# Authors:

Beth Sobba MD, Ochsner Clinic
Jennifer Gold MD, Ochsner Clinic
Sydney Graham MD, Ochsner Clinic
Emma Siewert MD, Ochsner Clinic

*This study guide is intended for OBGYN residents studying for EMIGS cognitive skills exam. It is not intended for medical advice or for redistribution by individuals without an active EMIGS subscription.

# EMIGS Modules

1. **General Endoscopic Principles - *Beth Sobba***
2. **Principles Applied Anatomy Physiology - *Jennifer Gold***
3. **Instrumentation - *Jennifer Gold***
4. **Energy Sources - *Beth Sobba***
5. **Operating Room Setup and Patient Positioning - *Jennifer Gold***
6. **Principles Operative Laparoscopy - *Emma Siewert***
7. **Principles Operative Hysteroscopy - *Emma Siewert***
8. **Laparoscopic Procedures - *Beth Sobba***
9. **Hysteroscopic Procedures - *Sydney Graham***
10. **Laparoscopic Complications - *Beth Sobba***
11. **Hysteroscopic Complications - *Sydney Graham***
12. **Special Considerations - *Sydney Graham***

# Module 1: General Endoscopic Principles

1.1 Recognize shock!

- Fluid = blood ie hemorrhagic vs
- Pipe = vessel ie distributive (sepsis) or obstructive(PE, tension PNX) vs
- Pump = heart ie cardiogenic

A 23 year old G1P0 with known ectopic pregnancy treated with methotrexate 5 days ago presents to the Emergency Department with worsening pain and syncopal episode. Initial vital signs reveal a heart rate of 143 beats per minute and blood pressure 52/palp. Your *next step* in management is:

**A. Obtain stat B-HCG**

**B. Obtain stat pelvic ultrasound**

**C. Obtain 2 large bore IVs, Blood Type and Cross, IV fluid resuscitation**

**D. Urgent laparoscopy for salpingectomy**

**E. Urgent laparotomy for salpingostomy**

1.2 Determine candidacy for laparoscopy and MIS

- MIS benefits: less EBL, improved post op pain, shorter hospital stay, less wound infection, faster return to work activities
- MIS disadvantage: longer operative time, higher risk of urinary tract injury and cuff dehiscence
- Pathology considerations: consider laparotomy instead of MIS if suspected extra uterine pathology or adnexal mass suspicious for malignancy
- Patient considerations: ability to tolerate general anesthesia and high intra-abdominal pressure, consider if laparoscopy vs laparotomy if extensive adhesive disease, hemodynamic instability is NOT a contra indication to laparoscopy as long as they are appropriately fluid resuscitated during laparoscopic case

A 57 year old, postmenopausal woman, with a 13-cm complex left adnexal mass and an elevated CA-125 is being evaluated for surgical intervention. The most appropriate surgical approach is

**A. Laparoscopy**

**B. Laparotomy**

**C. Robotically Assisted**

**D. Vaginal**

1.3 Indications and contra indications to hysteroscopy

- Many indications…
- Contraindications: pregnancy, pelvic infection (including if active vulvar infection), cervical or uterine cancer, inadequate experience or equipment
- Pre op: pregnancy test and bimanual exam

A 73 year old presents with postmenopausal bleeding. Endometrial biopsy was difficult due to stenosis and showed inflammatory mucous and benign endocervical tissue. Ultrasound showed a 12 mm heterogeneous, cystic appearing endometrial stripe. The next step in management is:

**A. Dilation and Curettage**
**B. Expectant management**
**C. Hysteroscopy with Dilation and Curettage**
**D. Hysterectomy**
**E. Repeat endometrial biopsy**


1.4 Assessing risk of malignancy in adnexal mass and management

- Ultrasound findings associated w malignancy: size > 10cm, irregular shape, free fluid or ascites, thick walled septations
- Adnexal masses in post menopausal patients: 2/3 benign 1/3 malignant
- Management by size
    - 1-3 cm no follow up
    - 3-5cm surveillance with repeat TVUS 3-6 months
    - 5-10cm surveillance or surgery
    - >10cm surgery

These are guidelines based on size alone, have to also consider if symptomatic, elevated tumor markers, changes in size lesion etc.

- Referral to Gyn Onc
    - If post menopausal with elev CA 125 > 35
    - Pre menopausal with significant elev CA 125 > 200
    - Imaging concerning for malignancy
    - Elevated risk assessment score (ROI, ROMA)

A 61 year old G0 presents with an 4 cm simple right ovarian cyst. This was incidentally found during a CT scan of the pelvis. Laboratory analysis reveals a CA-125 of 14. Your *next step* in management is:

**A. Aspirate the ovarian cyst and send for cellular cytology**
**B. Perform laparoscopic ovarian cystectomy**
**C. Perform laparoscopic salpingo-oophorectomy**
**D. Refer patient to gynecologic oncology**
**E. Repeat pelvic ultrasound in 3 months**

1.5 Pre operative evaluation

- Low <1% ie minor gyn

- Intermediate 1-5% ie major gyn
- High >5% ie major abdominal
- Diabetics: hold home metformin and short acting insulin, administer 50% of long acting insulin, schedule as first case of the day, post op BG <180
- Obesity: pre op anesthesia assess for airway management and OSA, tolerate trendelenberg, antibiotic dosing, assess for extended instruments
- Rheumatology: positioning (ie limitations of joints), consult rheum if need to hold immunosuppressants to decrease infection risk, assess if stress dose steroids indicated (yes if prednisone 5mg daily or any dose for 3 weeks or greater)

## Stress Dose Steroids

| | Major Surgery | Moderate Surgery | Minor Surgery |
|---|---|---|---|
| Maintenance Steroid | Continue | Continue | Continue |
| Preoperative Hydrocortisone | 100mg IV | 50mg IV | None |
| Postoperative Hydrocortisone | 50mg IV q8h for 24h, then taper to Maintenance Steroid | 25mg PO q8h for 24h, then resume Maintenance Steroid | Maintenance Steroid |

Assess for VTE ppx by Caprini score

## Perioperative Considerations-VTE Prophylaxis

| Risk of Symptomatic VTE | Definition |
|---|---|
| Low | Minor surgery (<30min) or noncomplex laparoscopic surgery in patients with no additional risk factors |
| Moderate | Minor or laparoscopic surgery in patients with additional risk factors; major gynecologic surgery for benign disease with no additional risk factors |
| High | Major surgery in patients with additional risk factors; major surgery in patients with malignancy |
| Highest | Major surgery in patients older than 60 y with cancer, a prior VTE, or both |

A 48 year old with uterine fibroids is scheduled to undergo total laparoscopic hysterectomy and bilateral salpingectomy. The level of surgical risk associated with this procedure is:

**A. 0%**
**B. <1%**
**C. 1-5%**
**D. 5-10%**
**E. >10%**

# Module 2: Principles Applied Anatomy Physiology

After placement of the right lower quadrant trocar, brisk bleeding from the abdominal wall is noted. The bleeding is likely the result of a vascular injury involving the:

A. Common iliac artery
B. External iliac artery
C. Inferior epigastric artery
D. Internal iliac artery
E. Superficial epigastric artery

## 2.1 Abdominal and Pelvic Anatomy

- Inferior epigastric vessels: immediately medial to round ligament
- Medial umbilical ligament/obliterated umbilical artery: termination of internal iliac artery, can be used to help identify origin of uterine artery

A 59 year old is referred for postmenopausal bleeding. She underwent an endometrial ablation 10 years prior. During the hysteroscopy, dilation of the cervix is challenging. The landmark that best indicates entry into the uterine cavity is:

A. Cervicouterine junction
B. Endocervical canal
C. Endometrium
D. Fundus
E. Tubal ostia

## 2.2 Hysteroscopic Landmarks

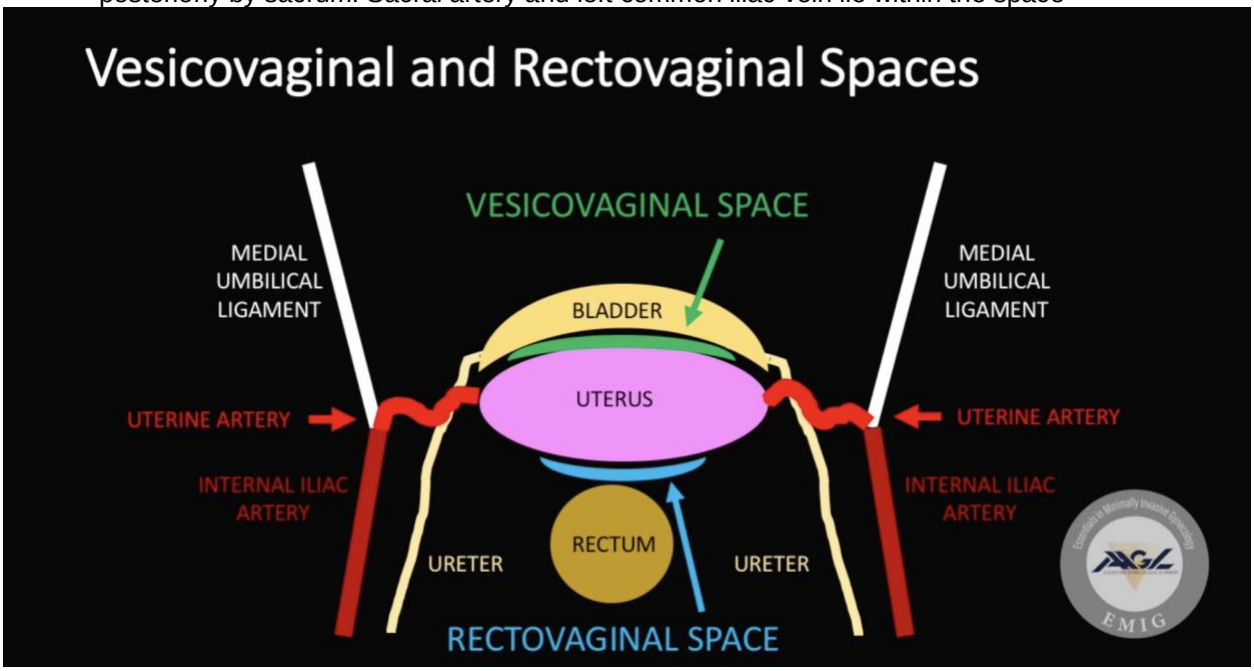
Anatomic landmarks: endocervical canal (3-4 cm in length) cervicouterine junction uterine fundus tubal ostia

- Visualization of tubal ostia confirms intrauterine entry

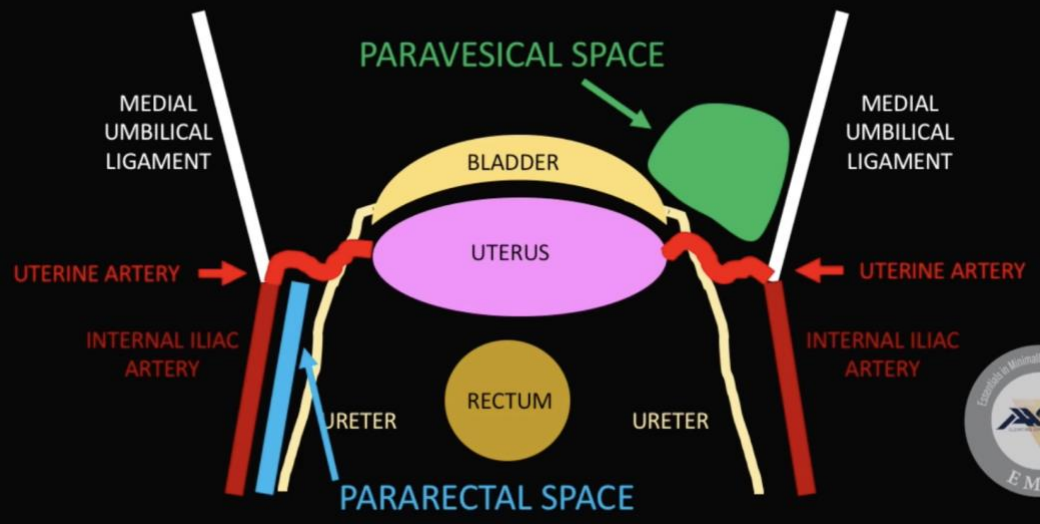
## 2.3 Anatomy of Retroperitoneum

Avascular spaces:

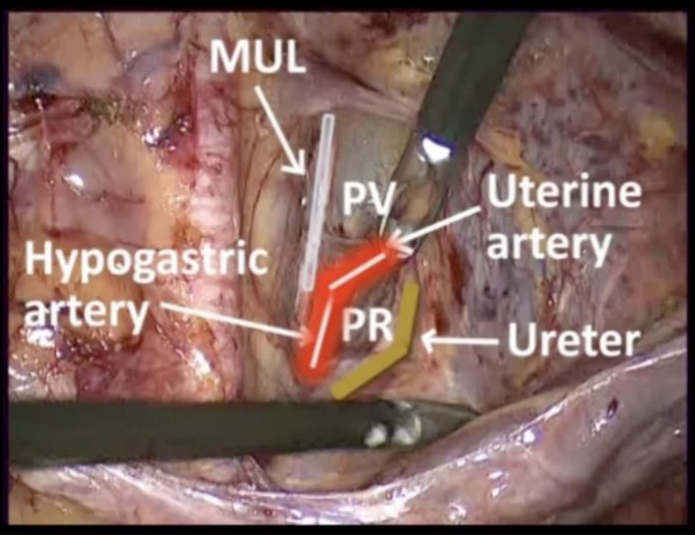
- Vesicovaginal: potential space between bladder and vagina
- Rectovaginal: potential space between rectum and vagina
- Paravesical: potential space bordered laterally by medial umbilical ligament, medially by bladder and caudad by uterine artery
- Pararectal: potential space bordered laterally by internal iliac artery, medially by ureter, cephalad by uterine artery
- Retropubic: space of Retzius bordered by pubic symphysis anteriorly, pubic rami and obturator internis laterally, and the bladder and endopelvic fascia posteriorly
- Presacral: bordered laterally by common iliac vessels and ureters, anteriorly by rectum and posteriorly by sacrum. Sacral artery and left common iliac vein lie within the space

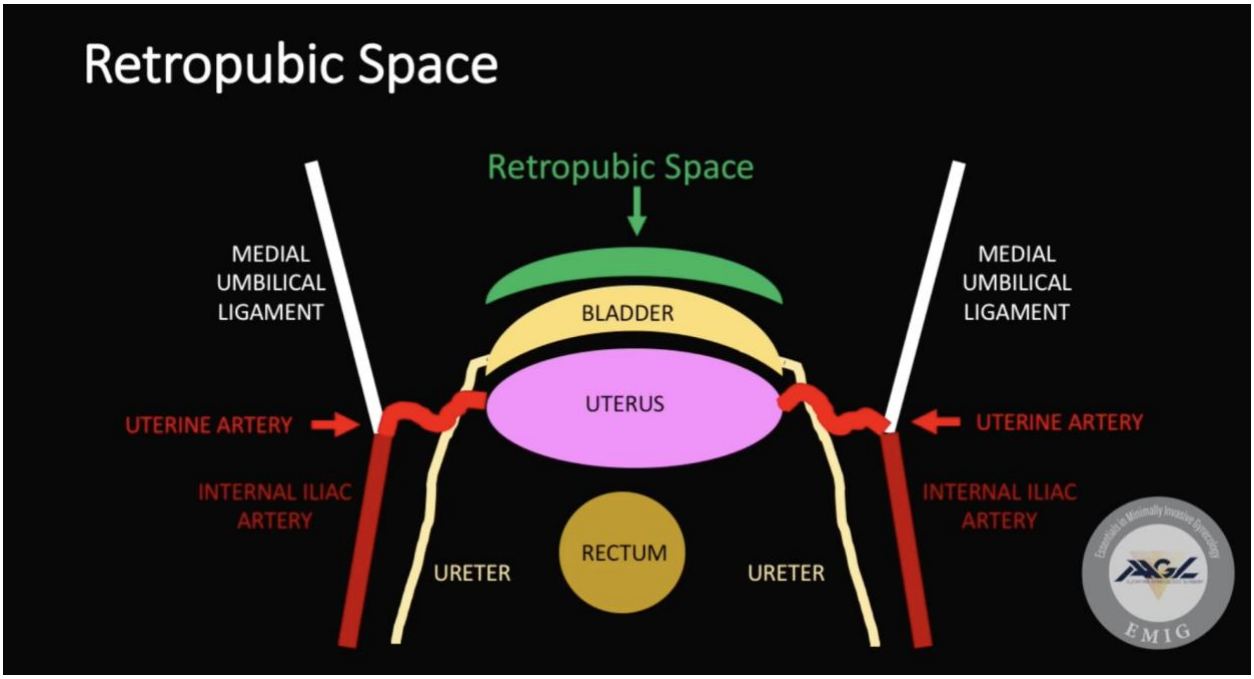


# Pararectal and Paravesical Spaces




Pararectal and Paravesical Spaces






A 27 year old G0 is undergoing laparoscopic excision of endometriosis. She has complete obliteration of the posterior cul de sac. Retroperitoneal dissection is used to identify normal tissue planes. The medial border of the pararectal space is:

**A. Internal iliac artery**
**B. Medial umbilical ligament**
**C. Rectum**
**D. Ureter**
**E. Uterine artery**

## 2.4 Course of Ureter

Ureteral Injuries: 75% by gynecologic surgery, 0.03 – 1.5% rate of injury with gynecologic surgery

Course: Exits kidney and courses inferiorly anterior to psoas muscle  enters pelvic coursing over iliac vessels at the level of the bifurcation of common iliac and travels deep to IP ligament  once in pelvis travels on the medial leaf of broad ligament  passes within 1 cm lateral to uterosacral ligaments and then travels into cardinal ligament under uterine vessels  medially along anterior vagina to enter bladder at trigone (between 1.5-2 cm lateral to cervix near internal os)

Can increase distance between ureter and uterine artery by providing cephalad traction on the uterus

A 75 year old G0 is undergoing a laparoscopic hysterectomy and bilateral salpingo-oophorectomy for treatment of endometrial hyperplasia. During the hysterectomy, the ureter is injured at the pelvic brim. The most likely surgical step to have caused the injury is:

**A. Colpotomy**
**B. Infundibulopelvic ligament transection**
**C. Round ligament transection**
**D. Uterine artery transection**
**E. Vesicouterine fold development**

## 2.5 Anatomy and Function of Pelvic Floor

Pelvic Floor

- Passive structures: pelvic fascia and connective tissue, bony pelvis (4 bones, 3 joints)
- Active structures: muscles

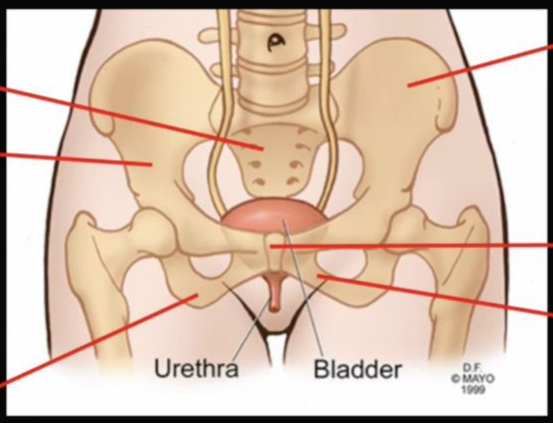
Bladder, urethra, cervix, and lower portion of uterus connected to pelvic side wall by connective tissue called endopelvic fascia. Uterosacral and cardinal ligaments directly attach to cervix

Support

- Level 1: apical suspension  uterosacral/cardinal ligament complex  suspend upper vagina and uterus  compromise = uterine or vaginal vault prolapse
- Level 2: lateral attachment  arcus tendinous fascia pelvis, pubocervical and rectovaginal fascia  support bladder and rectum  defects = anterior or posterior vaginal wall prolapse
- Level 3: lower support  perineal body, levator ani muscles  defects = rectal proplapse and anal incontinence

Function of pelvic floor muscles: pelvic organ support, breathing, lumbar stability, urinary and fecal incontinence, sexual functioning, voiding

# Bony pelvis




Sacrum

Ilium

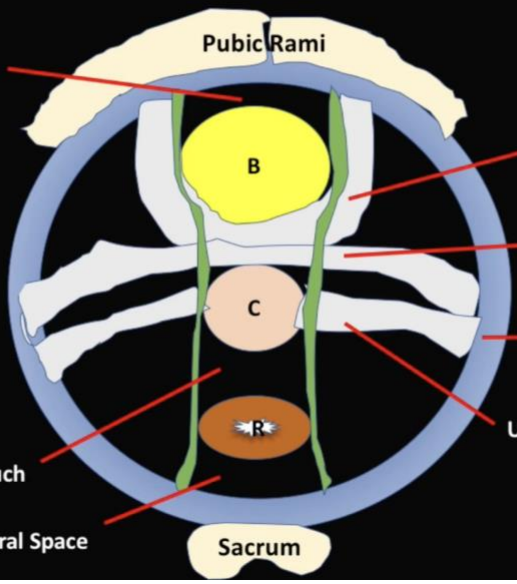
Iliac crest

Pubic symphysis

Ischium

Ischial tuberosity

# Ligaments and Pelvic Fascia




Retropubic Space

Pubocervical Ligament

Cardinal Ligament

Tendineus Arch of Levator Ani

Uterosacral Ligament

Rectouterine Pouch

Presacral Space


A 66 year old presents with chief complaint of a vaginal bulge. Pelvic exam with Valsalva maneuver reveals descent of the cervix to 1 cm beyond the hymen. The structure most responsible for this defect is:

A. **Arcus tendineus fascia pelvis**
B. **Levator ani muscles**
C. **Perineal body**
D. **Rectovaginal fascia**
E. **Uterosacral ligament**

## 2.6 Functional Ovarian Cysts

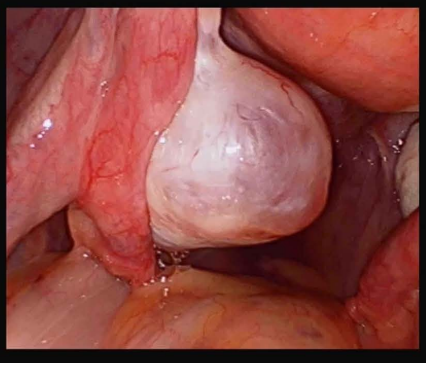
Physiologic cysts related to ovulation, usually < 3 cm in diameter

- Follicular cysts: from ovarian follicle, thin walled and fluid filled, on US unilocular, thin walled and anechoic
- Corpus luteal cyst: thick walled and yellow, US internal echos, central lucency and thickened walls

Aspiration: 30% risk of recurrence

A 32 year old G0 is undergoing a laparoscopic myomectomy and the left ovary is incidentally noted to have the appearance shown. The most appropriate management is:

A. Cyst drainage
B. Expectant management
C. Follow-up ultrasound in 6 weeks
D. Ovarian cystectomy
E. Salpingo-oophorectomy



# Module 3: Instrumentation

3.1 Endoscope Selection

Cystoscopy: 0°, 30°, or 70° scope. Urethra best visualized with 0 scope to provide circumferential view. Bladder best visualized with 30 or 70, 30 provides best view of base and posterior wall while 70 is best for anterior and lateral walls.

Hysteroscopy: flexible (lower resolution, more common in ambulatory setting, increased comfort) or rigid (30° allows for rapid evaluation of anterior and posterior walls) scope. Operative is only possible with 0° scope.

Laparoscopy: larger diameter = greater brightness, 30° = 152° view. 0° = 76° view, more panoramic

A 72 year old G0 is undergoing a diagnostic cystoscopy for possible urethral diverticulum. The most appropriate cystoscope to use is:

**A. 0°**
**B. 30°**
**C. 45°**
**D. 70°**
**E. 90 °**

## 3.2 Patient Burns During Laparoscopy

Increased risk of surgical fire: oxidizing gases (O2, NO + proximity of gas to field), flammable materials (drapes, sponges, alcohol based surgical preps, patient's hair, ET tubes), heat sources (electrosurgery, laser, fiberoptic light, drill, defib)

Electrosurgery Burns

- Direct coupling: when an active electrode comes in contact with a metal object within the operative field
- Capacitive coupling: when straight currents affect non-targeted tissue

Fire Risk Assessment tools: procedure performed above xyphoid, open O2 source, ignition source. > 3 = high risk

Reduce Surgical Burn Risk: avoid open delivery of O2, adequate drying time of alcohol based surgical preps, maintain ignition sources away from surgical drapes, lowest effective electrosurgical setting, protect heat/electrosurgery sources

A 32 year old G3 P2012 is undergoing a laparoscopic myomectomy using monopolar electrosurgery. Her abdomen was prepped using betadine. Her fire risk is:

**A. 0**
**B. 1**
**C. 2**
**D. 3**
**E. 4**

## 3.3 Poor Visualization During Laparoscopy

Assess: light source, equipment, focus and clean camera

A laparoscopic hysterectomy is being completed. While performing colpotomy, the image suddenly goes black. The next step you should take to address the problem is:

A. Attach smoke evacuator
B. Clean camera
C. Inspect light source connection
D. Suction intraperitoneal blood
E. Warm lens

## 3.4 Poor visualization during hysteroscopy

Optimal visualization: procedure performed during early proliferative phase of menstrual cycle, correct equipment set up

Hematometrium: adjust outflow port (increase outflow), increase distension pressure

A 48 year old with abnormal uterine bleeding is undergoing hysteroscopy. Visualization is limited due to hematometrium. The next step is:

A. Decrease intrauterine pressure
B. Discontinue procedure
C. Increase cervical dilation
D. Increase fluid outflow and suction
E. Perform curettage

## 3.5 Management of Over-Dilation in Hysteroscopy

Prevention: not mechanically dilating cervix, or only dilating enough to accommodate hysteroscope
Treatment: upsize hysteroscope to larger diameter, alice clamp to clamp cervix, stay sutures at 3’ and 9’ can be crossed

A 48 year old G4P4 with abnormal uterine bleeding is undergoing hysteroscopy. Visualization is limited due to under distension. The next step in management is:

A. Continue procedure with current visualization
B. Decrease cervical dilation
C. Decrease intrauterine pressure
D. Discontinue procedure
E. Increase fluid outflow and suction

## 3.6 Benefits of Uterine Manipulation

Purpose of uterine manipulator: optimize visualization, second assistant, delineation of cervical-vaginal junction

Upward traction with manipulator increases distance between uterine vessels and ureters

A 43 year old G2P2 with chronic pelvic pain is undergoing total laparoscopic hysterectomy. Movement of the uterine manipulator assists with the procedure by:

A. Allowing safe placement of trocars through anteversion
B. Assisting with development of the bladder flap through outward traction
C. Improving exposure of the uterosacral ligaments through retroversion
D. Increasing distance between uterine artery and ureter through inward pressure

## 3.7 Use of CO2 in Laparoscopy

Ideal insufflation gas: low cost, non-flammable, colorless, easily excreted, non-toxic
CO2: low cost, non-flammable, colorless, stable, high diffusion capacity, rapid absorption and excretion via lungs

Risks: hypercapnia  acidosis, cardiopulm complications (pulm edema, tachyarrhythmias), peritoneal irritation

A 43 year old with abnormal uterine bleeding is undergoing a total laparoscopic hysterectomy. The procedure is initiated by insufflating the abdomen with carbon dioxide. The main advantage of using carbon dioxide as the insufflation gas is:

**A. Chemically unstable**
**B. Excretion through respiration**
**C. Flammable**
**D. Low diffusion capacity**
**E. Slow systemic absorption**

## 3.8 Hysteroscopy Fluid Absorption

Fluid absorption: surgical disruption of venous sinuses (usually during operative), high intrauterine pressure

- Decrease absorption by: using non conductive/isotonic if possible (i.e. NaCl), monitor fluid deficit, minimize IUP, limit operative time, pre-op GnRh agonist, intracervical vasopressin (< 0.4 u/ml)

A 23 year old G0 with abnormal uterine bleeding is undergoing hysteroscopic myomectomy for a 4-cm submucosal leiomyoma. The most effective preventative measure to decrease fluid absorption and associated complication is:

**A. Increase intrauterine pressure**
**B. Increase operative time**
**C. Inject the cervix with vasopressin**
**D. Use glycine as distension media**

## 3.9 Monopolar Electrosurgery during Hysteroscopy

Monopolar circuit: generator monopolar → electrode→ tissue → return electrode/pad → generator

- Requires non-electrolyte media (i.e. glycine or sorbitol) otherwise will dissipate energy throughout uterus and possibly out into peritoneum (would need to perform diagnostic lap). Bipolar can use electrolyte containing media

A 23 year old G0 with abnormal uterine bleeding is undergoing hysteroscopic myomectomy for a 4-cm submucosal leiomyoma using a monopolar resectoscope. When the resectoscope is activated, no tissue effect occurs. The most likely issue is:

**A. Bipolar loop attached to monopolar operating sheath**
**B. Connections secured**
**C. Glycine being used as distension media**
**D. Grounding pad adequately applied**
**E. New electrode wire being used**

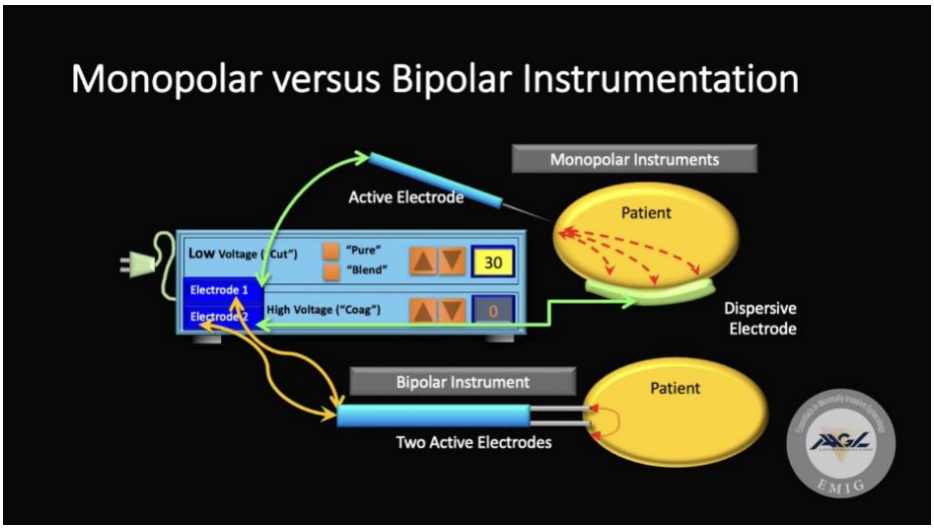
# Module 4: Energy Sources

4.1 Electrosurgical Principles
Electrocautery vs Electrosurgery
- Cautery: passive transfer of heat to tissue
- Surgery: electrical current applied to tissue > tissue desiccation and thermal injury

Electrical Physics
- Current = voltage / resistance (aka impedance)
- Power = voltage * current
- Impedance (R) is increased by tissue characteristics
    - Inherent ie fat vs muscle
    - Acquired ie scarring

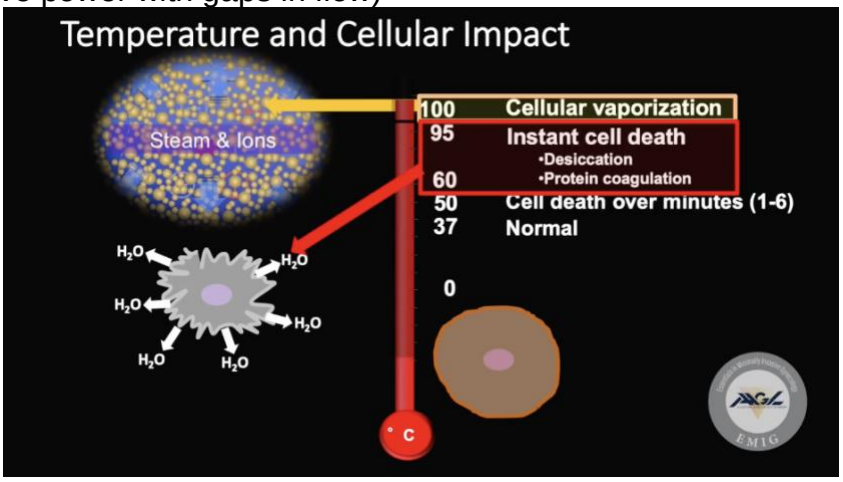
Constant (DC) vs Alternating Polarity
- Constant polarity circuit = direct current; unidirectional electron flow because polarity is fixed (ie battery)
- Alternating polarity circuit = alternating current; no net electron flow, just bidirectional electron movement back and forth (ie bipolar and monopolar energy)

Monopolar vs Bipolar Instrumentation
- Monopolar: active electrode + dispersive electrode (ie grounding pad); more dispersion through patient
- Bipolar: active electrodes only; less dispersion through patient




Waveforms

- Cut = low voltage waveform, continuous
- Coag = high voltage waveform, intermittent with gaps in flow (need high voltage to preserve power with gaps in flow)

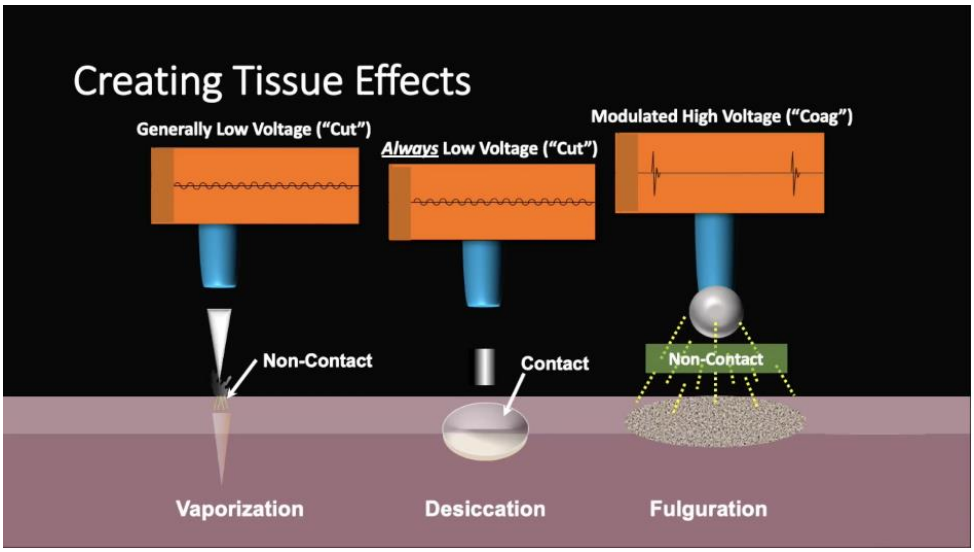



-

Creating Tissue Effects

- Vaporization via low voltage "cut" and non-contact with tissue (ie hover directly above tissue surface)
- Fulguration via high voltage "coag" and non contact with tissue (ie arc the current, held further away, can see the current or spark) useful for obtaining hemostasis over wider area
- Desiccation via low voltage "cut" and contact direct with tissue, this is a slower process of superficial heating that produces a char

*Non contact techniques = vaporization via cut and fulguration via coag*
*Contact technique = desiccation via cut*

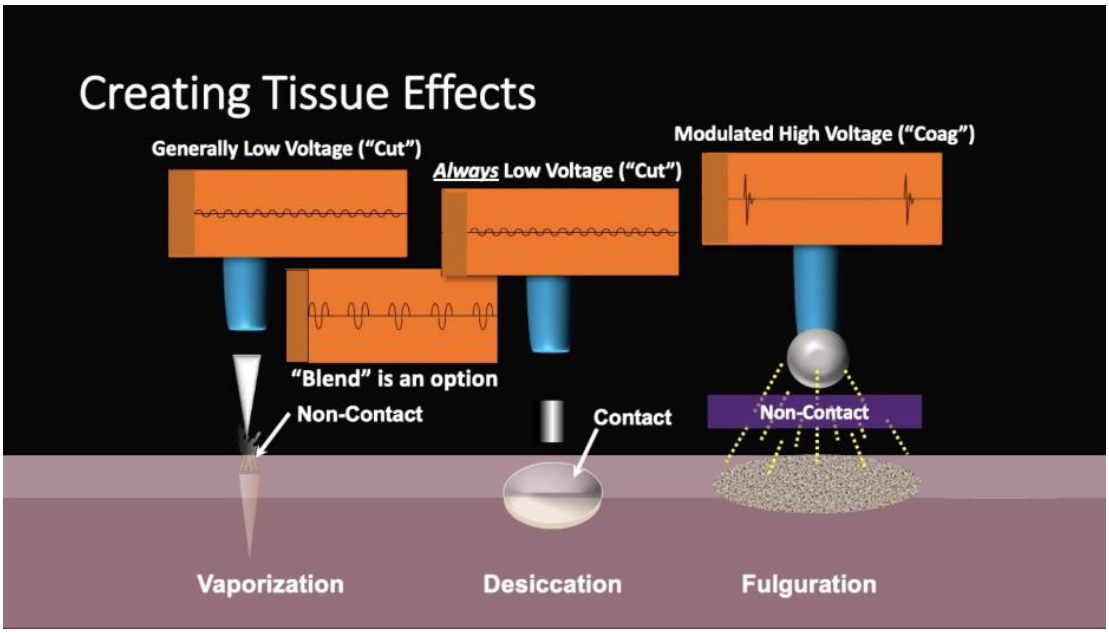



Radiofrequency alternating current causes intracellular ions and proteins to rapidly oscillate in the tissue that exists between two electrodes. The type of electrosurgery described by this circuit is:

**A. Electrosurgery with bipolar instruments**
**B. Electrosurgery with monopolar instruments**
**C. Electrosurgery with both bipolar and monopolar instruments**
**D. Description is an incorrect depiction of electrosurgery**

4.2 Effect of Electrosurgery on Tissue

- Current Density
  - Power density = area of electrode near/in contact with tissue
  - Blade electrode
    - Tip (narrow electrode) = high power density, less dispersion, **tissue vaporized**
    - Side (wide electrode) = medium power density, more dispersion, **tissue desiccated**
- Vaporization = low voltage, narrow electrode, non contact approx 1mm from tissue
- Desiccation = low voltage, wider electrode, contact with tissue
- Fulguration = modulated (intermittent) high voltage, non contact yet penetrates tissue approx 0.5mm depth




Linear vaporization ie cutting

- Can increase zone of thermal injury ie lateral thermal spread by increasing the voltage
- Other factors: electrode thickness, electrode speed, tissue impedance

Tissue Desiccation and Coagulation

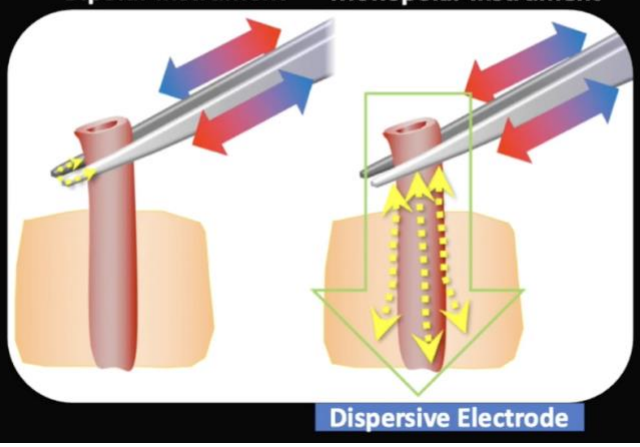
- Desiccation (cut) for large vessels
- Fulguration (coag) for small vessels ie oozing capillaries

Vessel Seal

- Ideal coapative coagulation with low voltage continuous output ie CUT
- Non ideal is high voltage intermittent current ie COAG
- Bipolar vs monopolar
    - Monopolar with more collateral spread between monopolar instrument and dispersive electrode

## Vessel Seal

Each jaw is a separate electrode




Both jaws are part of one electrode

## Summary

| | Low Voltage ("Cut"/"Blend" | High Voltage ("Coag") |
|---|---|---|
| CONTACT | (Desiccation/Coagulation) Deep Hemostasis Wide Electrode | (Desi…on/Co…lation/ …ar…izatio Inco…plete …stasis |
| NON-CONTACT | (Vaporization) Focal or Linear Vaporization (Cutting) Narrow Electrode | (Desiccation/Coagulation/ Carbonization) Fulguration = Superficial Hemostasis |

A laparoscopic excision of endometriosis is being performed using a monopolar instrument. During the surgery, a 2 mm vessel is encountered. The best means to achieve hemostasis is:

**A. Grasp and compress vessel, then activate "coag" waveform**
**B. Grasp and compress vessel, then activate "cut" waveform**
**C. Spray fulgurate using non-contact "coag" waveform**
**D. Use non-contact "cut" waveform**

4.3 Bipolar Electrosurgery

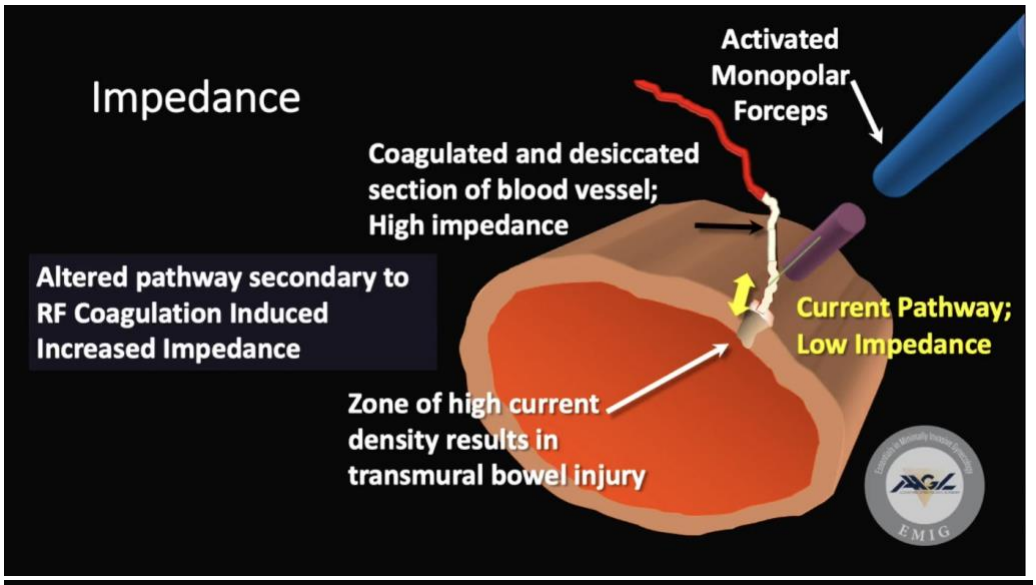
- All bipolar instruments use cutting (low voltage continuous waveform) to seal vessels
- Proprietary devices
    - Sensor determines coagulation/desiccation endpoint (impedance, temperature)
    - Transection mechanism
- Lateral thermal injury
    - Lateral current pathway
    - Convection (steam/water/vapor)
    - Conduction (direct contact)
- Suboptimal compression leads to greater degree of lateral thermal spread
- All devices 1-3mm of lateral spread
- Devices approved to seal vessels up to 7mm in diameter

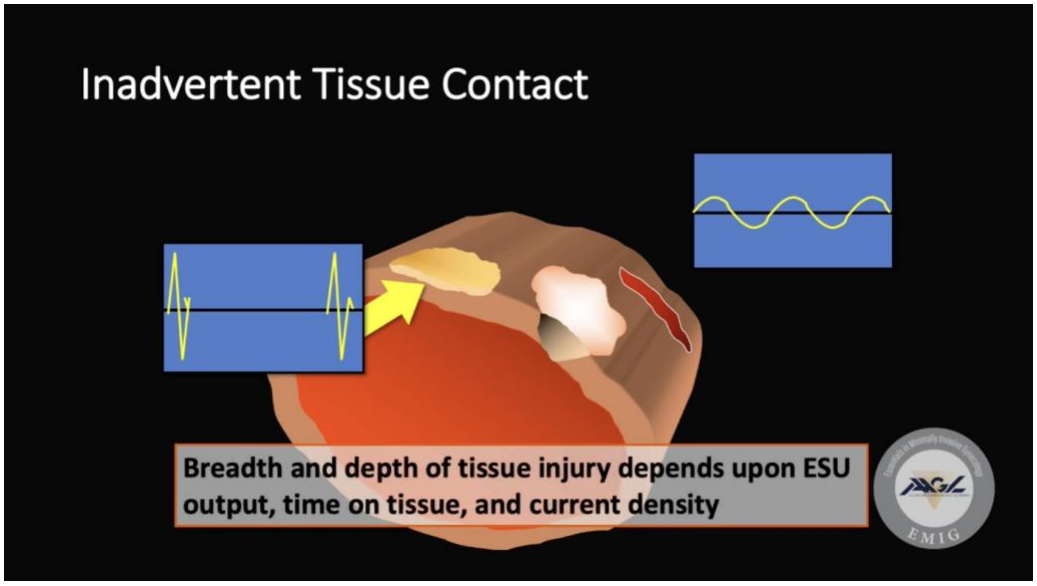
Bipolar electrosurgical devices used for sealing vessels and hemostasis use:

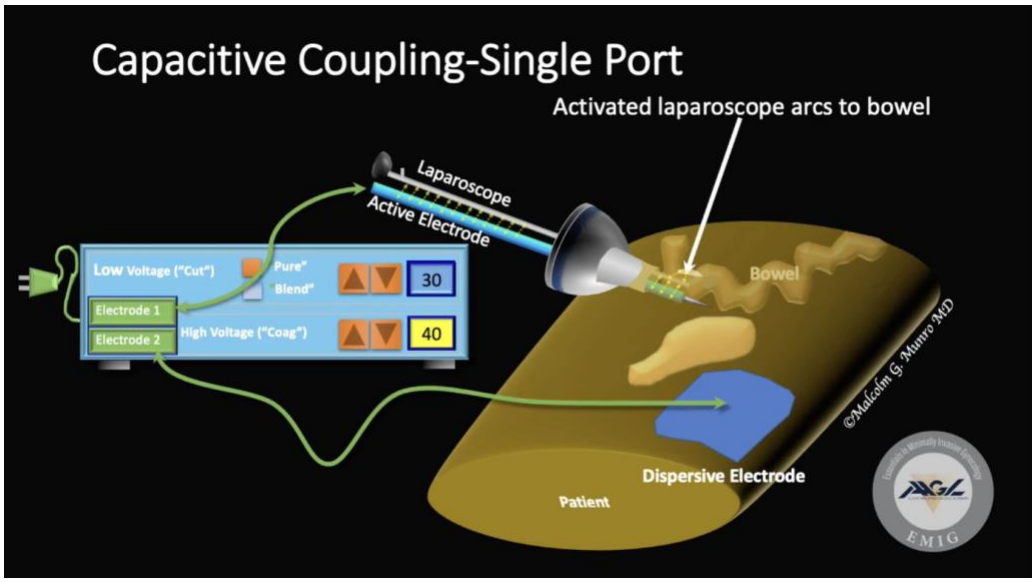
**A. Blend mode**
**B. Coagulation waveform**
**C. Cutting waveform**
**D. Different bipolar instruments use different modes**

4.4 Electrosurgical Complications

- Radiofrequency electrosurgical injury typically present 4-10 days post op
- Mechanisms injury:

- Direct extension
- Inadvertent tissue contact
- Current diversion: direct coupling, capacitative coupling, insulation failure
    - Capacitative coupling increased risk if: monopolar, modulated high voltage waveform ie COAG, open circuit activation, instrument to cannula diameter, single port surgery
- Dispersive electrode injury
- 

- 




- Summary:
  - Use lowest power setting for desired surgical effect
  - Low voltage CUT waveform preferred
  - High collate COAG waveform only for fulguration
  - Audible activation
  - Tip of electrosurgical device in view
  - Avoid unintended contact with other instruments

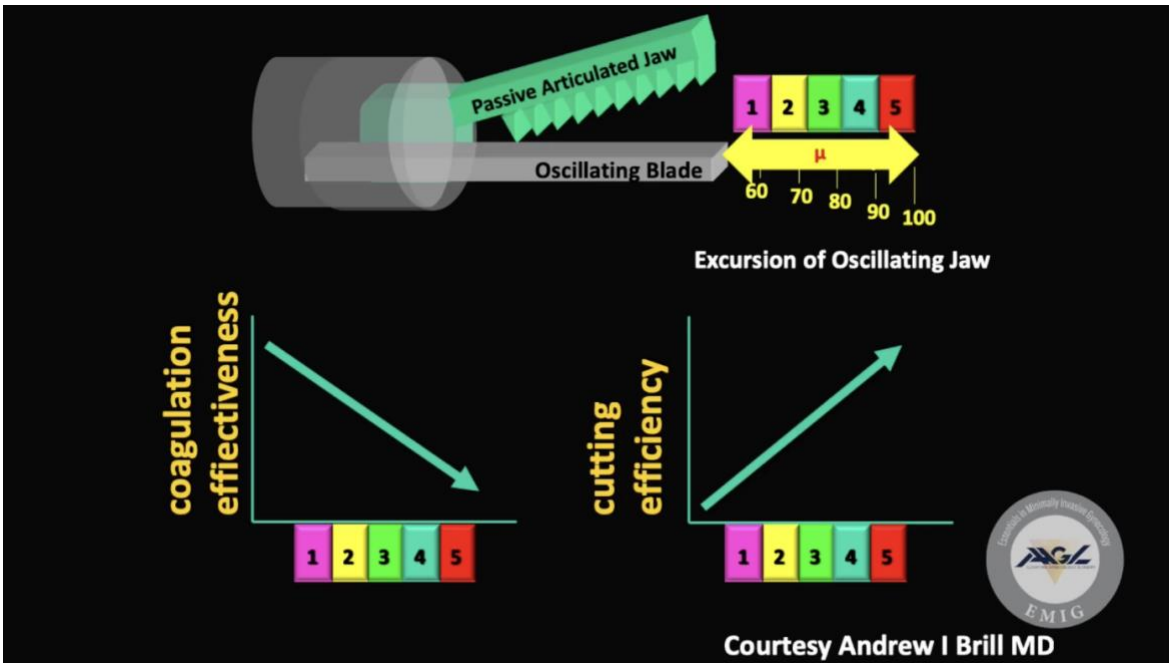
In electrosurgery, bipolar devices are at risk for:

**A. Capacitive coupling**
**B. Direct coupling**
**C. Indirect coupling**
**D. Lateral thermal injury**

4.5 Ultrasonic Technology

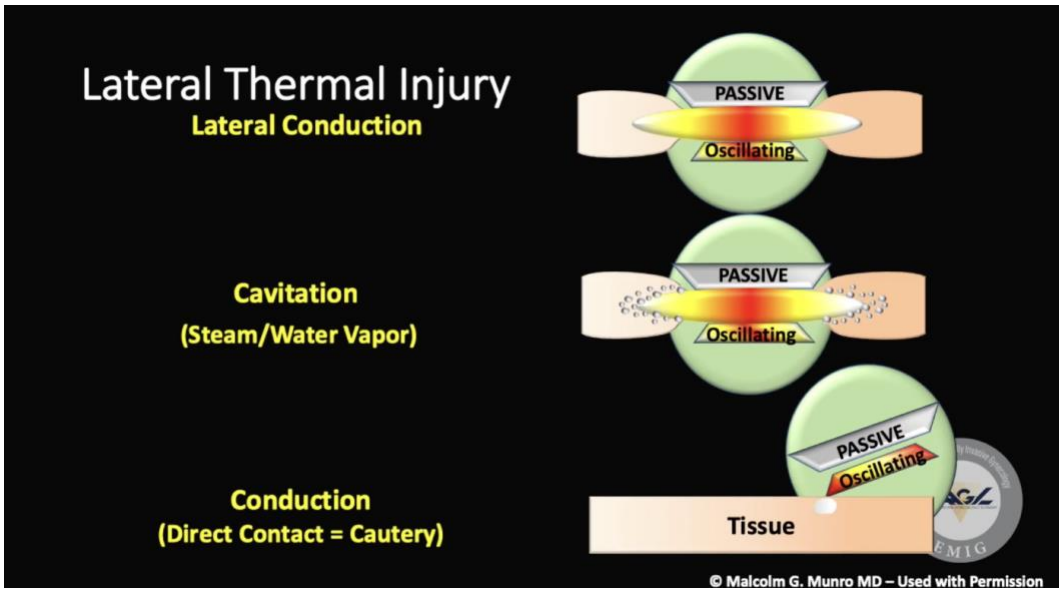
- Comparison of US to radiofrequency instruments: no electrical current running through patient, no risk of current diversion, still have risk of thermal injury

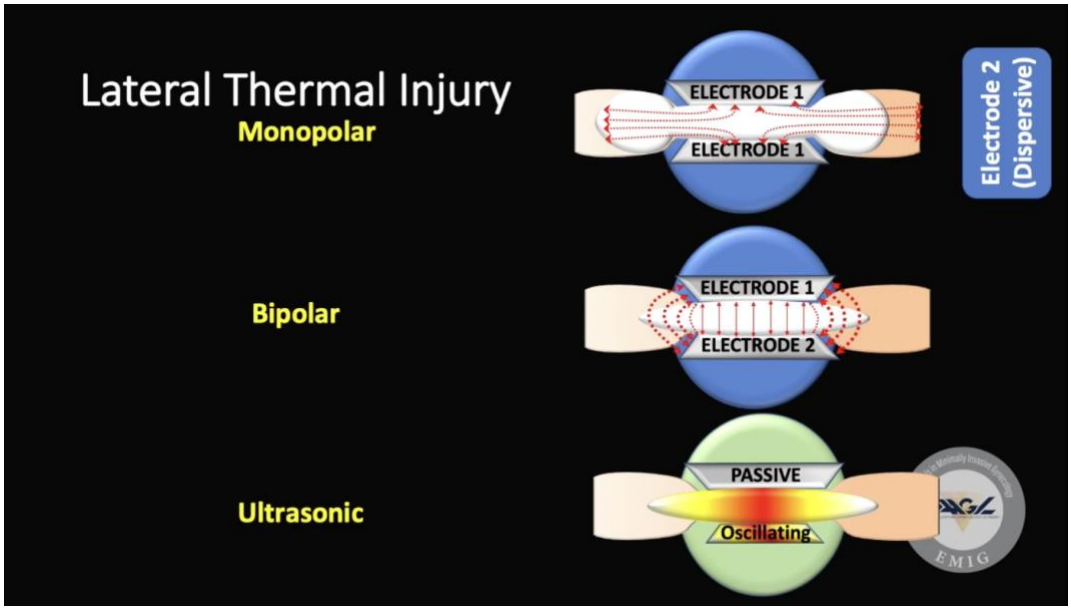
- Converts alternating current to mechanical vibration; oscillating blade 55,500 Hertz, blade oscillates 50-100 microns




- Cutting effectiveness
    - Narrow blade
    - Maximum blade excursion
    - Increase tissue tension
- Coagulation effectiveness
    - Wide blade
    - Minimum blade excursion
    - Reduce tissue tension
- Lateral thermal injury

-


Lateral Thermal Injury
Lateral Conduction
PASSIVE
Oscillating
Cavitation
(Steam/Water Vapor)
PASSIVE
Oscillating
PASSIVE
Oscillating
Conduction
(Direct Contact = Cautery)
Tissue
© Malcolm G. Munro MD – Used with Permission


Lateral Thermal Injury
Monopolar
ELECTRODE 1
ELECTRODE 1
Electrode 2
(Dispersive)
Bipolar
ELECTRODE 1
ELECTRODE 2
Ultrasonic
PASSIVE
Oscillating

## Ultrasonic and Radiofrequency Instruments

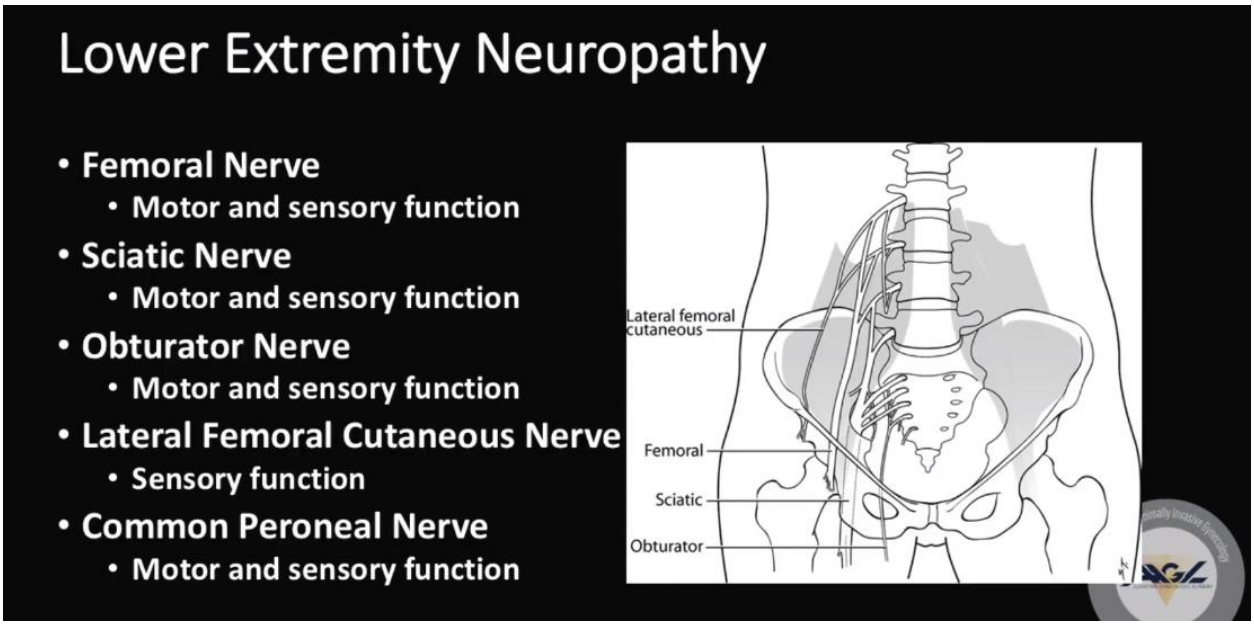
| Characteristic | Ultrasonic Shears | RF Bipolar Clamp | RF Monopolar Forceps |
|---|---|---|---|
| Lateral Thermal Spread | Varies: ~ 2mm | Varies: ~ 2mm | Varies: May be >> 2 mm |
| Smoke generation | Minimal | Minimal to moderate | Moderate to substantial |
| Retained Heat | Long duration | Short duration | Short duration |
| Maximum Vessel Diameter | Up to 7 mm Depends on Device | Up to 7 mm with most devices | No available data |
| Current Diversion | | | |
| Insulation Break | - | - | + |
| Direct Coupling | - | - | + |
| Capacitive Coupling | - | - | + |

When using ultrasonic surgical instruments, the following is not true:

A. **Capacitive coupling does not occur**
B. **Current diversion does not occur**
C. **Device cools more rapidly than radiofrequency instruments**
D. **Extent of lateral thermal injury similar to most bipolar sealing devices**

# Module 5: Operating Room Setup and Patient Positioning

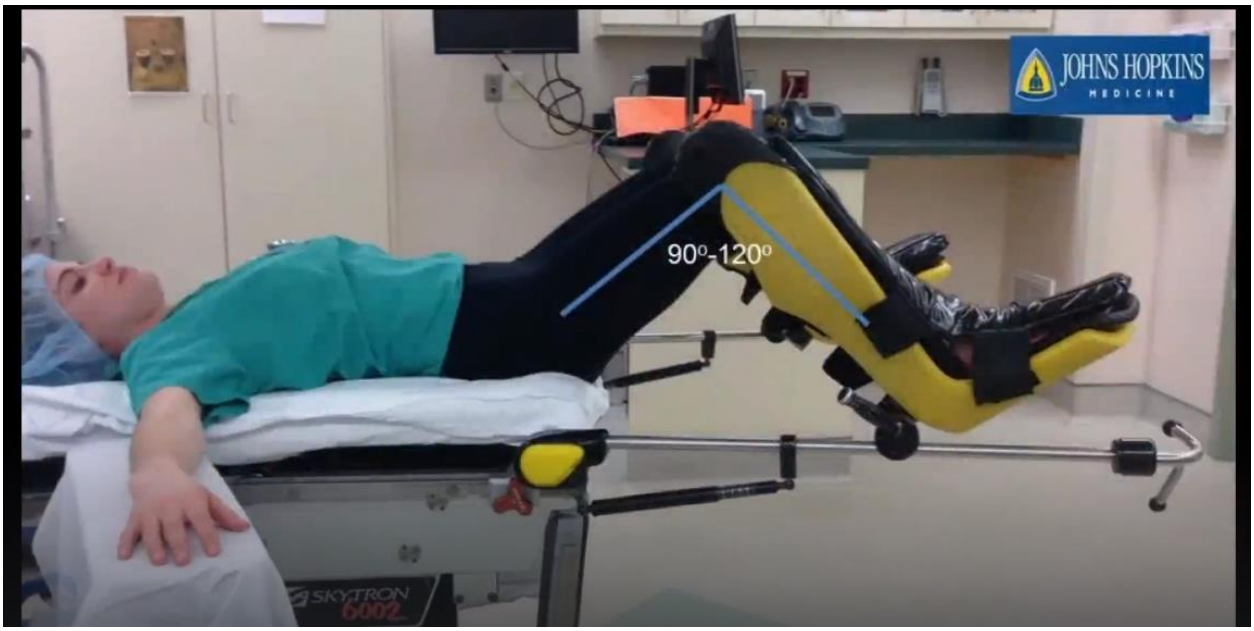
5.1 Safe Patient Positioning



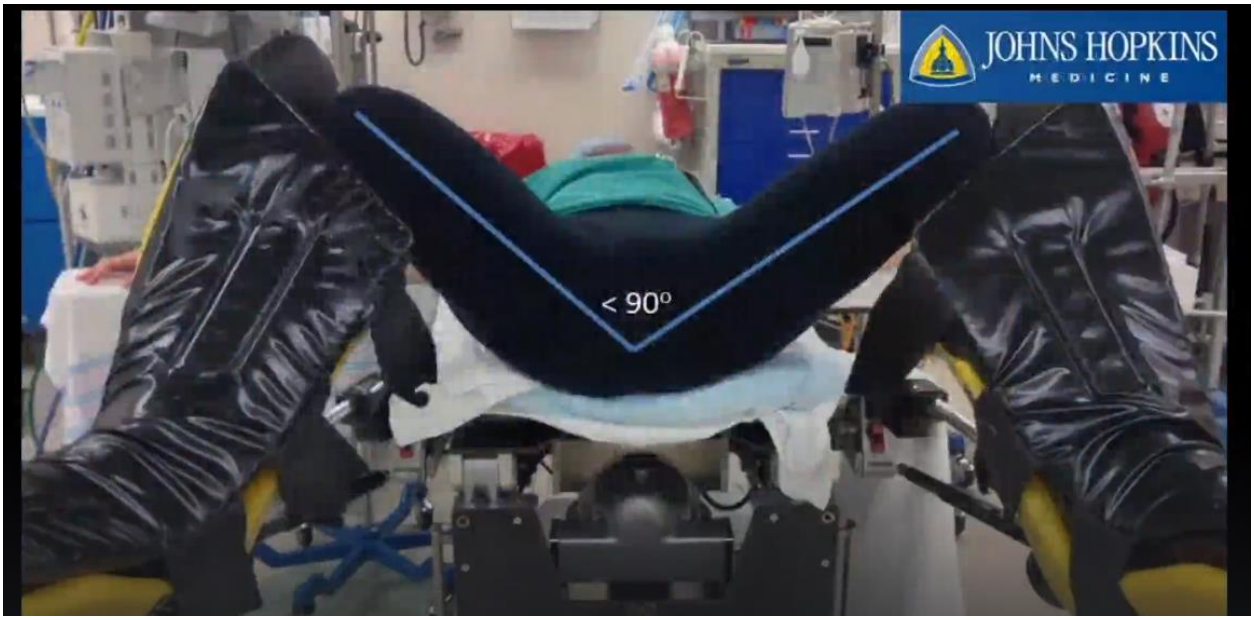

Lower Extremity Neuropathy from Nerve Injury

- Excessive hip flexion, abduction, and external rotation
    - Femoral nerve: most common iatrogenic nerve injury in gynecologic surgery
        - Injury → impaired knee extension + sensation to anterior thigh and medial calf
    - Lateral femoral cutaneous nerve: injury → numbness or pain on proximal lateral aspect of thigh
- Abduction and external rotation
    - Sciatic nerve: injury → numbness over calf and dorsal/lateral aspect of foot + inability to flex knee + foot drop
- Prolonged hip flexion and abduction
    - Obturator nerve: injury → loss of sensation of medial aspect of thigh, weakness with thigh adduction
- Direct pressure on lateral aspect of knee and prolonged knee flexion
    - Common peroneal nerve: numbness along lateral and anterior aspect of leg + foot drop
- Boots vs candy canes:
    - Boots decrease risk of neurologic injury, easily adjustable, minimize pressure on calf and improve support of lower extremity while allowing for increased control of degree of abduction and rotation of hips and knees
- Knee, umbilicus and CL shoulder should be in one line
- Hips should be in line with fulcrum of stirrups, should not be flexed more acutely than 60 degrees or more obtuse than 170 degrees.


- Knee flexion should range from 90-120 degrees




- Hip abduction should be less than 90 degrees

- 


Upper Extremity Neuropathy from Nerve Injury

- Higher with outstretched arms or steep trendelenburg
- Brachial plexus injuries can result in sensory deficits along medial aspect of arm, forearm and hand. Upper portion injury → Erbs palsy. Lower portion → Clumpke's paralysis/Horner syndrome
- Tuck arms at patients side with thumb pointed up

Steep Trendelenburg Positioning

- Shoulder braces should be used with caution, can increase brachial plexus injury
- Chest strap can compromise ventilation if too tight

A 47 year old G3P3 is undergoing total laparoscopic hysterectomy for treatment of leiomyoma. She is placed in the dorsal lithotomy position. Safe anatomical positioning demonstrated in this image is:

A. Arm positioning
B. Foot support
C. Hip rotation
D. Shoulder position
E. Use of foam

5.2: Surgeon Ergonomics

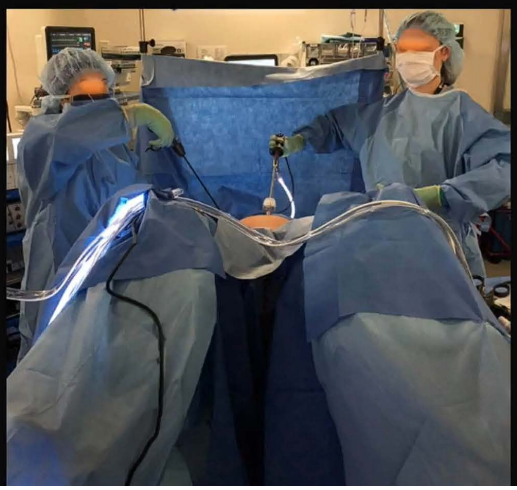
Upper Extremity Ergonomics: shoulders elevated, arms by side, elbow 90 degree, instrument below elbow level

Spine Ergonomics: avoid rotation, avoid extension, neck flexion 15 degrees

Lower extremity ergonomics: flat feet, hips level

A 47 year old G3P3 is undergoing total laparoscopic hysterectomy for treatment of leiomyoma. Incorrect ergonomic stance for the surgeon and the first assistant demonstrated in this image is:

A. Neck extension
B. Spine rotation
C. Uneven hips
D. Upper extremity elevation



# Module 6: Principles Operative Laparoscopy

6.1 Entry Insufflation Pressure

- Double click test
  - @Umbilica entry, 1. Fascia, 2. Peritoneum
  - LUQ (3 clicks), 1 Anterior fascia, 2. Posterior fascia, 3. Peritoneum
- Saline aspiration or injection
  - Aspirate-see blood, fecal matter, nothing
  - Injection-no flow/high resistance indicates pre-peritoneal or adhesive disease vs. minimal or no resistance indicates proper placement
- Hanging drop test
- Intraabdominal pressure
  - Normal pressure is 0-7mmHg
  - If >10, pull it out, improper location
  - Want it to be <10mm Hg
- Most accurate-intrabdominal pressure (test with highest sensitivity)

A 42 year old G3P3 with desire for permanent sterilization presents for laparoscopic salpingectomy. She has no prior abdominal or pelvic surgeries. During Veress needle entry, the most predictive test of proper initial placement is:

**A. "double click" test**
**B. Hanging drop test**
**C. Intraabdominal pressure <10 mmHg**
**D. Saline aspiration through Veress needle**

6.2 Laparoscopic Primary Entry

- Umbilical entry-thinnest aspect of abdominal wall, preferred
  - Relative contraindications
    - § Periumbilical adhesions
    - § Extremes of weight
    - § 2T of pregnancy
    - § Umbilical hernia
    - § Pelvic mass
- Peritoneal access
  - Closed approach (direct entry to make pneumoperitoneum with needle or trocar)

        - § Visual-utilizes laparoscope within optical trocar
            - · See layers of abd wallSkin-subcutaneous-fascia-peritoneum/fat-intraperitoneal
        - § Blind-direct entry without optical trocar
            - · Veress needle
    - Open technique- dissect layers of abd wall
        - § Hassan technique
            - · See video (~10min45sec)
            - · Curved straight, S retractors, stats to grab fascia
    - Best technique-that one preferred by the surgeon

A 23 year old G1P0 with known ectopic pregnancy is scheduled to undergo laparoscopic salpingostomy. The safest entry technique is:

**A. Direct trocar**
**B. Hasson**
**C. Optical trocar**
**D. Veress insufflation followed by direct trocar**
**E. Technique preferred by surgeon**

6.3 Laparoscopic Alternative Primary Entry

- Entry points
    - Umbilicus
    - LUQ-Palmer's point
        - § Left mid-clavicular line, 3cm below inferior costal margin
        - § Entered closed or open
        - § Indications
            - · Periumbilical adhesions (ie prior vertical midline laparotomy or pts with h/o multiple laparoscopy with umbilical entry)
            - · Hernia repair with mesh
            - · Failed umbilical entry
            - · Extreme obesity
            - · Pregnancy
        - § Contraindications (due to risk of underlying structures)
            - · Bariatric surgery
            - · Splenectomy

- Hepatosplenomegaly
- Portal HTN
- Upper abdominal adhesions

- Posterior vaginal fornix
  - § Avoid in obliterated posterior cul de sac or if mass suspected in posterior cul de sac
- Transuterine
  - § Not used often, limited data

A 43 year old G3P3 presents with a history of abdominal hysterectomy performed through a vertical midline laparotomy for treatment of uterine leiomyoma. She is now scheduled for a laparoscopic excision of an 8 cm mature ovarian teratoma. The safest location for abdominal entry is:

**A. Hasson at umbilicus**

**B. Optical trocar at umbilicus**

**C. Veress insufflation at Palmer's point followed by direct trocar**

**D. Veress insufflation at umbilicus followed by direct trocar**

**E. Veress insufflation at posterior vaginal fornix**

6.4 Laparoscopic Primary Entry Complications

- Overall rate ~5%
  - 25% are not recognized intra-op
  - 1/3 of injuries occur at time of initial abdominal entry
- Incidence of injury at time of entry: 0.3%
  - Potential sites: bladder, bowel, major vasculature, abdominal wall vessels
- Risk factors
  - Adhesions!! (intra-abdominal), Gyn path (PID, endometriosis, large fibroids, adnexal masses), Obesity (umbilicus can be lower than the bifurcation of the great vessels—can enter with Veress in more vertical angle (90 degree) (30 degree angle for Veress entry mostly preferred in normal weight)
- Frequency of umbilical adhesions with prior surgical history:
  - None: 0.68%
  - Laparoscopy: 1.6%
  - Low transverse incision: 19.8%
  - Vertical Midline Incision: 51.7%

A 35 year old G2P2 is seen in the Emergency Room with suspected ovarian torsion. Laparoscopic exploration is recommended. The patient had a prior vertical midline incision for her last cesarean section. The likelihood of encountering abdominal wall adhesions during laparoscopic entry is:

**A. <1%**

**B. 1-5%**

**C. 10-20%**

**D. 30-40%**

**E. >50%**

6.5 Fascial Closure during Laparoscopy

- Trocar site hernia incidence: 0.21-3.2%
    - 20% occur despite fascial closure
- When compared to laparotomy (5 year incidence of 12%), risk of hernia is lower in laparoscopy (5 year incidence of 3.2%)
- Risks for trocar site hernia
    - Trocar size and type
    - Close all port sites 10mm or greater
    - Blading vs dilating (create smaller defects) trocars
    - Tissue extraction site (incidence of 7%)
    - Medical comorbidities (obesity, increasing age, surgical site infection)
    - Surgical factors: trocar replacement, excessive traction

A 27 year old G0 is undergoing excision of endometriosis through a minimally invasive approach. After completion of the surgery fascial closure of the port sites is considered. Laparoscopic port sites not requiring fascial closure include:

**A. 8 mm robotic trocar**

**B. 10 mm umbilical Hasson trocar**

**C. 12 mm umbilical cutting trocar**

**D. 15 mm left lower quadrant dilating trocar**

6.6 Safety in Lateral Port Placement

- Anterior Abdominal Wall Neuroanatomy
  - Iliohypogastric and ilioinguinal nerve
    - § Injuries can cause searing nerve pain in lower abdomen and groin that radiates to the vulva
  - To avoid nerve injury, place above ASIS
  - Inferior epigastric vessels (MEDIAL to the round, Lateral to the medial umbilical ligament)
    - § Originate from external iliac
    - § Can be located immediately medial to the round ligament at the inguinal canal
    - § Medial umbilical ligament = obliterated umbilical artery, inferior epigastric lateral to these
    - § To avoid injury-lateral ports should be placed within 4cm of the midline OR more than 8 cm from the midline

A 27 year old G0 is undergoing excision of endometriosis through a minimally invasive approach. An injury to the inferior epigastric artery occurs during placement of a left lower quadrant trocar. In relationship to the medial umbilical ligament, the trocar was most likely placed:

**A. Inferior**
**B. Laterally**
**C. Medially**
**D. Superior**
**E. Through**

6.7 Port Placement with Extremes of BMI

- Low BMI-Veress at 30° angle for entry
    - Umbilicus lies 4mm caudad to the bifurcation of the aorta
- As BMI rises, weight of abdominal wall pulls umbilicus inferiorly
    - Angle of insertion should be 45° from the axis of the patient
    - Obese pt, 90° from axis of the OR table (primary entry for Veress)
- Palmer's point can be used in obese patients
- Accessory trocars
    - Longer trocars for obese patients
    - Trocars with fixation devices (balloon tip)
    - Angle of trocar placement!!-perpendicular to contour of insufflated abdomen
        - § Don't want to track, want trocar to move freely

A 27 year old G0 is undergoing laparoscopic excision of endometriosis. Her BMI is 36 $kg/m^2$. The preferred angle of entry with a Veress needle is:

**A. 0 degrees from the axis of the operating room table**
**B. 30 degrees from the axis of the operating room table**
**C. 45 degrees from the axis of the operating room table**
**D. 60 degrees from the axis of the operating room table**
**E. 90 degrees from the axis of the operating room table**

6.8 Port placement with prior Laparotomy

- Abdominal entry
  - Umbilicus is most frequent primary entry site
    - § Thinnest area of abdominal wall
    - § Shortest distance into abdominal cavity
  - High risk umbilical entry
    - § Prior abdominal surgery
    - § History of peritonitis
    - § PID
    - § Endometriosis
    - § Umbilical hernia repair (with or without mesh)
  - Alternative entry sites
    - § LUQ
    - § Subxiphoid
    - § Trans uterine or trans cul de sac insufflation
  - LUQ (Palmer's)
    - § 3cm below left costal margin, midclavicular line
    - § Need stomach decompression (OG or NG tube prior to trocar placement)
    - § Contraindications: hepatosplenomegaly, prior splenic surgery
  - Subxiphoid
    - § 3cm below xiphoid process
    - § Need stomach decompression
    - § CI: hepatosplenomegaly
  - Trans uterine Insufflation
    - § Veress needle inserted through uterine fundus (avoid uterine vessels)
    - § Need steep Trendelenburg (to reduce risk of bowel injury)
    - § CI: Stage 3 or 4 endometriosis, uterine fibroids, known adnexal mass
  - Trans cul de sac Insufflation
    - § Veress needle through posterior vaginal fornix
    - § Need steep Trendelenburg
    - § CI: Advanced endometriosis, fibroids, known adnexal mass

A 50 year old G3P3 sees you for preoperative consultation for a hysterectomy. She has a history of small bowel resection via vertical midline laparotomy. She desires a minimally invasive surgery. The safest location to place the primary trocar is:

**A. Left upper quadrant**
**B. Not a candidate for laparoscopy**
**C. Right upper quadrant**
**D. Suprapubic**
**E. Umbilicus**

6.9 Laparoscopic Tissue Extraction

- Morcellation (electromechanical or power morcellator)
  - Can cause injury to nearby structures/surrounding viscera
  - Keep blade in place, always under direct laparoscopic guidance
  - Occult malignancy
    - § Dissemination of tissue
    - § Upstaging disease
    - § Concern especially with leiomyosarcoma (risk increased with older age)
  - Benign disease
    - § Dissemination of tissue
    - § Parasitic leiomyomatosis, endometriosis
  - Impair pathologic evaluation
- To decrease risk associated with morcellation
  - Pre op eval, history and physical
  - Update Embx, pap smear, imaging
  - Avoid morcellation in menopausal women
  - Surgical technique (contained vs uncontained)
- See video of morcellation!! (52:51)
  - Electromechanical morcellation in endobag

A 45 year old G3P3 presents with an 7 cm fundal fibroid and heavy vaginal bleeding. She has failed medical management and desires to proceed with laparoscopic hysterectomy. The risks of morcellation that must be discussed with the patient include all of the following *except*:

**A. Development of parasitic leiomyomatosis**
**B. Difficulty with pathologic evaluation**
**C. Increased risk of laparotomy**
**D. Injury to surrounding structures**
**E. Upstaging occult malignancy**

6.10 Needle and Suture selection for laparoscopic suturing

- Suture selection
  - Tensile strength, ease in handling, knot security, tissue reactivity, resist infection
- Suture material
  - Absorbable: plain gut, chromic gut, polyglactin etc.
    - Loss of tensile strength varies, and amount of time until absorbed
  - Suture absorption rates can increase in patients with fever, infection, or protein deficiency
  - Non absorbable: silk, nylon, polypropylene
  - Natural: silk, chromic>>>superior knot strength when compared to synthetic
  - Synthetic sutures (polyglactin, polydioxanone, poliglecaprone) cause less of an inflammatory reaction compared to natural sutures
  - Monofilament suture-increased suture memory, increased resistance to infection
    - Can make suture handling more difficult
  - Braided-more pliable and easier to use, associated with increased risk of infection
  - Barbed suture-no knots, high tensile strength (polydioxanone)
  - Larger gauge suture is associated with increased tensile strength and is preferred for tissue under greater tension including
    - Fascia (0 or 1)
    - vaginal cuff (0 or 2-0)
    - Uterus
  - Medium gauge suture: Bowel (2-0)
  - Small gauge for skin closure (4-0)
  - Length of suture
    - Extracorporeal suturing, >/=70cm

§ Interrupted-shorter sutures

- Needle tip
  - § Cutting or Reverse cutting
  - § Taper (soft tissue)
- Best suture to close vaginal cuff: 0 polyglactin (absorbable and has good tensile strength)

## Absorbable Suture Material

| Suture | 50% Loss of Tensile Strength (Days) | 100% Loss of Tensile Strength (Days) | 100% Mass Absorption (Days) |
|---|---|---|---|
| Plain Gut | 3-5 | 14-21 | 70 |
| Chromic Gut | 7-10 | 14-21 | 90-120 |
| Poliglecaprone | 7 | 21 | 91-119 |
| Polylycomer | 14-21 | 28 | 90-110 |
| Polyglactin | 21 | 28 | 56-70 |
| Polydioxanone | 28-42 | 90 | 183-238 |
| Barbed Polydioxanone | 28-42 | 90 | 180 |

A 50 year old G2P2 with a fibroid uterus is undergoing a total laparoscopic hysterectomy. The most appropriate suture to close the vaginal cuff is:

**A. 0 chromic**
**B. 0 polyglactin**
**C. 0 polypropylene**
**D. 0 silk**

6.11 Risk for Adhesions following Laparoscopy

- Adhesions-abnormal fibrous attachments
  - Coaptation of traumatized mesothelial surfaces
- Consequences include infertility, intestinal obstruction, chronic pain, surgery complexity and risk

- Adhesion formation: surgery, inflammation/infection, radiation
- Adhesion formation
    - Peritoneal damagebleeding and inflammationfibrinogenfibrin matrixmigration of fibroblasts and development of collagenadhesions
- Prevention
    - Minimize tissue drying (irrigation), avoid tissue manipulation, decrease duration of surgery
    - Meticulous hemostasis and use electrosurgery judiciously
    - Surgical field contamination, foreign body, post op infectionincrease likelihood of adhesion formation
    - Laparoscopy-adhesion prevention
        - § Decreased risk of tissue drying and contamination
        - § Pneumoperitoneum and magnification-more hemostasis
    - Barrier methods (3 FDA approved), reduce adhesion formation?
        - § Oxidized regenerated cellulose
        - § Icodextran 4% solution
        - § Modified hyaluronate caroboxymethylcellulose

A 32 year old G0 with a fibroid uterus is undergoing a laparoscopic myomectomy. The least effective strategy to decrease the likelihood of adhesion formation is:

**A. Liberal use of electrosurgery**
**B. Meticulous hemostasis**
**C. Minimal surgical duration**
**D. Minimal tissue drying**
**E. Minimal tissue manipulation**

# Module 7: Principles Operative Hysteroscopy

7.1 Complications and Dosing of Local Anesthetics

- Systemic toxicity of local anesthetics
    - Varying concentrations-influenced by dose, site of administration, method of delivery, degree of vascularity
    - Can lead to neurological and cardiac toxicity
- Neurologic toxicity

- Perioral numbness
- Metallic taste
- Mental status changes
- Visual changes
- Muscle twitching
- Seizures
- Respiratory depression

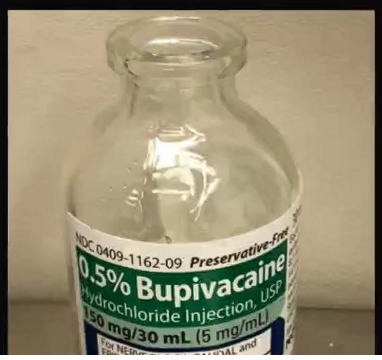
- Cardiac toxicity
  - Arrhythmia
  - Cardiac arrest
- Prevention
  - Avoid IV injection
    - § Draw back syringe to avoid injection into vessel
  - Use minimal dose
  - Maximum allowable dose VARIES!
    - § Anesthetic type
    - § And if with or without epinephrine
      - · With epinephrine>delayed vascular absorption
      - · Avoid epinephrine if area with limited blood supply (avoid necrosis)
  - Max local anesthetic dosing below (with and without epi)

## Maximum Local Anesthetic Dosing

| Anesthetic | Without Epinephrine (mg/kg) | With Epinephrine (mg/kg) | 70 kg Adult (with / without Epinephrine) |
|---|---|---|---|
| 2 % Lidocaine | 4.5 | 7 | 315 mg / 490 mg |
| 1.5% Mepivicaine | 5 | 7 | 350 mg / 490 mg |
| 0.5% Ropivacaine | 3 | 3.5 | 210 mg / 245 mg |
| 0.25% Bupivicaine | 2.5 | 3 | 175 mg / 210 mg |

The earliest symptom of bupivacaine toxicity is:

A. Cardiac arrest
B. Metallic taste
C. Muscle spasm
D. Seizure




7.2 Cervical Ripening

- Complications
  - Cervical tears
  - Creation of false cervical passage
  - Perforation
  - Bleeding
  - Inability to enter the uterine cavity
- Cervical prep
  - Prostaglandins
    - § Misoprostol
    - § Dinoprostone
  - Osmotic dilators
    - § Laminaria
  - Dilute Vasopressin (intracervical injection)

A 43 year old undergoes diagnostic hysteroscopy for evaluation of abnormal uterine bleeding. Upon insertion of the hysteroscope resistance is met at the cervix and despite multiple attempts the procedure is abandoned. The agent that can facilitate safe entry is:

A. Dilute Vasopressin
B. Dinoprostone
C. Misoprostol
D. Osmotic Dilators
E. All of the above

7.3 Hysteroscopy, Perforation on Entry

- Incidence
  - <1% of diagnostic hysteroscopy
  - ~1% with operative hysteroscopy
- Most common in fundal region or posterior and anterior walls of uterus
- False passage
- Risk factors
  - Cervical stenosis
  - Acute retroversion or anteversion
  - Distortion of uterine or cervical anatomy
  - PMP
- Diagnosis
  - Loss of adequate distension
  - Fluid deficit rapidly increases
  - Visualization of false passage/perf
  - Visualization of omentum/bowel
  - Bleeding
  - Within tissue sampling
- Expectant management if VSS, blunt instrument used, no electrosurgical energy, fundal location, no vascular or visceral injury concerns
- Surgical exploration (Laparotomy) if vitals unstable, electrosurgical energy used, lateral or cervical perforation, severe bleeding, suspected injury to nearby organs or vessels
- Prevention
  - Determine uterine position pre-op
  - Cervical prep agents
  - Treatment of vaginal atrophy
  - Visual guidance with hysteroscope
  - Use of U/S

During a operative hysteroscopy for polypectomy, uterine perforation occurs at the time of entry along the left lateral wall. Bleeding is noted within the uterine cavity. Her blood pressure is 78/46 and her heart rate is 130 bpm. The next step in management is:

**A. Complete the polypectomy**

**B. Perform a laparotomy**

**C. Transfer patient to post-anesthesia care unit**

**D. Utilize the bipolar hysteroscope to achieve hemostasis**

7.4 Hysteroscopy, Cervical Vasopressin Injection

- Vasoconstriction
  - Increased SVR
  - Increased MAP
- Benefits
  - Cervical dilation, decrease blood loss, decrease fluid absorption
- Risks
  - Hypertension, Bradycardia, Intra-op mortality
- Use lowest effect dose
  - Concentration between 0.1-0.2 U/mL
  - Avoid >1U/mL
  - <5U at a time
  - 5 units in 100 mL of NS
- Injection technique
  - Avoid IV injection, communicate with anesthesia, inject stroma of ectocervix

A patient is scheduled for hysteroscopic resection of a 3.5 cm submucosal fibroid. During surgical planning, use of a cervical injection of vasopressin is considered. A benefit of cervical vasopressin injection is:

**A. Decreased blood loss**

**B. Decreased cervical dilation**

**C. Increased absorption of distension fluid**

**D. Increased distension pressure**

7.5 Hysteroscopy: Types of Fluid for Monopolar and Bipolar Energy

- Fluid distension Media
- Resectoscope
  - Monopolar
    - § Require electrolyte poor distension fluid
      - 1.5% glycine
      - 3% sorbitol
      - 5% mannitol
        - Hypotonic
          - § Risks with fluid overload, electrolyte abnormalities, neurologic sequelae
          - § Lower fluid deficits allowed

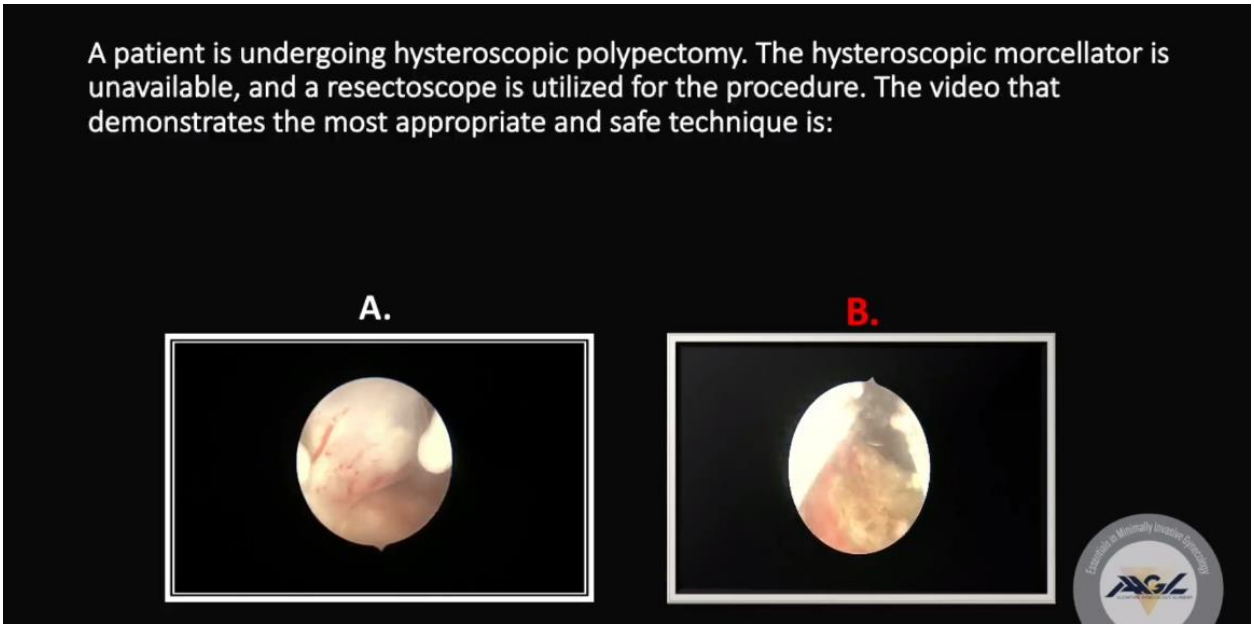
- Bipolar
  - § Electrolyte rich/containing fluid (isotonic)
    - · Worry about fluid overload
      - Normal saline
      - LR
    - · Higher fluid deficits permissible
- Fluid Deficits-When to stop the procedure
  - § Electrolyte poor fluid >1000mL
  - § Electrolyte rich >2500mL
  - § Individualize if comorbidity

During a hysteroscopic resection of a submucosal fibroid, a monopolar resectoscope is utilized. The appropriate distension fluid to use is:

**A. Dextran**
**B. Glycine**
**C. Lactated Ringers**
**D. Normal Saline**

7.6 Hysteroscopy: Safe Use of Resectoscope

- Techniques
  - Electrode should be observed at all times
  - Avoid advancement of active loop
  - Withdraw active loop over pathology
  - Avoid hysteroscope advancement with loop advanced
- Safe use
  - Use caution if resecting near cornua or where there was a prior cesarean scar (where myometrium is the thinnest
  - Can use U/S or laparoscopic guidance
- Cesarean scar-pre op imaging, isthmocele <3mm laparoscopic approach




# Module 8: Laparoscopic Procedures

8.1 Laparoscopic Adhesiolysis

- Adhesions most commonly include omentum or small bowel; less commonly large bowel
- Notice density, thickness and vascularity of the tissue
- Blunt dissection if avascular, thin filmy adhesions
- Sharp dissection (cold) if denser adhesions or near organs ie bowel
- If vascular adhesions:
    - Monopolar however monitor for arcing to surrounding structures
    - Bipolar however has most thermal spread, monitor proximity to surrounding structures
    - Ultrasonic energy however stays hot after use, avoid surrounding tissue until instrument is cool
    - Surgical clips or suture to ligate the vascular pedicles
- If cohesive adhesions
    - Abdominal wall - inspect for and avoid viscera, dissect along plane of adhesion closer to abdominal wall side rather than visceral organ side
    - Anterior cul de sac - start laterally, back fill bladder to identify borders bladder
    - Posterior cul de sac - start laterally, use EEA in rectum to identify borders colon

A 45 year old G1P2 with a history of Cesarean section via vertical midline skin incision, gastric bypass, and umbilical hernia repair requires adnexal surgery. She has dense adhesions involving small and large bowel. The safest approach to adhesiolysis is:

**A. Blunt dissection**
**B. Monopolar electrosurgery**
**C. Sharp dissection with laparoscopic scissors**
**D. Ultrasonic scalpel**

8.2 Laparoscopic Treatment of Ectopic Pregnancy

- Risk factors: h/o ectopic, FT damage, h/o tubal or pelvic surgery, ART, smoking (however 50% no risk factors!)
- Laparoscopic management: hemodynamic instability, ruptured ectopic, failed medical
    - Salpingectomy vs salpingostomy: no difference recurrent ectopic or subsequent IUP
    - Preferred salpingectomy if tubal damage or significant bleeding; appropriate if future fertility desires and contralateral tube is healthy appearing. Consider salpingostomy if the contralateral tube is damaged. If salpingostomy, trend bHcG post op.

A 26 year old G1 presents to the emergency department complaining of sudden onset of left lower quadrant pain, vaginal bleeding, and lightheadedness. She states her last menstrual period was 7 weeks ago and she had a positive urine pregnancy test. Pelvic ultrasound reveals a left sided adnexal mass and complex fluid in the cul de sac extending to the right upper quadrant. The most appropriate initial management is:

**A. Diagnostic laparoscopy**
**B. Methotrexate**
**C. Mifepristone and Misoprostol**
**D. Repeat ultrasound in 2 weeks**
**E. Serial quantitative hCG testing**

8.3 Laparoscopic Management of Adnexal Mass.

- Ovarian cystectomy whenever desire to leave functional ovary in place; ideally avoid cyst rupture. Intact technique: incise ovarian stroma with monopolar > extend incision > separate cyst from ovary with blunt or hydrodissection. If very large, consider controlled rupture prior
- Watch the videos!
- If ruptured cyst; remove entire cyst wall and maintain hemostasis. Ovary will heal by secondary intention!

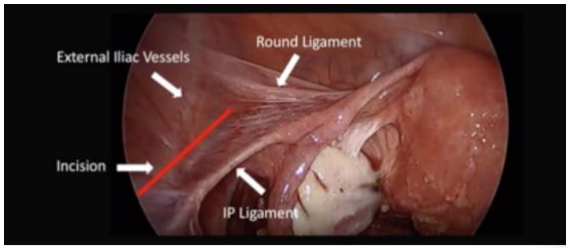
- Hemostasis:
    - If minor, hemostatic agents
    - If moderate, suture or electrosurgery
    - Oophorectomy ONLY if uncontrolled bleeding
- Cyst extraction via lap port, containment bag, controlled rupture etc

A 22 year old G0 is undergoing a laparoscopic ovarian cystectomy for treatment of a dermoid cyst. The least essential step of the procedure is:

A. Entire removal of cyst wall
B. Hemostasis of the cyst bed
C. Limited use of electrosurgery on the cyst bed
D. Ovarian reconstruction
E. Separation of the cyst from the ovary

8.4 Laparoscopic Oophorectomy

- Indications: benign neoplasms, risk reduction, torsion, TOA, cancer, gender dysphoria
- Technique: incise peritoneum lateral to IPL > identify ureter > lateralize ureter > create window between ureter and IPL > coagulate and transect IPL > coagulate and transect utero-ovarian ligament > remove ovary




- If retroperitoneal dissection: visualize ureter, identify iliac vessels, isolate IPL
- Watch videos!

- Risks: injury to ureter, vasculature; ovarian remnant syndrome

A 46 year old G3P2012 is undergoing laparoscopic oophorectomy for treatment of a 6.5 cm left ovarian endometrioma. During this procedure, the key surgical principle that should be followed is:

**A. Create a window under the ureter**
**B. Dissect the ureter medially**
**C. Identify the ureter retroperitoneally**
**D. Transect the IP ligament close to the ovary**

8.5 Ovarian Torsion

- Risk factors: reproductive age, mass > 5cm, pregnancy, ovulation induction, h/o torsion
- Presents w lower abd pain, pelvic mass, N/V, fever
- Clinical diagnosis, pelvic US, laparoscopy to confirm diagnosis
    - Surgery to assess ovary viability, cystectomy vs oophorectomy (if post menopausal or necrosis)
- Prevent via ovarian cyst suppression, oophoropexy

A 23 year old G0 presents with acute onset of left lower quadrant pain. Pelvic ultrasound shows a 6 cm left ovarian cyst consistent with a dermoid. Absent venous doppler flow is also seen and the patient is diagnosed with a possible ovarian torsion. The next best step is:

**A. Discharge with outpatient follow-up**
**B. Operative laparoscopy**
**C. Observation with serial examinations**
**D. Ultrasound-guided cyst drainage**

8.6 Myomectomy Complications

- Minimally invasive myomectomy: reduced pain, decreased fever, shorter hospitalization, pregnancy rates unchanged, recurrence rates unchanged, uterine rupture rates unchanged
- Surgical risks: hemorrhage, adhesive disease, infection, recurrence, uterine rupture
    - Hemorrhage most common complication, transfusions 28%, hysterectomy 4%, decrease risk via misoprostol, vasopressin or GnRh agonist
    - Adhesive disease: decrease risk via meticulous surgical technique with gentle handling tissues, running suture technique has fewer adhessions

A 39 year old G1 P0010 presents for laparoscopic myomectomy. Pelvic ultrasound shows a 27 week sized uterus with 3 dominant, type VI uterine leiomyoma. Pre-operative hemoglobin is 8 g/dL. Her greatest surgical risk is:

**A. Hemorrhage**

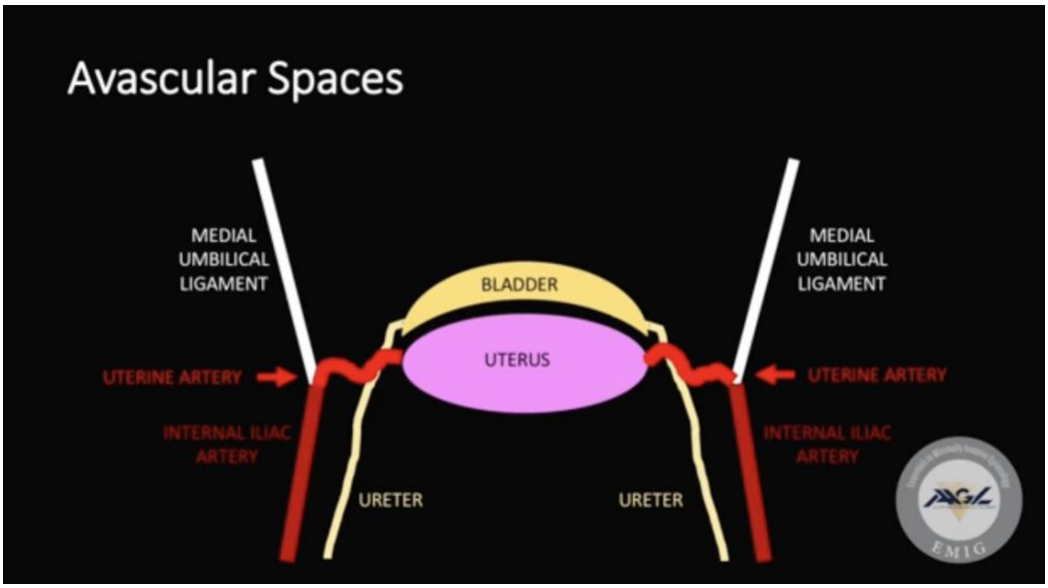
**B. Hysterectomy**

**C. Infection**

**D. Leiomyoma recurrence**

8.7 Ureteral Injury During Hysterectomy

- Rate of ureter injury 0.03-1.5%
- By location: vaginal cuff 71%, pelvic brim 29%
- Ureter identification is first step of hysterectomy! Visualize either transperitoneally or retro-peritoneally
    - If unable to visualize trans-peritoneally, dissect retroperitoneally but important to know paravesical space (medial border is ureter, lateral border is internal iliac artery)




A 75 year old G0 is undergoing a laparoscopic hysterectomy and bilateral salpingo-oophorectomy for treatment of endometrial hyperplasia. During the hysterectomy, the ureter is injured at the level of the vaginal fornix. The most likely surgical step to have caused the injury is:

**A. Broad ligament dissection**
**B. Infundibulopelvic ligament transection**
**C. Round ligament transection**
**D. Uterine artery transection**
**E. Vesicouterine fold development**

## 8.8 Supracervical Hysterectomy: Indications and Contraindications

- Contraindications: malignancy, h/o cervical dysplasia or endometrial hyperplasia
- Myths: prolapse, urinary incontinence, sexual satisfaction, surgical risk
- Risks: persistent bleeding, pain, additional surgery

- Benefits: decreased operative time, decreased blood loss, no cuff dehiscence

A 45 year old G0 is undergoing hysterectomy for treatment of uterine leiomyoma. Her medical history is significant for CIN2 on cervical biopsy one year prior. Your recommendation regarding supracervical versus total hysterectomy is:

**A. Supracervical hysterectomy to limit impact on sexual function**
**B. Supracervical hysterectomy to limit risk of prolapse**
**C. Supracervical hysterectomy to limit risk of urinary incontinence**
**D. Total hysterectomy based on history of cervical dysplasia**
**E. Total hysterectomy to limit risk of complication**

8.9 Endometrioma Treatment

- Operative management if symptomatic, desire optimizing fertility, enlarging
- Options: drainage, cyst wall fenestration, coagulation or ablation of cyst wall, ovarian cystectomy
- Cystectomy
    - Decreases recurrence, future surgery, dysmenorrhea, dyspareunia
    - Increases spontaneous pregnancy
- Post op: COCs, GnRH agonist/antagonist, progestins, LNG IUD

A 28 year old G0 presents with severe dysmenorrhea and worsening pelvic pain. Over the last 6 months, she has been treated with NSAIDs and continuous combination oral contraceptives. Pelvic ultrasound reveals a 6 cm right ovarian cyst consistent with an endometrioma. The best management option is:

**A. Hormonal suppression alone**
**B. Laparoscopic cyst drainage with cyst wall ablation**
**C. Laparoscopic ovarian cystectomy**
**D. Ultrasound-guided cyst drainage**

# Module 9: Hysteroscopic Procedures

9.1- AUB:

- Diagnosis:
    - Endometrial Biopsy: specificity 96-99%, sensitivity 83% (good positive predictive value, bad negative predictive value)
    - Dilation and Curettage: potentially therapeutic
    - Hysteroscopy Biopsy: highest sensitivity

A 72 year old postmenopausal patient presents with vaginal spotting for five days. A pelvic ultrasound was obtained by her primary care provider. The endometrial lining measures 8 mm. There is a focal lesion which measures 11 mm x 4 mm x 6 mm. The next best step in management is:

A. Blind dilation and curettage
B. Diagnostic hysteroscopy, possible operative hysteroscopy
C. Observation
D. Office endometrial biopsy
E. Pelvic MRI

9.2- Endometrial Ablation:

- Types:
  - Radiofrequency Electricity
  - Freezing
  - Heated Fluid
- Pre-Operative:
  - Evaluate: etiology, structure, histological
- Contraindications:
  - Cavity size, mullerian anomaly, pregnancy (can be associated with poor placentation, malpresentation, accreta, prematurity), uterine infections, hyperplasia/ malignancy
- Counseling:
  - Outcome, future fertility, contraception, procedure, risks, alternatives
    - Risks: cervical laceration, uterine perforation, thermal injury, fluid overload, infection (< 1%), pregnancy, post ablation tubal ligation syndrome, need for reliable contraception

A 46 year old underwent an endometrial ablation 1 year prior. She relies on tubal ligation for birth control. She complains of cyclic cramping pain and spotting. Pelvic ultrasound is shown below. The most likely cause of her symptoms is:

A. Adenomyosis
B. Endometritis
C. Endometrial ablation failure
D. Post-ablation tubal ligation syndrome


9.3- Myomectomy:

- Classification: ESGE (depth of penetration, angle of fibroid to uterine wall), Step W (largest diameter, topography, orientation within uterus)
- Type:
  - 0: within cavity (hysteroscopically removed)
  - 1: < 50% myometrial extension (hysteroscopically resect, GnRH agonist
  - 2: > 50% myometrial extension (hysteroscopy, alternative route)

A 32 year old presents with heavy menstrual bleeding and intermenstrual bleeding. Pelvic examination and imaging are consistent with a fibroid uterus. On hysteroscopy, a intracavitary, submucosal fibroid is identified. No other intracavitary lesions are seen. The patient desires to avoid hysterectomy. The next best step in management is:

**A. Abdominal myomectomy**
**B. Expectant management**
**C. Hysteroscopic myomectomy**
**D. Uterine artery embolization**

9.4- Polypectomy Hysteroscopic Resection:

- Presentation: heavy/ prolonged menses, intermenstrual, postmenstrual bleeding
- Diagnosis: pelvic ultrasound, SIS, hysteroscopy
- Removal:

- Surgical: hysteroscopy survey, identifying landmarks, polyp forceps and curettage
    - Directed: survey, landmarks, scissors/ graspers
    - Bipolar resection: survey, landmarks, loop electrode
    - Mechanical: survey, landmarks, mechanical tissue tractions
- Risks: bleeding, infection, perforation, adhesion, fluid overload, air embolism, death

A 36 year old presents with 6 months of heavy menses and intermenstrual bleeding. An endometrial polyp is identified on saline infusion ultrasound. The surgical approach for removal of the polyp associated with the lowest risk of recurrence of the polyp and highest accuracy for removal is:

**A. Blind dilation and curettage**

**B. Hysteroscopy with mechanical resection**

**C. Hysteroscopy with polyp forceps**

**D. Suction dilation and curettage**

# Module 10: Laparoscopic Complications

10.1 Ureteral Injury Management

- Etiology: ligation, angulation, transection, resection, crush, ischemia
- Injury identification:
    - Universal cystoscopy increases rate of recognition
    - When ureteral injury occurs in MIS high rate conversion to laparotomy
    - Delayed recognition occurs in 62% of cases
- Management
    - Ligation, Angulation: de-ligation by removing offending suture, assess viability, stent placement
    - Transection, Resection, Crush, Ischemia:
        - Upper and middle 3rd: uretero-ureterocystotomy over stent
        - Lower 3rd(within 6cm of UVJ): uretero-neocystotomy with psoas hitch over stent, tension free repair
        - Watch video!
- Suspected unrecognized injury
    - Post op symptoms: unilateral cramping, flank pain, ileus, watery vaginal discharge
    - Post op signs: creatinine, fever, ascites, retroperitoneal fluid collection

- Diagnosis: renal US to assess for hydroureter or hydronephrosis, CT AP w IV contrast to assess for integrity of GU system and for uroma

A 49 year old G0 is undergoing a laparoscopic hysterectomy and excision of stage IV endometriosis. Significant pelvic sidewall adhesions are encountered during the procedure. Following the hysterectomy, partial transection of the ureter is noted at the level of the pelvic brim. The next best step in management is:

**A. Heal by secondary intention**
**B. Ileal conduit**
**C. Psoas hitch**
**D. Ureteroneocystostomy**
**E. Ureteroureterostomy**

10.2 Retroperitoneal Injury

- Major vascular injury: 1/10,000 procedures, 33% mortality with delayed diagnosis
- **Expanding** retroperitoneal hematoma: communicate surgical emergency, direct pressure (no further dissection), emergent vascular surgery consult, vertical midline laparotomy, massive transfusion protocol
- **Non expanding** retroperitoneal hematoma: observe (reassess without pneumoperitoneum), inspect, communicate, proceed with surgery

A 45 year old G1P1 with morbid obesity is undergoing a total laparoscopic hysterectomy for abnormal uterine bleeding. Direct umbilical entry is attempted. Difficulty is noted due to the patient's body habitus. Pneumoperitoneum is established and a rapidly enlarging hematoma is noted along the right external iliac vessels. The most appropriate next step is:

**A. Direct pressure**
**B. Evacuate pneumoperitoneum**
**C. Observation**
**D. Reevaluation at procedure conclusion**
**E. Retroperitoneal dissection**

10.3 Injury During Secondary Port Placement

- Secondary port injuries:
    - Visceral: bladder (suprapubic port placement), bowel (excessive force)
    - Vascular (tracking)
- Preventing bladder injury
    - Identify bladder dome; incision cephalad
- Preventing inferior epigastric vessel injury
    - Visualize round ligament and medial umbilical ligament
- Managing inferior epigastric vessel injury
    - Foley catheter under direct visualization
    - Electrosurgery
    - Suture ligation; proximally and distally

A 27 year old G0 is undergoing excision of endometriosis through a minimally invasive approach. When placing a secondary port in the right lower quadrant, brisk bleeding is noted from the anterior abdominal wall. There is concern for an injury to the inferior epigastric vessels. The least appropriate next step is:

**A. Convert to laparotomy**

**B. Place a third port and suture ligate the injury**

**C. Place a third port and use electrosurgery to treat the injury**

**D. Tamponade using urinary catheter**

-

10.4 Small Bowel Injury

- GI injury during laparoscopy: incidence 0.03-0.18%, most commonly small bowel, high morbidity and mortality
- Etiology: abdominal entry, dissection, electrosurgery, trauma
- Minimize bowel injury: pre op preparation, entry technique, intra op recognition
- Management small bowel injury:
  - <2 mm expectant
  - 2+ mm primary repair either laparoscopic or laparotomy, transverse plane
- Steps of side:side anastamosis
  - 1. Define segments of bowel proximal and distal to the point of injury
  - 2. Make an enterotomy in each segment of the bowel
  - 3. Insert one limb of the linear stapler into each enterotomy directly anti mesenteric with no intervening tissue
  - 4. The antimesenteric bowel walls are compressed, and the instrument is activated
  - 5. Inspect the inside of the staple line for hemostasis
  - 6. Reinforce the corners of the staple line for the GI anastomosis

| AAST Grade | Characteristic of Injury | Management |
|---|---|---|
| I | Contusion or hematoma without devascularization; partial-thickness laceration | Primary repair in one or two layers; transverse closure |
| II | Small laceration (<50% of circumference) | |
| III | Large laceration (≥50% of circumference) | |
| IV | Transection | Resection and reanastomosis |
| V | Transection with tissue loss; devascularized segment | |

A 48 year old G2P2 with past surgical history significant for exploratory laparotomy and small bowel resection for Crohn's disease and two cesarean sections is undergoing a laparoscopic hysterectomy. Primary entry was performed through the umbilicus using direct trocar entry. Diagnostic laparoscopy reveals air bubbles emerging from the small bowel wall. The least appropriate next step is:

**A. Administer additional antibiotics**

**B. Consider general surgery consultation**

**C. Laparoscopic evaluation of the entire large and small intestine**

**D. Secondary port placement**

**E. Urgent laparotomy**

10.5 Evaluation of Bowel Integrity

- Assessing for SB injury > run the bowel, identify ileocecal junction (assess appendix) and follow to ligament of Treitz, assessing medially and laterally
    - Only grasp mesentery, avoid direct traction on bowel wall, hand over hand technique
- Assessing for large bowel injury > air bubble test or methylene blue enema
    - Tests can be used for both suspected bowel injury and to test bowel wall integrity after anastamoses
    - Most common is rectosigmoid colon
    - Rigid sigmoidoscopy for direct visualization

A 47 year old G0 is undergoing a laparoscopic excision of stage IV endometriosis. The procedure required extensive dissection and multiple instrument exchanges. The best strategy to ensure no injury to the small intestines is to proceed with:

**A. Air bubble test**
**B. Methylene blue test**
**C. Overnight observation**
**D. Running the bowel**
**E. Sigmoidoscopy**

10.6 Bladder Injury

- Anatomy: dome + base (trigone, ureteral orifices, urethra)
- Incidence 0.33%; bladder 0.8% and ureter 0.3%
    - More likely with TLH > TVH/TAH
- Etiology: ligation, crush, transection, laceration
- Risk factors: unfamiliar with anatomy, distorted anatomy, pelvic adhesions, pelvic radiation history, pelvic surgeries, undrained bladder
- Intra operative identification
    - Hematuria
    - Routine cystoscopy
    - Stain urine with dye and monitor (methylene blue, ICG)
- Location of injury: posterior bladder wall > dome
- Repair of injury:
    - Identify surrounding anatomy and proximity to ureters, urethra,
    - Cystotomy edges excised if thermal injury
    - Two layer closure with absorbable suture
        - 1st layer: bladder mucosa and detrusor muscle
        - 2nd layer: imbricating layer of bladder muscularis, serosa and parietal peritoneum to take tension off first layer
    - Backfill bladder
    - Maintain indwelling catheter
    - If bladder dome injury <1cm can do expectant management
- Unrecognized injury
    - Presentation: vaginal drainage, ileus, oliguria, ascites, pain

- Long term sequeae: fistula

A 49 year old G3 P3003 is undergoing a laparoscopic hysterectomy for treatment of uterine leiomyoma. Her prior surgical history includes myomectomy followed by three cesarean sections. During development of the bladder flap, significant adhesions were encountered and an incidental cystotomy occurred. Initial inspection reveals a likely 2 cm defect. The least appropriate management is:

**A. Backfill bladder**

**B. Expectant management**

**C. Indwelling urinary catheter**

**D. Two layer closure**

**E. Visualization of the ureteral orifices**

10.7 Cardiac Arrest During Laparoscopy

- Asystole or bradycardia causes: gas embolism, subQ or preperitoneal emphysema, pneumomediastinum or PNX, hypoxia or hypercapnia, vagal reaction, diminished cardiac preload
- Gas embolism: incidence 1/1000 however mortality 28.5%
    - Mechanism: Veress needle inserted into vein or parencyhmal organ
    - Signs: decrease in end tidal CO2, hypotension, cyanosis
    - Tx: discontinue insufflation, hyperventilation with 100% FiO2, Trendelenberg position to increase cerebral perfusion
- SubQ or pre peritoneal emphysema
    - Incidence 0.3-2.34%
    - Mechanism: pre peritoneal insufflation
    - Signs: skin crepitus, hypercarbia, cardiac arrhythmias, HTN
    - Tx: increase ventilation rate
- Pneumomediastinum or PNX
    - Incidence 0.03%
    - Mechanism: diaphragm defect, ascending peritoneal gas
    - Signs: emphysema in neck face or chest, cyanosis, increased airway pressure
    - Tx: remained intubated until swelling decreases; if PNX admin 100% FiO2 and place chest tube
- Hypoxia or hypercapnia
    - Incidence 1/1000
    - Mechanism: aspiration or excessive CO2 absorption
    - Signs: hypoxia, high airway pressures, bronchospasm, gastric contents in esophagus
    - Tx: increased O2, bronchodilators, PEEP, decreased intra abdominal pressure
- Vagal reaction
    - Incidence 27%; cardiac arrest 1/1000
    - Mechanism: vagal nerve irritation due to distention or manipulation of viscera
    - Signs: bradycardia, asystole, hypotension

    - Tx: deflate abdomen, give anticholinergic agent
- Diminished cardiac preload
    - Mechanism: significant compression of IVC ie gravid uterus, adnexal mass or pneumoperitoneum
    - Signs: bradycardia, asystole, hypotension
    - Tx: left lateral tilt, pneumoperitoneum <15mmHg
- Asystole and Bradycardia Initial Management
    - STOP insufflation and deflate peritoneal cavity
    - Stop all medications contributing to myocardial depression
    - Administer 100% oxygen and anticholinergic agent
    - Assess for cause
    - Take patient out of Trendelenburg positioning
    - Chest compressions

A 45 year old G3P2012 with no past medical history is presenting for a total laparoscopic hysterectomy for treatment of uterine leiomyoma. The anesthesia team reports asystole after insufflation of the abdomen is initiated with the Veress needle. The next step in management is:

**A. Continue surgery laparoscopically**

**B. Convert to laparotomy**

**C. Deflate the abdomen**

**D. Obtain EKG**

**E. Ultrasound the abdomen**

10.8 Vascular Injury and Hemodynamic Instability

- Major vascular injury - primary entry
    - Mortality 9-17%; highest risk time is at time of closed entry
    - Recognition: blood in Veress needle or trochar, evaluate for HDS
    - Communicate: if suspected, need additional vascular access and notify blood bank, call vascular surgery
    - Midline laparotomy
    - Pressure
- Major vascular injury - secondary port placement
    - Managed differently! Injury is visible, occurs during trochar placement or with organ injury
    - Recognition
    - Communication: notify blood blank, emergent vascular or general surgery consult
    - Pressure: venous injuries occluded distally, arterial injuries occluded proximally
    - Repair either laparoscopically or via laparotomy
- MTP
    - 1:1:1 pRBCs FFP PLT
    - Decreased morbidity and mortality
- Minor vascular injury

    - Pressure
    - Visualize ie suction blood
    - Obtain hemostasis: electrosurgery, suture or surgical clip
- Post op hemodynamic instability
    - Vitals, pain level, UOP
    - Physical exam
    - Bleeding vs cardiopulmonary event
    - Labs: CBC, poss coags
    - Observation
        - Serial abdominal exams, lab eval
        - Replete fluid and blood
        - Consider imaging
    - Return to OR

A 34 year old G0 is undergoing a laparoscopic excision of endometriosis. Abdominal entry is performed using a Veress needle. The abdomen does not insufflate when pneumoperitoneum is applied and blood is visualized coming through the Veress needle. Anesthesia alerts you that the patient is hypotensive. The next step in management is:

**A. Increase $CO_2$ flow**

**B. Obtain entry through Palmer's point**

**C. Obtain entry through direct trocar insertion at umbilicus**

**D. Perform midline laparotomy**

-

10.9 Intestinal Burn Injuries

- Mechanisms
    - Direct application
    - Direct coupling ie monopolar transfers energy to a second instrument
    - Capacitive coupling ie energy transferred to conductive material without direct contact
    - Insulation failure
- Intestinal thermal injury
    - Present 4-10 days postoperative (vs intestinal perforation present within 24-48H)
    - Coagulation necrosis > loss of bowel wall integrity > delayed lumen injury
    - Signs: see below; large bowel injury generally sicker in appearance

## Intestinal Thermal Injury Presentation

| Sign | Large Bowel | Small Bowel |
|---|---|---|
| Normal or Subnormal Temperature | 61.2% | 50.6% |
| Fever | 38.8% | 49.3% |
| Tachycardia | 63.3% | 54.3% |
| Hypotension | 42.9% | 18.5% |
| Anemia | 77.6% | 63.0% |
| Depressed WBC Count | 40.8% | 22.2% |
| Elevated WBC Count | 49.0% | 39.5% |
| Bandemia | 51.0% | 37.0% |
| Elevated Creatinine and BUN | 24.5% | 6.2% |


-
- Management:
    - Identification; CT AP with IV and PO contrast
    - Extend of injury difficult to detect; thermal injury can extend beyond what is visibly damaged
    - Resection and reanastomosis; wide margin of resection, several centimeters

A 30 year old G2P2 with a BMI of 55 kg/m$^2$ is undergoing a total laparoscopic hysterectomy and excision of endometriosis for treatment of pelvic pain. Intraoperatively, tissue manipulation is suboptimal due to patient's body habitus. The surgeon inadvertently causes a superficial injury to the small bowel while fulgurating endometriosis using monopolar electrosurgery. The next step in management is:

**A. Bowel resection**

**B. Expectant management**

**C. Local excision and primary repair**

**D. Over sew injured area**

-

10.10 Bowel Injury After Laparoscopy

- Signs and symptoms: abdominal pain, distention, nausea anorexia, mobility, tachycardia and tachypnea, decreased urine output, incisional drainage
- Presentation peritonitis, intra abdominal abscess, enterocutaneous fistula ie bowel contents draining from skin incision
- Diagnosis

    - High index of suspicion; unrecognized bowel injury mortality 20-50%!
    - Abdominal imaging: CT AP w IV and PO contrast; sensitivity specificity >90%
    - Exploratory surgery
- Post op complications: bowel obstruction, bowel leak, wound dehiscence, repeat laparotomy, parenteral nutrition, pneumonia, sepsis, ICU admission

A 31 year old G0 underwent laparoscopic excision of endometriosis and extensive adhesiolysis 5 days ago. She reports generalized malaise, difficulty eating and drinking, worsening abdominal pain, and absence of flatus. She is unsure the last time she voided and reports only needing to void once or twice daily. The next best step in management is:

**A. Enema administration**
**B. Immediate evaluation**
**C. Increase narcotic pain medication**
**D. Outpatient IV fluid administration**
**E. Reassurance that this is normal**

-

10.11 Fistula After Hysterectomy

- Incidence: 0.02% vesicovaginal, 0.2% ureterovaginal, 0.2% uretero-sigmoid
- Presentation: continuous LOF worse with standing or Valsalva 10-20 days post hysterectomy, unexplained fever, hematuria, flank vaginal or suprapubic pain, abnormal urinary stream, recurrent cystitis
- Diagnosis: history and physical exam, speculum exam (fluid pooling, body fluid creatinine ie > 10), dye test
    - Dye test: tampon in vagina, consume oral phenazopyridine (orange) and back fill bladder with methylene blue. If tampon blue then vesicovaginal fistula or if orange then ureterovaginal fistula.
    - IV urography
    - Cystourethroscopy
- Treatment
    - Nonsurgical: small fistulas, before urinary tract epithelializes
        - Urinary diversion; Foley catheter for vesicovaginal and ureteral stent for ureterovaginal fistulas, 4-8 weeks
    - Surgical:
        - If tissue healthy, can repair immediately within 48H
        - If delay diagnosis or inflammation, repair delayed 3-6 months
        - Transvaginal repair if lower portion of bladder
        - Transabdominal repair if higher portion of bladder, multiple or ureteral repair

A 41 year old G0 underwent laparoscopic excision of endometriosis and total hysterectomy 7 days ago. She reports constant leaking of urine that is greatest when getting out of bed. She denies any prior urinary incontinence. She is otherwise without complaint. The most likely diagnosis is:

**A. Occult urinary incontinence**
**B. Urinary tract infection**
**C. Vaginal cuff dehiscence**
**D. Vaginitis**
**E. Vesicovaginal fistula**

-

10.12 Ileus After Laparoscopy

- Mechanical disruption
- Peristalsis disruption
- Normal post op function: small bowel and stomach return in 8H, large intestine return in 24-48H
- Risk factors: dehydration, intestinal manipulation, general anesthesia, narcotics, immobility, surgical complications, electrolyte abnormalities (hypomagnesemia), diabetes, chronic laxative use
- Symptoms: N?v, pain, absent flatus, distention/tympany, hypoactive bowel sounds
- Diagnosis: distinguish from mechanical obstruction
    - Abdominal XR: ileus with intermittent air throughout GI tract, can also see air fluid levels. Small bowel obstruction will not show gas in colon
- Treatment: bowel rest, IVF, electrolyte repletion, activity, narcotic avoidance
- Prevention: ERAS, chewing gum, caffeine

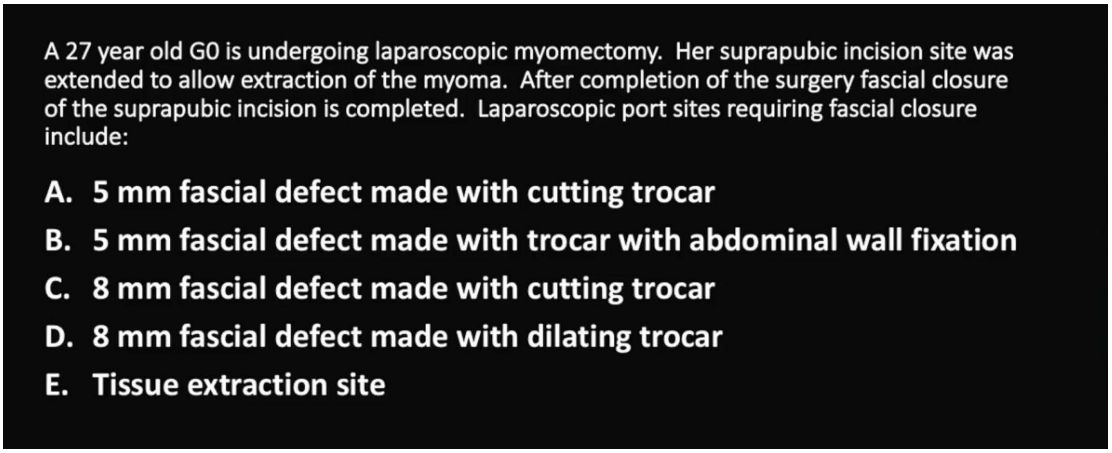
A 49 year old G0, diabetic underwent a laparoscopic hysterectomy and excision of stage IV endometriosis 3 days prior. Preoperatively, she was requiring use of Bisacodyl and polyethylene glycol daily to assist with bowel movements. She calls the office reporting gradual worsening of abdominal distension, nausea, and vomiting. She denies passing flatus or having a bowel movement since surgery. She also denies severe abdominal pain or fever. The most likely diagnosis is:

**A. Ileus**
**B. Large bowel obstruction**
**C. Large bowel perforation**
**D. Small bowel obstruction**
**E. Small bowel perforation**

10.13 Port Site Hernia Prevention

- Incidence 0.21-3%
- Prevention - trocar
    - Cutting trocars - size of trocar is size of defect
    - Dilating trocars - size of defect can be 50% smaller than trocar size

    - Fixation of trocar to abdominal wall helps decrease risk of hernia and prevent slippage
- Prevention - fascial closure
    - Any trocar > 10mm
    - Tissue extraction size (facia is stretched) risk of hernia is 7%




10.14 Vaginal Cuff Dehiscence

- Incidence up to 4%, evisceration up to 1%; can occur up to several years following hysterectomy
- Surgical Modality
    - TAH 23%
    - TVH 26%
    - TLH 58%
    - Other pelvic surgery 5%
- Precipitating event
    - 70% spontaneous
    - 8-48% intercourse
    - 16-30% defecation or Valsalva
- Presenting symptom
    - Abdominal pain 58-100%
    - Vaginal bleeding or watery discharge 33-90%
    - Vaginal pressure 30%
    - Evisceration 70% ie bowel in vaginal vault
    - Asymptomatic 50%
- Risk factors: age, atrophy, surgical hx, poor wound healing, Valsalva, infection, hematoma
- Prevention: cuff closure with monofilament suture, minimal electrosurgery, full thickness closure (vaginal mucosa, pubocervical fascia, uterosacral ligaments), vaginal estrogen
- Repair: discretion of surgeon, none is superior
    - Transvaginal if medically stable, no peritonitis, no bowel injury
    - Laparotomy or laparoscopy if prolapsed bowel with vascular compromise or if traumatized bowel

- Approx 4% repeat dehiscence risk

A 44 year old G2P2 underwent a total laparoscopic hysterectomy for treatment of uterine leiomyoma 6 weeks ago. Her postoperative course was uncomplicated. She calls the emergency on call provider at 10:30 PM with complaint of acute onset of pelvic pain and vaginal bleeding after intercourse. The next step in management is:

**A. Evaluate in office the following day**
**B. Expectant management**
**C. Immediate evaluation in emergency department**
**D. Reassurance that this is normal**
**E. Pain management using ibuprofen**

10.15 Neurologic Injury

- 1-2% incidence; most commonly lumbosacral or brachial plexus
- Mechanism: compression, stretch, entrapment, transection
- Femoral nerve injury (L2-L4)
    - Compression injury ie self retaining retractors, hyper flexion patient positioning
    - Symptoms: motor (hip flexion, knee extension, loss patellar reflex) and sensory (anterior and medial thigh)
- Ilioinguinal/iliohypogastric nerve injury (T12-L1)
    - Entrapment or transection during lateral port placement or fascial closure; avoid by placing ports above ASIS
    - Symptoms: decreased sensation of inner thigh, labia majora. If hypogastric nerve injured sensation decreased in the gluteal and hypogastric region.
- Genitofemoral nerve injury (L1-L2)
    - Stretch or transection injury during pelvic sidewall or pelvic LN dissection
    - Symptoms: decreased sensation mons pubis, labia majora, femoral triangle
- Obturator nerve injury (L2-L4)
    - Stretch, transection or entrapment injury
    - Symptoms: motor (decreased hip adduction), sensory (decreased sensation upper medial thigh)
- Sciatic nerve injury (L4-S3)
    - Stretch injury
    - Symptoms: motor (decreased hip extension, knee flexion) and sensory (decreased sensation posterior thigh and leg)
- Common peroneal nerve (arises from sciatic nerve in mid thigh)
    - Compression injury
    - Symptoms: motor (foot drop, decreased dorsiflexion) and sensory (decreased sensation lateral leg, dorsum of foot)
- Pudendal nerve injury
    - Entrapment injury ie sacrospinous ligament fixation
    - Symptoms: sensory (perineum, vulva)

- Brachial plexus nerve injury (C5-T1)
    - Stretch injury ie shoulder pads
    - Symptoms: motor (upper extremity) and sensory (upper extremity)

A 40 year old underwent a laparoscopic hysterectomy with excision of endometriosis for treatment of chronic pelvic pain. Her surgery was complicated by extensive adhesive disease. On postoperative day one she notes difficulty with ambulation and examination reveals decreased sensation of the medial thigh and difficulty with hip adduction. The most likely nerve injured is:

**A. Common peroneal**
**B. Femoral**
**C. Genitofemoral**
**D. Ilioinguinal**
**E. Obturator**

# Module 11: Hysteroscopic Complications

11.1- Excess Fluid Absorption:

- Categories: viscosity, osmolality, electrolytes
    - 0.9% NaCl: low/isotonic/rich
    - 5% Mannitol: low/isotonic/poor
    - 1.5% Glycine: low/hypotonic/poor
    - 3% Sorbitol: low/hypotonic/poor
- Risks: osmolarity, volume, menopausal status, CV or renal disease, procedural conditions
    - Premenopausal: increased estrogen, increased risk of electrolyte shifts with electrolyte poor
    - Procedural conditions: intrauterine pressure, MAP, myometrial penetration, surgical duration, uterine cavity size
    - Fluid overload: pulmonary edema, heart failure
- Fluids:
    - Isotonic: rarely significant electrolyte abnormalities
    - Hypo-Osmolar: can cause hyponatremia which can lead to cerebral edema, neuro impairment, seizures, death
        - Hypo-Natremia: < 125 mmol/L, no change in serum osmolarity
            - Initial: headache, nausea, vomiting
            - Late: agitation, confusion, visual disturbance, lethargy, seizures, arrhythmias
    - Sorbitol: hyperglycemia, hypocalcemia
        - Symptoms: myoclonus, DKA
- Evaluation:
    - Order: CMP/BMP, CXR, EKG, Strict Fluid Balance, Multidisciplinary Involvement
- Management:

- Asymptomatic:
    - Na > 120
        - Fluid restriction
        - Loop diuretic
- Symptomatic:
    - Na < 120
        - 3% Hypertonic NaCl
        - Serial BMP
        - O2
        - Foley
        - ICU/ Anesthesia Management

- Prevention:
    - Careful instrument/ media selection
    - Bipolar
    - Avoid excess fluid loss
        - How?
            - Vasopressin, cervical dilation, intrauterine pressure (don't set above MAP), monitor fluid deficit, pre-set fluid deficit
                - Vasopressor can cause: coronary vasoconstriction, bradycardia, arrhythmia, myocardial ischemia
- Fluids Limits:
    - Electrolyte Rich/ Isotonic:
        - 2500: healthy
        - 1500: elderly/ comorbid conditions
    - Electrolyte Poor/ Hypotonic or Isotonic:
        - 1000: healthy
        - 750: elderly/ comorbid conditions
- Safety:
    - Prompt recognition, evaluate, treat

A 49 year old with hypertension and a 3 cm submucosal fibroid undergoes a hysteroscopic myomectomy using a monopolar resectoscope. At the conclusion of the surgery, a 1 L fluid deficit of 1.5% glycine is noted. During postoperative recovery, the patient complains of headache, nausea, vomiting, and weakness. Your *next step* in management is:

**A. Administer furosemide**
**B. Observe the symptoms**
**C. Order a STAT basic metabolic panel and monitor for fluid overload**
**D. Treat with anti-emetics and pain medications**

11.2- Hemorrhage:

- Complications:
  - < 1%, hemorrhage < 0.3%
- Where?
  - Operative bed, cervical laceration, uterine perforation
- Management:
  - Perforation: exploration
  - Localized Bleeding: cauterization
  - Cervical Laceration: suture, direct pressure
  - Diffuse: uterine compression, intrauterine catheter, clotting factors, embolization, hysterectomy

After completing a hysteroscopic myomectomy with a mechanical tissue extractor, significant bleeding is noted from the external os. The *next step* in management is:

**A. Evaluate for a perforation using hysteroscopy**
**B. Perform an endometrial ablation**
**C. Place an intrauterine Foley catheter balloon**
**D. Send a complete blood count, INR/APTT**

11.3- Perforation with Electrosurgery:

- Management:
  - Observation:
    - Low risk vascular/ visceral, blunt instrument, absence of bleeding
  - Laparoscopy:
    - Sharp instrument, suction, electrosurgical, bleeding, risk of vascular/ visceral
      - Visceral:
        - How to evaluate:
          - Urinary Tract:
            - Cystoscopy (intra-operative)
            - CT urogram (post-operative)
          - Intestinal Tract:
            - Laparoscopy/ Laparotomy (intra-operative)
            - CT scan (post-operative

A 35 year old is undergoing a hysteroscopic myomectomy with a resectoscope. During the procedure, a perforation occurs at the fundus. The patient is hemodynamically stable. The *next step* in management is:

**A. Abort the procedure and transfer the patient to the postoperative unit for observation**
**B. Complete the resectoscope procedure**
**C. Laparoscopy for abdominal exploration**
**D. Laparotomy for abdominal exploration**

11.4- Office Adverse Reaction:

- Vasovagal Reaction:
  - Pathophysiology: increased cardiac-vagal tone, bradycardia, decreased peripheral sympathetic activity, venous dilation, hypotension
  - Incidence: 0.72 to 1.7%
- Symptoms: lightheaded, warm/ cool, sweating, palpitations
- Management: Vital signs, D/C procedure, IVF, atropine
- Risk factors: pain, rigid instruments, CO2 distension media
- Ways to reduce risk factors: anesthesia, flexible scope, fluid distension

A 50 year old is undergoing an in-office hysteroscopy. During the procedure she complains of lightheadedness and nausea. Vital signs are BP 79/50 and pulse 58. The procedure is stopped and IV fluids are administered. Ten minutes later her symptoms persist and repeat vitals are BP 75/45 and pulse 45. The *next step* in management is:

**A. Administer atropine 0.5mg IV**
**B. Administer epinephrine 1mg IV**
**C. Initiate chest compressions**
**D. Place defibrillator pads for pacing**
**E. Utilize ammonia smelling salts**

11.5- Complication of Endometrial Ablation:

- Indications: heavy menstrual bleeding, premenopausal, normal uterine cavity, fertility not desired
- Complications: fluid overload, bleeding, injury to reproductive tract
  - Fluid overload: edema, hyponatremia, hypo-osmolality, cerebral edema, brainstem herniation, neuro injury, death

- Uterine trauma: cervical laceration, uterine perforation
- Thermal injury: vaginal/vulva, capacitive coupling
- Post Complications: pregnancy, infection, PATLS
    - Pregnancy: ectopic, malpresentation, premature, abnormal placentation
    - PATLS: residual active endometrium, cavity distortion, hematometra
    - Malignancy: pre-operative endometrial sampling, post procedural cavity distortion

A 42 year old underwent an endometrial ablation and tubal ligation 7 years prior. She presents complaining of cyclic pelvic and abdominal pain. Urine pregnancy test is negative. Pelvic ultrasound shows an endometrial stripe of 14 mm in the left cornua. The most likely diagnosis is:

**A. Endometrial hyperplasia**
**B. Endometriosis**
**C. Hematometra**
**D. Pelvic inflammatory disease**

# Module 12: Special Considerations

12.1- Obese:

- Benefits of Laparoscopy:
    - Easier recovery
    - Improved wound healing
    - Decreased blood loss
- Surgical Risks:
    - Based on co-morbidities:
        - HTN, HLD, DM
- Physiological Considerations:
    - Cardiovascular:
        - Increased cardiac output
        - HTN
        - CHF
        - Arrhythmias
    - Pulmonary:
        - Decreased chest wall compliance
        - Decreased lung volume (restrictive lung disease)
    - GI:

        - Increased intra-abdominal pressure
        - Esophageal dysfunction
        - *Both can increase risk of GERD
- Patient Positioning:
    - Goals:
        - Minimize injury
        - Maximize exposure
    - How to achieve:
        - Non-slip surface
        - Tucked arms
        - Appropriate stirrups
        - Avoid shoulder braves
- Peritoneal Access:
    - Umbilicus may be displaced inferior
    - Elevated opening pressure
    - *Can use Palmer's Point
        - Layers: fat → anterior sheath → rectus muscle → posterior sheath → peritoneum
            - 3 pops!
- Intraoperative Challenges:
    - Insufflation pressure (may need to be lowered in the setting of poor ventilation)
    - Trandelenburg (may not tolerate)
    - Exposure:
        - Can retract colon with suture up to the left upper quadrant (use epiploeica)

A patient with BMI of 52kg/m$^2$ is scheduled for robotic hysterectomy. Patient positioning is being planned to minimize movement on the operating room table. The positioning device most likely to contribute to a brachial plexus injury is:

**A. Arm sleds**
**B. Chest band**
**C. Egg crate**
**D. Gel pad**
**E. Shoulder brace**

12.2- Pregnant:

- Safety:

    - Any trimester
    - Must remember impact from anatomic and physiological changes
    - Laparotomy may be necessary
    - Similar advantages
- Incidence:
    - 1/500
    - Gyn: adnexal masses (1-4%), torsion
        - Adnexal mass: less than 2% risk of acute complication
            - Most benign with spontaneous resolution
    - Non- Gyn: appendicitis, cholecystitis
- Physiological Changes:
    - CV:
        - Increased CO, HR, PV
        - Aortocaval Compression
        - Decreased SVR, Colloid Oncotic Pressure
    - Pulmonary:
        - Increased mechanical ventilation
        - Decreased FRC, RLV, SVO2
        - Increased airway edema
- Adjustments:
    - Avoid delay, VTE prophylaxis, proper positioning, adjust for gestational age, decrease intra-abdominal pressure, fetal monitoring, progesterone (if corpus luteum cyst removed)
- VTE:
    - Early mobilization, Pneumatic SCDs, LMWH
- Positioning:
    - Left lateral decubitus (after 16 weeks, minimizes compression)
        - 15 degree tilt
- Abdominal Entry:
    - Adjust to fundal height
        - Palmer's Point
        - Supraumbilical
- Pneumoperitoneum:
    - Decreased 15 mmHg intra-abdominal pressure
    - End tidal CO2 monitoring
- Fetal Heart Monitoring:
    - Pre/Post
    - No prophylactic tocolysis
- Corpus Luteum:
    - Supports pregnancy 7-9 weeks then to placenta at 9 weeks
    - Progesterone therapy if CL removed
        - Vaginally or IM (PO less effective)
- Fascial Closure:
    - > 10 mm needs to be closed

A 27 year old is 12 weeks gestation. She presents with acute abdominal pain associated with nausea and vomiting. Ultrasound demonstrates a 7 cm simple appearing right adnexal mass with absent Doppler flow. Your *next step* in management is:

**A. Admission for serial abdominal exams**

**B. Percutaneous drainage of the adnexal mass by interventional radiology**

**C. Place 2 large bore IVs, Blood Type and Cross, IV fluid resuscitation**

**D. Urgent laparoscopy for de-torsion of the ovary and possible ovarian cystectomy or oophorectomy**

**E. Urgent laparotomy for oophorectomy**

12.3- Medical Comorbidities:

- Elderly patient:
    - Age negatively impacts outcome
        - Increased incidence/decreased operative mortality
    - System:
        - Neurological: decreased brain size, increased pharm sensitivity, diminished ventilatory response, decreased pain perception, increased pain threshold
        - CV: CAD, comorbidities
        - Pulm: increased carbia, decreased FRC, increased hypoxemia
        - Renal DIsease
        - Gastric pH
        - Portal circulation
- Surgical history:
    - Hernia repair with or without mesh

A 79 year old undergoes a laparoscopic right oophorectomy for a persistent and symptomatic simple ovarian cyst. She has a prior history of gastro-esophageal reflux and was treated for pneumonia 1 year prior. The surgical duration is 41 minutes. Total intravenous lactated ringers administered is 1200 mL. The patient's greatest risk for postoperative respiratory depression is:

A. **Age**
B. **Duration of Surgery**
C. **Fluid administration**
D. **Medical history**