Electrosurgery and Laparoscopy
...what every surgeon should know

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Radiofrequency Electrosurgery
Goals

• Electrical physics
• Bioeffects of electrical energy
• Creating tissue effects
• Laparoscopic applications and safety
• Conclusions

Radiofrequency Electrosurgery
Goals – Speaking the Language

• “Bovie”
• “Hot Bovie”
• “Cautery”
• “Hot Bovie Cautery”
• “Cauterize”
• “Burn”
• “Ground Pad”
• “Return Electrode”

• Electrosurgical Generator/Unit (ESU)
• Techniques / Tissue Effects
  – Vaporize
  – Cut (linear vaporization)
  – Desiccate
  – Fulgurate
• Electrodes
  – Active
  – Dispersive”
Radiofrequency Electrosurgery

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Voltage “V”

\[ I = \frac{V}{R} \]

Ohm’s Law

**P = V x I**

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**Electrosurgical Generators**

What do they do?

- **Conversion of low frequency to RF output**
- **Allows adjustment of wattage and indirectly, voltage**
- **Control of duty cycle**

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**Electrosurgical Generators**

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Electrosurgical Generators
What do they do?

• Not all generators are created equal
• Variables include:
  – Peak voltage
  – Duty cycle adjustment
  – Response to increasing impedance

\[ I = \frac{V}{R} \quad P = V \times I \]

Electrical Physics

Direct Current

Radiofrequency: About 500,000 cycles/second
All RF electrosurgery is bipolar...

...what differentiates systems is the location of the second electrode
Electrosurgery
Generator Output

Electrosurgery
Duty Cycle, Output Voltage

Electrical Physics
Radiofrequency Electrosurgery

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Bioeffects of RF Electricity
Effect on Cells

Bioeffects of RF Electricity
Effect on Cells: Vaporization

> 100 ° C
Bioeffects of RF Electricity
Effect on Cells: Vaporization

Bioeffects of RF Electricity
Effect on Cells: Desiccation

Bioeffects of RF Electricity
Effect on Cells: Coagulation
Bioeffects of RF Electricity
Effect on Cells: Coagulation

> 70° C; < 100° C

Bioeffects of RF Electricity
Effect on Cells: Coagulation

Protein bonds break with heat then reform bridging the gap between cells

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What is Electrosurgery?

RF Electrosurgery
Tissue Effects

Vaporization Desiccation Fulguration

Electrosurgical Desiccation with Vaporization
Relationship to Voltage
RF Electrosurgery
Tissue Effects

Vaporization Desiccation

Tissue Effects of RF Energy
Vessel Compression is Necessary for Vessel Coaptation

Tissue Effects of RF Energy
Voltage, Modulation and Tissue Effect

"Cutting" Current

"Coagulation" Current
Factors Affecting Lateral Propagation of Thermal Injury

- Energy delivery – pulsed versus continuous
- Tissue temperature
- Compressed tissue thickness

RF Tissue Effects
Fallopian Tube Desiccation and RF Waveform

“Cutting”

“Coagulation”

Grade 1

Grade 2

Grade 3
Fallopian Tube Desiccation and RF Waveform

What is Cautery?
Cautery is the passive transfer of heat

What is Electrosurgery?
The intracellular conversion of electromagnetic... to kinetic energy to thermal energy...
creating one or a combination of cellular and tissue effects...

Vaporization
Fulguration
Desiccation
Radiofrequency Electrosurgery

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Laparoscopic Applications of RF Electrosurgery

Hand Instruments

Laparoscopic Applications of RF Electrosurgery

Focal and Linear Vaporization

Vaporization
Laparoscopic Applications of RF Electrosurgery
Desiccation / Coagulation

Tissue Effects
RF Desiccation for Hemostasis

Factors Affecting Lateral Propagation of Thermal Injury
- Energy delivery
- Tissue temperature
- Compressed tissue thickness

Compress the vessel - Coaptive Desiccation
Laparoscopic Applications of RF Electrosurgery

Linear Cutting & RF Desiccation

Bipolar RF Energy Systems

Linear Cutting & RF Desiccation
Laparoscopic Applications of RF Electrosurgery

**RF Desiccation & Linear Cutting**
Non-dedicated ESU – Bipolar Device

![Image of tissue desiccation and cutting with RF electrosurgery device]

**RF Electrosurgery**
**Tissue Effects**

- **Vaporization**
- **Desiccation**
- **Fulguration**

![Image of tissue effects and electrosurgical waves]

**RF Electrosurgical Hemostasis**

**Fulguration**
- High voltage modulated current
- Oozing capillary beds
- “no touch”
- Large surface area electrode; ABC
- INCREASED RISK OF CAPACITATIVE COUPLING!
Laparoscopic Applications of RF Electrosurgery

Safety issues...
...Current diversion

Safety: Current Diversion with Monopolar RF Instrumentation
Insulation Defects

Safety: Current Diversion with Monopolar RF Instrumentation
Direct Coupling
Safety: Current Diversion with Monopolar RF Instrumentation

Capacitative Coupling

- Open circuit
- High voltage output ("coagulation")

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