allowed vaporization of tumor nodules at the base of the mesentery without compromising vascularity
- No increased morbidity


Keys to Success

Start with simple cases
Vaporization of Endometriosis
Vaporization of Condyloma

- Start with pulsing the energy, on low power
- Start with tip away, bring in to tissue to desired effect
- Use at an angle
- Coag setting for most GYN applications
- Increase power as you are able to increase your speed moving the tip with comfort
- Power = Speed

Pitfalls to Avoid

- Be careful around veins
- Pull peritoneum away from vital tissues
- Start low until comfortable
- Cut has higher kinetic energy
- Smoke evacuation needs to be maximized

Conclusions

- Plasma energy is a versatile addition to the energy modalities in the operating room
- It’s minimal depth of penetration allows for treatment of lesions near vital structures
- Can cut, coagulate, vaporize by varying the distance to the tissue
- Not a vessel sealing device, however, an excellent energy for endometriosis
THANK YOU  
ANNAPOLIS HARBOR AT SUNSET  
rpmarvel@gynpain.com

References

- Roman H, Vaporization of Ovarian endometrioma using plasma energy: Histologic Findings in a pilot study, Fertility and Sterility; Volume 95, issue 5, pg1853-56, 2011.
- Roman H, Auber M, Bourdel, N, Martin C, Marpeau, L, Puscasu, L; Postoperative recurrence and fertility after endometrioma ablation using plasma energy: retrospective assessment of a 3 year experience, JMGM, June 2013

Evaluation and Post Test

- Which of the following are NOT benefits of plasma energy?
  
a) Minimal lateral thermal spread  
b) Versatility of tissue effect  
c) Minimal smoke production  
d) Production of light and kinetic energy  
e) Not applicable to my area of practice

Correct answer is c minimal smoke production.
Disclosure
I have no financial relationships to disclose.

Managing Energy-Related Complications in Gynecologic Surgery

Moty Pansky Prof. M.D
Gyn. Endoscopy Unit, Assaf Harofe Medical Center, Zerifin, Israel.
Affiliated to Sackler Medical School, Tel Aviv University

Only One End Point!!!!

↓

HEAT

One Energy only!!-Electrical

RF Electrical Energy
Ultrasonic
laser

Monopolar
Bipolar

Tissue link floating ball
Vessel Sealers
Plasma Kinetics

And in Surgery....

And In Surgery!!!!

Cutting + Vaporation

Necrosis

Thermal SpreadCharring

Voltage
Energy Related Complications

**Thermal Damage**
- Burns
- Perforations
- Fistula
- Strictures


Energy Related Complications

**Risk Factors**
- Pelvic Adhesions
- Endometriosis
- Large pelvic masses
- Distorted anatomy
- Lack of education
- Inadequate Instruments
- Inadequate set up
- Lack of experience
- New modalities

**Management of thermal bowel injury**
- The golden rule of laparoscopy is that patient *gradually gets* better with each passing hour.
- Increasing pain, tachycardia and fever should raise the suspicion of bowel trauma.
- Thermal injuries may not become symptomatic for several days
- Patients who present after several days have experienced either delayed necrosis of damaged bowel or had leak which temporarily sealed off.

Energy Related Complications

**Bowel injury during laparoscopy**
- *Incidence - 0.13% (430/329935)* (Van der Voort 1994)
- Bowel Perforation - 0.2% (66/329935)
- Small intestine - 55%
- Large intestine - 39%

**Mechanism of Injury**
- Direct Entry - 42%
- Coagulation - 26%
Management of thermal bowel injury

Small Bowel Injury
- Single layer closure of small bowel is adequate in most cases.
- Suture lines should be perpendicular to the long axis of the bowel to prevent narrowing of the bowel lumen.

Colonic Injury
- Repair is similar to that described for small bowel injury.
- Lack of preoperative bowel prep is not an indication for colostomy.
- If bowel reanastomosis cannot be performed, a diverting colostomy may be required.

Management of thermal bowel injury

- Burn injuries require resection of 1-2 cm of viable tissue around the injury site, to ensure that all of the damaged tissue has been removed.
- The resected loop of bowel should be examined by the pathologist to ensure that all of the damaged tissue has been excised.

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- Suture lines should be perpendicular to the long axis of the bowel to prevent narrowing of the bowel lumen.

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Urinary Tract Injury

Incidence – 1% (Gilmoure 2006)

<table>
<thead>
<tr>
<th>Type of surgery</th>
<th>Bladder</th>
<th>Ureter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdominal hysterectomy</td>
<td>9.25/1000</td>
<td>3.22/1000</td>
</tr>
<tr>
<td>Vaginal</td>
<td>6.33/1000</td>
<td>14.16/1000</td>
</tr>
<tr>
<td>Laparoscopic</td>
<td>1.33/1000</td>
<td>0.15/1000</td>
</tr>
<tr>
<td>Adnexal Surgery</td>
<td>1/1000</td>
<td></td>
</tr>
<tr>
<td>First CS</td>
<td>3.3/1000</td>
<td></td>
</tr>
<tr>
<td>Repeat CS</td>
<td>6.8/1000</td>
<td></td>
</tr>
</tbody>
</table>

Thermal Injury To the Bladder

Diagnosis:
Intraoperative:
Visual inspection (Hematuria or Foley catheter in abdomen) – Can be diagnosed up to 38% of cases (Ibeanu 2009)
Intravesical dye- Will be effective only in complete laceration
Cystoscopy- Will be effective in sever and deep burns.

Risk Factors:
Prior pelvic Surgery
Endometriosis
Urinary tract abnormalities
Pelvic irradiation
Obesity
Large pelvic mass
Surgery for malignancy
Advanced pelvic reconstructive surgery
Laparoscopic hysterectomy
Thermal Injury To the Bladder

**Diagnosis**
- Postoperative: Leakage of urine from vagina or abdominal incision
- Hematuria
- Oliguria
- Anuria
- Abdominal pain or distention
- Nausea with or without vomiting
- Ileus
- Fever
- High BUN and creatinin in fluid sample from leakage
  - Cystoscopy
  - Cystography

**Intraoperative**
- Should be repaired intraoperatively!
- The damaged area should be removed as much as possible
- Generally a 2 layer closure with running 03 absorbable suture
- Closure should be tested to see if it is watertight
- Bladder catheter should be placed for 5-14 days followed by a cystogram

**Postoperative**
- Stop Urine leakage-Foley catheter
- Consider broad spectrum antibiotics
- Surgical reconstruction should be considered according to the extent of the damage
- Injuries to the trigone and below should include evaluation of the ureters and urethra.

Thermal Injury To the Ureter

**Diagnosis**
- Intraoperative: Visual inspection and very high rate of suspicion.
- Intravesical dye- Will be effective only in complete laceration
- Cystoscopy- Will be effective in very low and deep burns.
- Transient hematuria

**Postoperative**
- Retrograde pyelogram
- CT
- Urography
- US—Urinoma, Hydronephrosis and urinary ascites.

Treatment of thermal Injury To the Bladder

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Treatment of thermal Injury To the Ureter

**Intraoperative**
- Should be repaired intraoperatively!
- In cases of small thermal damage ureteral stent for 6-8 weeks
- In cases of large thermal damage resection and re-anastomosis should be considered on site.

**Postoperative**
- Stop Urine leakage with ureteral stent or with percutaneous nephrostomy.
- Due to anatomical distortions and edema consider evaluation of ureteral function after 6-8 weeks

Thermal Injury to the Ureter

**Diagnosis**
- Thermal uretral injuries are caused by excessive use of an energy near the ureter.
- These are best managed with resection of the damaged portion and reimplantation of the ureter.
- If untreated a relatively late genitourinary fistula or urinoma may develop.
- Most cases will be diagnosed postoperatively

**Intraoperative**
- Should be repaired intraoperatively!
- In cases of small thermal damage ureteral stent for 6-8 weeks
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- Should be repaired intraoperatively!
- In cases of small thermal damage ureteral stent for 6-8 weeks
- In cases of large thermal damage resection and re-anastomosis should be considered on site.
Thank You

**Summery**

- The risk of complications depends upon the extent and approach to surgery and patient characteristics.
- Choose the appropriate surgical energy generators for each surgery.
- Be familiar with new technologies.
- Most thermal injuries will be missed intraoperatively.
- Thermal injuries may *not* become symptomatic for several days.
- Late clinical manifestations should be considered as high probability for thermal damage.
- Immediate repair is the rule of thumb for most thermal injuries.
- The only exception is postoperative diagnosis of ureteral damage.
Lasers in Gynecology

Larry R. Glazerman, MD, MBA, FACOG

Disclosure
- Consultant: Bayer Healthcare Corp.
- Speakers Bureau: Bayer Healthcare Corp.

Objectives
- Understand the basics of laser physics
- Appreciate the various laser wavelengths used in gynecology
- Describe the use of lasers in gynecologic procedures

How is Laser Light Unique
LASER is an acronym which stands for:
- Light
- Amplification by the Stimulated Emission of Radiation

Laser Beam Effects on Tissue
- Light can either be transmitted (through), reflected or scattered (back) or absorbed (into tissue):
  - Transmission – laser light passes through tissue and continues to propagate.
  - Reflection (Specular) – laser energy is reflected off mirror-like surface.
  - Scatter (Diffuse Reflection) – laser energy is spread out by reflection from matted or uneven surface.
  - Absorption – tissue absorbs laser energy to achieve the desired effect.

In order of penetration through tissue:
- Reflection (Specular)
- Absorption
- Scatter (Diffuse)
- Transmission
How does a laser cut tissue?

Laser energy applied → Water boils at 100°C → Water vapor and solid particles

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Tissue Degradation</th>
<th>Visual Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>37°C – 90°C</td>
<td>Heating</td>
<td>No Change</td>
</tr>
<tr>
<td>60°C – 90°C</td>
<td>Coagulation/Denaturation</td>
<td>White/Grey</td>
</tr>
<tr>
<td>90°C – 100°C</td>
<td>Drying/Puckering</td>
<td>Wrinkling/Puckering</td>
</tr>
<tr>
<td>100°C</td>
<td>Vaporization/Cutting</td>
<td>Golden/Char/Smoke</td>
</tr>
</tbody>
</table>

Temperature, Tissue Degradation, Visual Effect

Laser Colors and Wavelengths

<table>
<thead>
<tr>
<th>Name</th>
<th>Color</th>
<th>Wavelength (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argon</td>
<td>Blue</td>
<td>488.0, 514.5</td>
</tr>
<tr>
<td>Blue</td>
<td>Blue</td>
<td>488.0, 514.5</td>
</tr>
<tr>
<td>Green</td>
<td>Green</td>
<td>532.0</td>
</tr>
<tr>
<td>Yellow</td>
<td>Yellow</td>
<td>577.0</td>
</tr>
<tr>
<td>Red</td>
<td>Red</td>
<td>632.8</td>
</tr>
<tr>
<td>Red</td>
<td>Red</td>
<td>632.8</td>
</tr>
<tr>
<td>Ruby</td>
<td>Red</td>
<td>694.3</td>
</tr>
<tr>
<td>Ruby</td>
<td>Red</td>
<td>694.3</td>
</tr>
<tr>
<td>Holmium/YAG</td>
<td>Grey</td>
<td>946.5</td>
</tr>
<tr>
<td>Holmium/YAG</td>
<td>Grey</td>
<td>946.5</td>
</tr>
<tr>
<td>Er:YAG</td>
<td>Grey</td>
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<tr>
<td>Er:YAG</td>
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<tr>
<td>Nd:YAG</td>
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</tr>
<tr>
<td>Nd:YAG</td>
<td>Grey</td>
<td>946.5</td>
</tr>
</tbody>
</table>

Absorption of Laser Energy in Water

- CO₂: 10.600 nm, 0.3 water drops
- Holmium: 2.100 nm, 0.5 water drops
- Nd:YAG: 1.064 nm, 0.1 water drop glass
- KTP: 532 nm, 0.5 scattering points

Penetration & Absorption of Laser Energy in Tissue

What Does Water Absorption Mean?

Thermal Damage & Heat Propagation in Tissue

Nd: YAG Laser

CO₂ Laser
Uses of lasers in Gynecology

- Lower Genital Tract
  - Vulva
  - Vagina
  - Cervix
- Intra-abdominal
  - Laparotomy
  - Laparoscopy
- Intrauterine
- Cosmetic

CO₂ Laser Vaporization of the Cervix

CO₂ Laser Laparoscopic Vaporization of Endometriosis

Intrauterine Laser

- Endometrial Ablation
- Septoplasty
- Polypectomy
- Myomectomy

Cosmetic Lasers in Gynecology

- Carbon dioxide 1.064 nm
- Erbium-YAG 2.940 nm
- Diode 810 nm 108 mWcc long pulse 395
- Alexandrite 755 nm Q-switched for blue, black and green tattoo removal
- Ruby long pulse 694 nm Q-switched
- Nd:YAG 1.064nm long pulse, Q-switched, frequency doubled 532 nm for red or orange ink tattoo removal

Cosmetic Laser Surgery

- Hair Removal
- Vein Treatment
- Skin Resurfacing
- Vaginoplasty
  - Laser Vaginal Rejuvenation®
Impact of Electrosurgical Complications

- Surgical burns and fires related to the use of electrosurgery as a Top 10 health technology hazard.[1]
- Electrosurgical burn prevention one of the top five safety measures for outpatient surgery centers.[2]
- In laparoscopic surgery, the incidence of thermal injuries related to electrosurgery is estimated at 1-2 per 1,000 patients, the results of which include mortality from delayed bowel perforation.[3]

So what is the FUSE Program?

- Fundamental Use of Surgical Energy
- Developed by the SAGES (Society of American Gastrointestinal and Endoscopic Surgeons)
- Two components:
  - Educational module
  - Web based training
  - High stakes test
- The goal is to make FUSE a national standard for general surgeons

Why learn about surgical use of energy?

- The SAGES Manual on the Fundamental Use of Surgical Energy (FUSE)
- Liane E. Podracky, MD, FACS, F:D:SE
- Pascal R. Fuchsberger, MD, PhD, FACS
- The Vermont Medical Center, VC, Wa, USA
- The FUSE Manual

The SAGES Manual on the Fundamental Use of Surgical Energy (FUSE)

The FUSE Training Website
Create a chart

The FUSE Exam
FUSE Examination

- Designed as a “High Stakes” examination
- Exhaustive and rigorous development with expert advice, peer input, under direction of psychometricians
- Taken at a testing center
- 75 Questions
- There is a charge
- Certificate to those who pass

Malcolm G. Munro MD, FRCS(c), FACOG
Professor, Department of Obstetrics & Gynecology
David Geffen School of Medicine at UCLA
Director of Gynecologic Services
Kaiser Permanente, Los Angeles Medical Center
Los Angeles, CA, USA
Governor Arnold Schwarzenegger signed into law AB 1195 (eff. 7/1/06) requiring local CME providers, such as the AAGL, to assist in enhancing the cultural and linguistic competency of California’s physicians (researchers and doctors without patient contact are exempt). This mandate follows the federal Civil Rights Act of 1964, Executive Order 13166 (2000) and the Dymally-Alatorre Bilingual Services Act (1973), all of which recognize, as confirmed by the US Census Bureau, that substantial numbers of patients possess limited English proficiency (LEP).

California Business & Professions Code §2190.1(c)(3) requires a review and explanation of the laws identified above so as to fulfill AAGL’s obligations pursuant to California law. Additional guidance is provided by the Institute for Medical Quality at http://www.imq.org.

Title VI of the Civil Rights Act of 1964 prohibits recipients of federal financial assistance from discriminating against or otherwise excluding individuals on the basis of race, color, or national origin in any of their activities. In 1974, the US Supreme Court recognized LEP individuals as potential victims of national origin discrimination. In all situations, federal agencies are required to assess the number or proportion of LEP individuals in the eligible service population, the frequency with which they come into contact with the program, the importance of the services, and the resources available to the recipient, including the mix of oral and written language services. Additional details may be found in the Department of Justice Policy Guidance Document: Enforcement of Title VI of the Civil Rights Act of 1964 http://www.usdoj.gov/crt/cor/pubs.htm.

Executive Order 13166, “Improving Access to Services for Persons with Limited English Proficiency”, signed by the President on August 11, 2000 http://www.usdoj.gov/crt/cor/13166.htm was the genesis of the Guidance Document mentioned above. The Executive Order requires all federal agencies, including those which provide federal financial assistance, to examine the services they provide, identify any need for services to LEP individuals, and develop and implement a system to provide those services so LEP persons can have meaningful access.

Dymally-Alatorre Bilingual Services Act (California Government Code §7290 et seq.) requires every California state agency which either provides information to, or has contact with, the public to provide bilingual interpreters as well as translated materials explaining those services whenever the local agency serves LEP members of a group whose numbers exceed 5% of the general population.

If you add staff to assist with LEP patients, confirm their translation skills, not just their language skills. A 2007 Northern California study from Sutter Health confirmed that being bilingual does not guarantee competence as a medical interpreter. http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2078538.