Hemostasis and Energy Sources

Thomas S. Lendvay, M.D.
Assistant Professor
University of Washington
Overview

- Operative planning
- Laparoscopic hemostasis modalities
  - Non-energy
  - Energy
- Tips for maintaining dry field
- Bowel injury
- Future perspectives
Operative Planning

- Pre-op imaging
- R/o bleeding diathesis/Rx
- Adequate exposure
- Instrument preparedness
- Stay calm
- Bleeding and charring steal light
- For many bleeders, direct instrument pressure
  - Raise pneumo (judiciously)
- Add port, open
Non-energy Techniques

- Suture ligature
  - Pros
    - Proven effective
    - Excellent training
  - Cons
    - Time intensive
    - Technically challenging
Non-energy Techniques

- Titanium clips
  - Pros
    - Withstand highest burst pressures
    - No collateral damage
  - Cons
    - Dislodgement
    - May preclude stapler
    - Nidus for adhesions
- Plastic (locking)
  - Pros
    - As above
  - Cons
    - Application error
    - Multiple clips
    - Leave stump
    - No data on adhesions

- Vascular endo-staplers
  - Easy to use
  - Good for large vessels
  - But need big port 12 mm
  - Firing malfunction
  - $$$

- Vascular clamps
  - Bulldogs
  - Satinsky
Non-energy Techniques

- Tissue sealants
  - Gelatin matrix (FloSeal)
    - Thrombin and gelatin from bovine sources
    - Collagen crosslinked to gluteraldehyde
  - Fibrin glues (Tisseel)
    - Elements of clotting cascade
    - Fibrinogen/thrombin/Factor VIII/ Ca++
      - Extracted from human blood products
- Surgicel
  - Fibrinogen and thrombin fleece
Energy Techniques

- Monopolar
  - shears, hook, blade
  - > 85% laparoscopists

Click here to view this video

Click here to view this video
Energy Techniques

• Ultrasonic (55,000 Hz)
  • Pizoelectric transducer in hand piece
  • Denatures hydrogen bonds – coagulum
  • FDA approved for 3 mm vessels
  • Lower energy transduced
    • May lead to smaller spread
  • Thermal spread
    • continuous >> intermittent activation
  • Works as grasper well
Energy Techniques

- Emam et al. (2003)
  - After 15 sec of US
    - 1 cm away 140 C
  - Setting < than 4 less than 10 seconds
Thermal Techniques

- Bipolar Feedback (Ligasure)
  - FDA approved for vessels up to 7 mm
  - High current 4 A, low voltage < 200V
  - Denatures collagen and elastin
Energy Techniques

• Argon beam coagulation (1989)
  • Monopolar current via electrode
  • Conduction of RF energy thru ionized beam of argon gas
  • Depth 2-5mm (solid organ)
    • Pros
      • Parenchymal surfaces, diffuse bleeding
      • Minimal smoke
      • Large surface areas
    • Cons
      • Not vessels
      • Gas embolization (vent abdomen)
    • Lower flow, lower risk of embolism
      • < 4L/min for lap
      • Hand piece 1 cm from tissue (embolism)
Energy Techniques

- LASER
  - Bloodless dissection with coagulation
  - Less tissue damage
  - Depth 2 mm
Head to Head Studies

• Harold et al. (2003)
  • Ligated vessel burst pressure
    • Ultrasonic/Ligasure/Titanium clips/Plastic clips
      • Ligasure > US burst pressure for 4-7 mm
      • Clips highest burst pressure
      • Ligasure as good as clips for 4-5 mm
      • Thermal spread energy sources ~2mm

• Hruby et al. (2007)
  • Harmonic Ace (up to 5mm), Ligasure (up to 7 mm)
    • Consistent reproducible force
      • Proper coaptation of vessel which aids in coagulum
      • Too much, vessel cut too early
      • Too little, not coapted, not coagulated
    • Harmonic ACE faster X 2
Head to Head Studies

- Landman et al. (2003)
- Pig vessel burst pressure tests
  - Ligasure v. Harmonic scalpel v. Titanium clips v. Endostapler
  - Ligasure
    - Arteries up to 6 mm
    - Veins up to 12 mm
    - Ligasure not as good as clips or staples
  - 2-6mm peripheral damage
  - $$$ Ligasure and repeating clip applier similar in cost but generator $17K
    - Staples most expensive
  - Harmonic faster
Head to Head Studies

- Tulikangas et al. (2001)
- Pig bowel injury experiment
- ME v. BE v. LASER v. US
  - BE/ME at 40W, US at 3.5
  - Coagulative denaturation of collagen bundles
  - ME>>>US bowel and bladder
  - CO2 LASER no deep tissue injury
  - LASER most shallow
  - BE injury 1.5 cm away in ureter, 1 cm away in bladder
  - ME 2.3cm and 1cm
Head to Head Studies

- Diamantis et al. (2006)
  - Monopolar vs. Bipolar v. Ligasure v. Ultrasonic
  - Divide short gastrics in 16 rabbits
    - Studied coagulation sites and adjacent gastric wall
  - LS/US complete hemostasis, no complications
  - LS least adjacent thermal injury, fastest healing
  - Failure rates – ME (25%), BE(30%), LS (0%), US (6%)
  - Adhesions in ME>BE>>LS/US
  - LS/US safer and more effective

![Lesion Depth Graph](image)
Thermal Injury

- Underreported
- Reasons
  - Insulation failure
    - High voltage, cleaning wear, trocar passage
  - Instrument coupling
    - Transmit current through adjacent instrument (metal)
  - Capacitative coupling
    - Parallel current running in tissue
- Decreased field of view
  - Hard to see other than tip
- Fecal peritonitis mortality 25%
- Possible signs of stray current
  - Electrical interference on monitor
  - Reduced power at end-effector
Thermal Injury

• Bowel injury
  • 2nd most common (Vascular #1)
  • 0.2-1.2% urologic lap procedures
• Over sew serosal injuries
• Late diagnosis > 50%
• Free air after 24-48 hr
• Presentation (up to 2 weeks)
  • Low grade fever
  • Leukopenia
  • Localized trocar site pain
  • Diarrhea
Laparoscopic Immune Response

- El Hakim et al. (2004), 40 bowel injured rabbits
  - Lap/open/pneumoperitoneum/sham
- Peritoneal fluid WBCs > in surgery grps, open > lap
- Decrease in lymphocytes and monocytes in lap at 3 days
- Systemic WBCS equal
- Peritoneal IL-8 > in lap vs. pneumo but = open and lap
- Granulation tissue open > lap
- IL-8 elevated in pneumo over open sham
- Lap did not sustain local inflammatory response
  - Blunted peritoneal immune response
    - mask clinical signs /sx’s of peritonitis
Laparoscopic Immune Response

- El-Hakim et al. (2005), rabbits
  - Monocyte migration assessed
  - Monocyte apoptosis lap < open
  - Migration Lap > open
  - Lap injuries
    - Decreased priming of cellular immunity
    - Mask peritonitis
Future Perspectives

- RF anastomotic sealers
  - Bipolar fusion devices
  - Smulders et al.
    - Pigs bowel anastomoses
      - 7/8 intact POD#7
      - Normal re-epithelialization
Final Words

- Keep all metal in field of view
- Short bursts of activation
- Ligasure/Ultrasonic probably safest
- Use lowest settings
- Respect the clinical signs
References