Endoscopic Management of Surgical Complications

General and bariatric

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Endoscopic management of surgical complications

“It is easier to stay out of trouble, than to get out of trouble…”

Alfred Baker, MD
Endoscopic management of surgical complications

“A friend in need is a friend indeed…”

Anonymous

- Even when the process is perfect, the outcome will not necessarily be
Endoscopic management of surgical complications

- There are no easy trips back to the operating room
The problem

- Obesity is now more prevalent worldwide than malnutrition from hunger
- 1.6 billion adults are overweight
  - ≥ 400 million adults are obese
- By 2015, 2.3 billion adults will be overweight
  - > 700 million adults will be obese


The solution

- Lifestyle modification
  - Diet
  - Exercise
- Medication
- Surgery
- Minimally invasive options
203 women
- randomized to control group vs home exercise

Results
- Some weight reduction in first 6 months, but no difference noted at 1 year

Understanding bariatric surgical anatomy

- Restrictive procedures
- Malabsorptive procedures
- Combination restrictive and malabsorptive procedures
Restrictive Procedures

Gastric pouch
Mesh or silastic ring/band
Adjustable
Lap band
Subcutaneous port

Illustration: John E. Pandolfino, MD

VBG  Lap Band

Vertical Sleeve Gastrectomy: restrictive
Malabsorptive Procedures

Illustrations: John E. Pandolfino, MD

Roux-en-Y Gastric Bypass:
restrictive and malabsorptive

Illustration: John E. Pandolfino, MD
Upsides of bariatric surgery

- Safe and effective
  - Rapid weight loss
  - Improved comorbidities
  - Durable results

Illustrations: John Pandolfino, MD

The only durably effective therapy for severe obesity is currently surgery
- Significantly reduces the risk of mortality associated with obesity

The downsides of bariatric surgery: gastrointestinal complications

- Complications common to all bariatric surgery
  - Gallstone disease
  - Peptic ulcer disease (PUD)
  - Gastroesophageal reflux disease (GERD)
- Complications occurring more commonly after gastric banding
  - GERD
  - Food impaction
  - Band displacement
  - Band erosion
- Complications occurring more commonly in Roux-en-Y gastric bypass (RYGB), gastric resection, and biliopancreatic diversion (BPD)
  - Anastomotic complications
  - Suture-line and staple-line complications

Complications of Roux-en-Y Gastric Bypass (RYGB)
Postoperative Complications

Perioperative mortality of bariatric surgery is less than 1% but morbidity can be substantial:

- Mortality 1%
- Anastomotic Leak 1.5%
- Pulmonary Embolism 2%
- Acute Gastric Distention rare
- Pneumonia 1.9%
- Wound Infection 6%

<table>
<thead>
<tr>
<th>Early (within 30 days)</th>
<th>Late</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Stomal Stricture 3 – 20 %</td>
<td></td>
</tr>
<tr>
<td>- Stomal Ulceration 3 – 20 %</td>
<td></td>
</tr>
<tr>
<td>- Marginal ulcer (J)</td>
<td></td>
</tr>
<tr>
<td>- Stomal ulcer (GP)</td>
<td></td>
</tr>
<tr>
<td>- Staple line disruption 1%</td>
<td></td>
</tr>
<tr>
<td>- Internal Hernia rare</td>
<td></td>
</tr>
<tr>
<td>- Incisional Hernia 15%</td>
<td></td>
</tr>
<tr>
<td>- Fistula rare</td>
<td></td>
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</tbody>
</table>

Anastomotic Complications: where do they occur?

- Pouch
  - Stomal ulcer
- Anastomosis
  - Marginal ulcer
  - Anastomotic stricture
- Remnant stomach
  - PUD
- Duodenum
  - PUD
- Roux anastomosis
  - Bleeding
  - Stricture
  - Ulceration

Illustrator: John E. Pandolfino, MD
Anastomotic Ulcer

- Occur in 3-20% of patients after RYGB
- Usual presentation is epigastric pain, but nausea and/or vomiting may accompany pain or be the sole presenting symptom(s)
- Ulcers on jejunal side (marginal ulcers) require careful endoscopic examination to detect

Anastomotic Ulcer Treatment

- Treatment is medical
  - Acid suppression with PPI will heal nearly all
  - Sucralfate
  - Eradicate H. pylori
    - Schirmer, et al., 2002: marginal ulcers with + without preop HP screening
      - +screen 2.4%
      - -screen 6.8%
      - P<0.05
  - Rare cases require reoperation
Anastomotic Stricture

- Occur in 10% of RYGB patients
- Usual presentation is vomiting or early satiety with or without nausea, but abdominal pain may also present
- Stoma diameter usually greater than 1cm when created
- Stricture arbitrarily defined as inability to pass standard diagnostic gastroscope across anastomosis without resistance
- May be early or late complication

Anastomotic Stricture Treatment

Treat Endoscopically

- Gastrograffin swallow
- Endoscopic view of stomal stenosis with ulceration
- Dilation with a through-the-scope balloon dilator

**Anastomotic Stricture**

- Endoscopic balloon dilation
  - Short through-the-scope dilation balloon, with or without guidewire
  - Balloon diameter approximating anastomotic diameter at original operation
  - More than one session may be required

**Leaks, fistulas, suture-line and staple-line disruptions**

- Can occur at suture line or at anastomosis
- Most common fistula post-Roux-en-Y gastric bypass is between gastric pouch and gastric remnant
Leaks, fistulas, suture-line and staple-line disruptions
Leaks and Fistulas

Image of medical procedure.

Leaks and Fistulas

Image of medical procedure.
Leaks and Fistulas

Leaks and Fistulas
Leaks and Fistulas

Fistula closed

Anastomosis widely patent

Fistula closed
Removing Foreign Material

Removing retained staples: why bother?

Removing retained sutures: why bother?

Ulcers

1 2
3 4
Removing Foreign Material
Removing retained sutures: why bother?

Ulcers

1 2
3 4

Strictures

Removing Foreign Material
Removing retained sutures: more than meets the eye

YES!

1 2
3 4

NO!
Removing Foreign Material
Removing retained sutures: double-channel scope approach

Gastrointestinal Bleeding

- Anastomotic bleeding
  - Pouch-enteric anastomosis
  - Jejuno-jejunostomy anastomosis
- Peptic ulcer disease
  - Gastric pouch
  - Gastric remnant
  - Duodenum
- Approach to afferent Roux limb or jejuno-jejunostomy anastomosis requires deep-enteroscopy, laparoscopically-assisted endoscopy, or surgery

Artwork: John E. Pandolfino, MD
Complications of Laparoscopic Adjustable Gastric Banding (LAGB)
Endoscopic Management of Post-Gastric Banding Complications

- Symptoms similar to RYGB patients: GERD symptoms, nausea, vomiting, pain, dysphagia

- Endoscopist’s role much more diagnostic, much less therapeutic
- Endoscopically identifiable etiologies include
  - GERD-related stigmata
  - Band overinflation
  - Peptic ulcer disease
  - Band slippage or gastric prolapse

Gastric Banding Complications

- Food impaction / pouch outlet obstruction
- Band displacement / slippage
- Band erosion
- Gastric pouch dilatation
- Esophageal dilatation
Gastric Banding Complications

- Food impaction / pouch outlet obstruction
- Band displacement / slippage
- Band erosion
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Gastric Banding Complications

- Food impaction / pouch outlet obstruction
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- Esophageal dilatation
Gastric Banding Complications

- Band erosion

Sleeve Gastrectomy Complications
Sleeve Gastrectomy Complications

Sleeve Gastrectomy Complications
Endoscopic Management of Other Bariatric Surgical Complications

- Bile duct stone management
  - Post-gastric banding
  - Post-RYGB
    - Laparoscopically-assisted ERC
    - PTC
    - Via deep enteroscopy (Roux ≤ 150 cm)

Schreiner, et al. Gastrointest Endosc 2012;75:748-56.)
Endoscopic Management of Other Post-Bariatric Surgery Complications

- Bile duct stone management
- Endoscopic removal of eroded / lumenalized band (VBG)
- Endoscopic removal of endoluminal balloons
- Perforation → clip and co-manage with surgical colleague?

Endoscopic Management of Other Post-Bariatric Surgery Complications

- Gastric pouch enlargement or pouch-enteric anastomotic dilation
  - Endoscopic suture reduction of pouch volume or of stomal diameter
  - Smaller, and more recently, larger trials demonstrate short-term effectiveness
    - Multicenter RCT: 50 subjects, 27 controls endoluminally sutured pouch outlet reduction
      - greater mean percentage weight loss in the study group in 6-month follow up.
    - Long-term efficacy is less clear, but trials are ongoing.  
Endoscopy Post-Bariatric Surgery

Symptomatic indications for EGD

- Threshold is lower than in non-bariatric patients
- Vomiting +/- nausea
- Abdominal pain (usually epigastric)
- Weight gain / decelerated weight loss
- GI bleeding
  - Hematemesis
  - Melena
- Bloating (possibly)
- Vague abdominal discomfort (possibly)
- Jaundice (possibly)

What if endoscopy doesn’t provide an answer?
**Post-endoscopic Workup of Post-Bariatric Surgery Complications**

- Symptoms including GERD nausea, vomiting, pain, bloating
  - Consider CT first if pain is main symptom
  - Consider SBFT or CT enterography if nausea or bloating are pre-eminent
  - Consider US if symptoms are pancreatico-biliary in character, especially if GB *in situ*; MRCP if LFT's are elevated as well
  - Role of capsule endoscopy undetermined in this population: case-by-case basis for bleeding or pain; role for Agile patency capsule?

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**Abdominal pain**

- Upper abdominal pain
  - Heartburn alone?
    - Yes: Treat empirically with acid suppression (PPI)
    - No:
      - Epigastric: Upper GI endoscopy to exclude GERD, PUD, anastomotic ulcer or stricture
      - Right upper abdomen: Check liver enzymes, ultrasound to exclude biliary source
  - Endoscopy normal
    - Abdominal CT scan: Normal
Nausea and vomiting

Nausea or vomiting

↓

Nausea alone?

Yes

Consider GERD, PUD, anastomotic ulcer

↓

EGD or empiric treatment

No

Vomiting

↓

EGD to exclude anastomotic stricture, food impaction or bezoar, PUD, or GERD

EGD normal

Abdominal CT scan and consider systemic or CNS etiology

↓

Normal

What do I need to get started?

Treat endoscopically or medically

EGD abnormal
Bariatric endoscopist’s toolbox

- **Necessities (it doesn’t take a lot to get started)**
  - Diagnostic endoscope
  - Standard biopsy forceps
  - Hydrostatic dilation balloons
    - Diameter: 8 – 16 mm
    - Length: 4 – 6 cm (“pyloric” or “colonic”)
      - Non wire-guided (when scope visualizes jejunal lumen) $ 
      - Wire-guided (when scope can’t visualize jejunal lumen) $$$
    - Guidewire
  - Endoscopic suture scissors
    - Reusable
    - “surgical scissors”, NOT “endoscopic loop cutter”
  - Small rat-tooth forceps

- **Necessities (though you’ll reach for them infrequently)**
  - Hemostatic clips
    - Small
    - Large
  - Small rat-tooth forceps
  - Large rat-tooth forceps
  - Snares
  - Foreign body retrieval net
  - Stone extraction basket
  - Retrieval forcep (tripod, quadripod, etc.)
  - Overtube
  - Double-channel endoscope
  - Pediatric or transnasal-diameter endoscope
Bariatric endoscopist’s toolbox

- Luxuries or occasional-use instrumentation
  - Fluoroscopy
  - Propofol / MAC anesthesia
  - Pseudocyst drainage needle-catheter (19 or 21 ga)
  - APC unit (with multiple probes)
  - Cytology brush
  - Deep enteroscope (for Roux-en-Y issues)
    - Balloon-overtube type
    - Rotational-type

ASGE / SAGES Clinical Practice Guideline

Role of endoscopy in the bariatric surgery patient


Access at: www.asge.org
Conclusion

- *In bariatric patients, scope sooner rather than later*
- Change is opportunity
  - New operations create new anatomy with new complications
  - Minimally invasive surgery interfaces seamlessly with interventional endoscopy
  - Both create opportunities for *high-impact* endoscopy
- Novel technology & concepts are spawning new endoscopic techniques to manage bariatric surgical complications definitively
- A comprehensive interdisciplinary treatment plan constitutes the foundation for every successful endoscopic treatment of a bariatric complication

Endoscopic management of biliary complications
Biliary complications

- Bile duct injuries
  - Bile leaks
  - Biliary strictures
- Liver transplant biliary complications
  - Bile leaks
  - Biliary strictures
  - Ischemic cholangiopathy

Background

- Bile duct injuries
  - Most are iatrogenic: more predictable
  - Few result from trauma: less predictable
  - All require multidisciplinary management
  - Majority will respond durably to endoscopic treatment especially if detected early
  - Surgery is still sometimes the best approach
Anatomical caveats

- Bile duct injuries
  - Small leaks tend to respond well and durably to endoscopic management
  - Larger rents and transections: less so
  - Drainage of biloma is urgent
  - Always think about potential duct ischemia at leak site and risk of future development of upstream stricture
  - Be aware of incomplete opacification of biliary tree: biliary discontinuity

Strasburg classification

Endoscopic management of bile leaks

- ERCP with stenting or sphincterotomy yields
  - Prompt relief of bile peritonitis symptoms
  - Rapid & durable resolution of leak itself
  - Stent better than sphincterotomy

- Short, large diameter 10 Fr transpapillary stent is most effective therapy

- Stent removed at EGD 2-12 wks later (usu 4-6)
- Fluid collection/biloma drained percutaneously (usually first—to speed symptom relief)
- Large leaks/rents
- Transection: sometimes technically possible, but durability unclear

Modified from Tung, et al., Dig Dis 1999;17:133.

Endoscopic outcomes

  - 528 bile duct injury pts 1993-2010
  - Outcomes of multidisciplinary care
  - No need for further intervention after 12 months therapy

- Upshot
  - Endoscopic management of bile leaks: 96% success
  - Overall success rates for biliary injury treatment
    - Surgery 88% (P < 0.05)
    - Endoscopy 76%
    - IR 50%
    - *outcomes best for surgery in pts stented > 6 mos (P < 0.01)

Endoscopic outcomes

**TABLE 6. Percent Successful Outcomes by Timing (Strasberg B–E)**

<table>
<thead>
<tr>
<th>Time Interval (wk)</th>
<th>Percutaneous</th>
<th>Endoscopic</th>
<th>Surgical</th>
<th>All Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>2–4</td>
<td>47</td>
<td>77</td>
<td>40</td>
<td>63</td>
</tr>
<tr>
<td>4–6</td>
<td>50</td>
<td>100</td>
<td>57</td>
<td>88</td>
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<tr>
<td>6–8</td>
<td>NA</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>&gt;24</td>
<td>59</td>
<td>71</td>
<td>80</td>
<td>73</td>
</tr>
</tbody>
</table>

*From initial surgery until first therapy.*

**FIGURE 2.** (A) Outcomes by management (Strasberg B–E). (B) Outcomes by management over time (Strasberg B–E).

Endoscopic outcomes

**TABLE 7. Percent Successful Outcomes by Strasberg Type**

<table>
<thead>
<tr>
<th>Strasberg Type</th>
<th>Percutaneous</th>
<th>Endoscopic</th>
<th>Surgical</th>
<th>All Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>67</td>
<td>50</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>NA</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>C</td>
<td>100</td>
<td>88</td>
<td>100</td>
<td>92</td>
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<tr>
<td>D</td>
<td>50</td>
<td>75</td>
<td>80</td>
<td>77</td>
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<tr>
<td>E</td>
<td>50</td>
<td>67</td>
<td>95</td>
<td>77</td>
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<tr>
<td>F</td>
<td>50</td>
<td>88</td>
<td>83</td>
<td>81</td>
</tr>
<tr>
<td>G</td>
<td>50</td>
<td>73</td>
<td>89</td>
<td>73</td>
</tr>
</tbody>
</table>

*NA indicates not applicable.*

**FIGURE 5.** Overall outcomes by stent duration (Strasberg B–E).

**FC-SEMS in biliary injuries**

- Fully covered SEMS for biliary injuries
  - Most data are series of benign strictures, intrinsic and extrinsic (not injuries)
  - Durable results 50-90%
  - Response better in intrinsic vs extrinsic stx
  - Technical success good, easy to remove
  - Complications comparable to other endotherapy
  - Need head-to-head studies with aggregate plastic stenting, and cost-benefit analysis
  - May pose increased risk of ischemic stricture in post-OLT patients

**A new role for choledochoscopy?**

- Predictive value of choledochoscopy stricture recurrence after endoscopic treatment of post-chole biliary strictures
  - 20 pts with biliary injury / leak
  - Increasing number of plastic stents
  - Prospective
  - Small n

- **Upshot**
  - Choledochoscopic appearance of duct hyperplasia significantly (P < 0.01) predicted stricture recurrence

“The achilles heel of liver transplantation”

—Sir Roy Calne


Background

Biliary Complications in OLT

- Major cause of morbidity post-OLT (10-35%)
  - Sossenheimer, et al., 1996
    - Survey of 30 transplant centers, 6415 OLTs
- Cadaveric liver transplants (CLT)  7-34%
- The most important technical cause of morbidity after living-donor liver transplant (LDLT)
Common Biliary Complications in OLT

- Bile leak (5-33%)
- Anastomotic stricture (~10%)
- Ischemic cholangiopathy
  - Proximal (donor-segment) biliary strictures
  - Luminal biliary obstruction (casts, stones)
- Ampullary stenosis

Post-OLT bile leak—anatomy

- Less common in post-T-tube era
- Typical locations
  - Anastomosis
    - Beware of duct ischemia
    - Potential for stricture
  - Cystic duct—either one or both!
  - Duct of Luschka
  - Cut surface
  - Orphan duct

Post-OLT bile leak—treatment

- Same algorithm as other bile leaks, but
  - Anastomotic leak: consider longer stent
    - Beware of duct ischemia
    - Potential for stricture
  - Ascertain patient does not have a R-Y hepaticojejunostomy reconstruction prior to ERCP, especially if R-Y was recent!
Post-OLT Biliary Stricture

- Occur in up to 15% of CDLT
- Account for up to 40% of post-OLT biliary complications
- Usual presentation: asymptomatic LFT elevation
- Not always accompanied by biliary dilation on U/S, CT, or MR
- Cholestasis on LBx, jaundice, fever, or pain may be late findings or absent

Endoscopic Management of Post-OLT Anastomotic Stricture

ERCP—technique

- Guidewire access
- Fluoroscopic dilation to waist obliteration
- Polyethylene stent(s)
- Repeat in 6-12 weeks
- No guidelines exist regarding number of treatments or endpoint of treatment (Costamagna method)
Biliary Anastomotic Stricture: CDLT

Biliary Anastomotic Stricture: CDLT
Biliary Anastomotic Stricture: CDLT

Post-dilation stenting improves durability

Schwartz, et al., Gastrointest Endosc 2000

- 15 patients underwent 23 ERCPs with balloon dilation of post-OLT C-C anastomotic strictures

Upshot: | n | good/excellent result |
<table>
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<tr>
<td>Dilation only</td>
<td>29</td>
<td>41%</td>
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<tr>
<td>Dilation + stent</td>
<td>62</td>
<td>74%</td>
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ERCP-dilation-stenting in post-OLT Biliary Anastomotic Stricture

<table>
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<tr>
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<th>n</th>
<th>Therapeutic “success”</th>
<th>Follow up (months)</th>
<th>Complication rate</th>
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<tr>
<td>Elmi</td>
<td>15</td>
<td>87%</td>
<td>1-44</td>
<td>40%</td>
</tr>
<tr>
<td>Schwartz</td>
<td>62</td>
<td>74%</td>
<td>6-42</td>
<td>17%</td>
</tr>
<tr>
<td>Mahajani</td>
<td>29</td>
<td>86%</td>
<td>1-58 (µ=18)</td>
<td>6%</td>
</tr>
<tr>
<td>Pfau</td>
<td>8</td>
<td>50%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Rizk</td>
<td>10</td>
<td>90%</td>
<td>(µ= 22)</td>
<td>3%</td>
</tr>
</tbody>
</table>

Fully-covered SEMS for OLT biliary strictures

- Use unclear and investigative
- Only for CBD-CHD duct-to-duct strictures (not for compound anastomoses)
- No head-to-head studies with maximal aggregate plastic stenting
- Increased complications (in Phillips, et al., 2011 — but was for leaks)
- Concern re increased susceptibility of OLT bile duct to ischemic injury
Non-anastomotic Post-OLT Biliary Stricture

Non-anastomotic strictures = ischemic cholangiopathy

- Most commonly ischemic etiology
  - Preservation injury (CIT > 10-15 hrs)
  - HA thrombosis / stenosis
- Donor side of biliary tree only—CHD, hilum, IHDs
  - Less focal than anastomotic strictures
  - Complex anatomy or length of stricture may complicate attempts at endoscopic or percutaneous treatment


Ischemic Cholangiopathy

Ischemic biliary stricture post-CDLT secondary to HA thrombosis
Post-OLT Biliary Cast Disease

Ischemic Biliary Disease
Ischemic Biliary Disease
Ischemic Biliary Disease
Ischemic Biliary Disease

Background: LDLT

  - Initially driven by organ shortage in pediatric age group
- Organ shortage in adults remains critical
- Usual anatomy for adult LDLT
  - Right lobe graft
  - Biliary anastomosis now mostly choledochocholangio-choledochostomy (duct-to-duct) in adults
  - Technically more difficult than cadaveric transplant
  - Can require multiple complex biliary anastomoses or ductoplasty
Background: LDLT

Technical & anatomic features of LDLT which may relatively predispose to biliary complications:

- Biliary radicles at cut surface of liver
- Smaller & multiple biliary anastomoses
- Variant R biliary anatomy / vascular supply
- Smaller arterial anastomoses
- Increased tension on anastomoses
- Donor bile duct ischemia from required or excessive dissection

Adapted from Kugelmas, 2003.

Biliary Anastomotic Variants:

Adult R-lobe LDLT

From Hisatsune H, et al., Transplantation 2003;76:810.
Biliary Anatomy: LDLT

From Gondolesi, et al., Transplantation 2004.

Biliary Anastomotic Variants: Adult
R-lobe LDLT Choledochocholedochostomy

Illustration: Jason Cisler with Jonathan Fryer, Northwestern University
Biliary Anastomotic Stricture: LDLT

Reports of LDLT series demonstrate at least twice as high a rate of biliary complications (30-40% vs ~15%), and biliary anastomotic strictures (20-60% vs ~10%), compared to CLT.

- R-Y
  - Lower stricture rate in some series
  - Higher leak rate in some series
  - Much less amenable to endoscopic intervention

- D-D
  - Higher stricture rate in some series (esp if < 4cm duct)  
  Sugawara, et al., 2003; Gondolesi, et al., 2004.
Biliary Anastomotic Variants: Adult R-lobe LDLT Roux-en-Y

Illustration: Jason Cisler with Jonathan Fryer, Northwestern University

Biliary Anastomotic Stricture: LDLT

ERCP #1
Biliary Anastomotic Stricture: LDLT

ERCP #1

Biliary Anastomotic Stricture: LDLT

ERCP #1
Biliary Anastomotic Stricture: LDLT

ERCP #1
Complex Anastomotic Stricture: LDLT
Complex Anastomotic Stricture: LDLT
Complex Anastomotic Stricture: LDLT

Complex Anastomotic Stricture: LDLT
Complex Anastomotic Stricture: LDLT
Complex Anastomotic Stricture: LDLT

Complex Anastomotic Stricture: LDLT
Bile leak: LDLT
Bile leak: LDLT

Bile leak: LDLT
Bile leak: LDLT
Bile leak: LDLT

Bile leak: LDLT
Ischemic Cholangiopathy: LDLT
LDLT biliary complications: caveats

- Optimal stent therapy has not been standardized in LDLT biliary complications
- Smaller, more fragile ducts
- Strictures may involve multiple small duct branches but main duct size may have limited capacity to accommodate multiple stents
- Tight turns in intrahepatic ducts may cause polyethylene stents to kink or buckle
- Long, narrow stents may have suboptimal flow characteristics
- Not a lot of data...

Future Directions-LDLT Complications

- Opportunity exists for more thoughtful retrospective analyses of existing data
- Careful analysis of existing data pools should assist in designing much-needed prospective studies (e.g., A2ALL: www.nih-a2all.org)
- Both will provide guidance in developing useful treatment paradigms
From Poley, et al., GIE 2012.

What does R-Y altered anatomy ERCP require?

Two or more of the following:

- Understanding surgical anatomy
- Different technology
- Different techniques
  - Balloon overtube
  - Rotational overtube
  - Stiffening wire
  - Fluoroscope
Getting there

Balloon enteroscopy

- Deep enteroscopy has revolutionized Roux-en-Y ERC
Deep enteroscopy has revolutionized R-en-Y ERC
Balloon enteroscopy

Balloon enteroscopy

ACG/FGS Spring Symposium - Bonita Springs, FL
Copyright 2014 American College of Gastroenterology
Deep enteroscopy has revolutionized Roux-en-Y ERCP

- Rotational enteroscopy
Balloon enteroscopy caveats

- It takes a long time…
  - 120-200 minutes peroral or retrograde

- Effortful
  - May require anesthesia
    (logistical issues, risk, cost)
  - Skill acquisition

- Requisite expertise
  - Diagnostic
  - Therapeutic

Balloon enteroscopy caveats

- Surgical anatomical caveats: fixed bowel
  - Peritoneal adhesions
  - Anatomotic strictures
  - Esophageal strictures
Balloon enteroscopy caveats

- Surgical anatomical caveats: fixed bowel
  - Roux-en-Y anatomy
    - Anastomoses
      - Ectatic anastomoses
      - Hairpin turns
        » Fixed
        » Scope radius
        » Scope stiffness
    - Peritoneal windows
    - Gastric looping
      - Hiatal hernia
Clinical application

- Choice of deep enteroscopy platform is largely institution-dependent, and institutionally-driven
  - Endoscope manufacturer holding contract for unit
  - Availability of local operator experience and expertise
  - Applies to capsule as well as balloon / rotational enteroscopy

Clinical application

- When to bother
  - Whipple
  - R-Y choledochojunostomy
  - R-Y gastric bypass?
- Data
  - Confounded by mixed populations of B-II, Whipple, and R-Y HJ patients
- Schreiner, et al, GIE 2012
  - Comparo: R-Y enterosc ERC vs lap in RYGB patients
Outcomes

Schreiner, et al., 2012:
R-Y ERC; 32 balloon enteroscopic, 24 laparoscopic

<table>
<thead>
<tr>
<th>TABLE 3. BEA-ERCp versus LA-ERCp outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>BEA-ERCp</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>Roux-en-Y anastomosis identification, %</td>
</tr>
<tr>
<td>Papilla identification, %</td>
</tr>
<tr>
<td>Cannulation, %</td>
</tr>
<tr>
<td>Therapeutic success, %</td>
</tr>
<tr>
<td>Mean total procedure time, min</td>
</tr>
<tr>
<td>Mean endoscopist time, min</td>
</tr>
<tr>
<td>Complications, % of (n/n)</td>
</tr>
<tr>
<td>Mean postprocedure hospital stay, days*</td>
</tr>
</tbody>
</table>

BEA: Balloon enteroscopy assisted; LA: laparoscopic assisted; N/A: not available.

*Successful cases with intervention.

Schreiner, et al., GIE 2012; 75:748.

Outcomes

<table>
<thead>
<tr>
<th>TABLE 4. BEA-ERCp success rate factors: univariate and multivariate analyses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Success rates, %</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>Roux + LEL limb length &lt;150 cm vs ≥150 cm</td>
</tr>
<tr>
<td>Previous cholecystectomy vs no previous cholecystectomy</td>
</tr>
<tr>
<td>Open vs laparoscopic RYGB</td>
</tr>
<tr>
<td>Single vs double balloon enteroscopy</td>
</tr>
<tr>
<td>Previous LGA vs no previous LGA</td>
</tr>
<tr>
<td>Short vs long double-balloon enteroscopy</td>
</tr>
</tbody>
</table>

BEA: Balloon enteroscopy assisted; LEL: Ligation of Efferent limb; RYGB: Roux-en-Y gastric bypass; LGA: Lysis of adhesions.

Schreiner, et al., GIE 2012; 75:748.
Outcomes

- Post-RYGB patient in need of ERCP
- RYGB operative report available?
  - Yes
    - Roux + LTJJ limb length <150cm
      - BEA-ERCP
    - Roux + LTJJ limb length ≥150cm
      - Clinical indicators suggest long Roux + LTJJ limb?
        - Absolute weight loss >150 lbs?
        - Pre-RYGB BMI >55?
          - Yes
            - LA-ERCP
          - No
            - LA-ERCP

Technical caveats

- R-Y HJ
- R-Y in liver transplantation
- The Hudson Loop

Schreiner, et al., GIE 2012;75:748.
Getting in

Access: what’s different?
Deep-enteroscopic ERC
Special anatomical considerations

Surgical anatomy

- Roux-en-Y
Special anatomical considerations

Surgical anatomy

• Roux-en-Y
Special anatomical considerations

Surgical anatomy

- Roux-en-Y
Special anatomical considerations

Surgical anatomy

• Roux-en-Y
R-Y Hepaticojejunostomy
R-Y Hepaticojejunostomy
R-Y Hepaticojejunostomy: Stricture

R-Y Hepaticojejunostomy: stricture
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R-Y Hepaticojejunostomy: Rendezvous
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LDLT – Roux-en-Y anastomotic stricture
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LDLT – Roux-en-Y anastomotic stricture
Upper GI benign stricture management: what’s new for anastomotic strictures?

Benign esophageal stricture management

- Dilation
  - Passage
  - Balloon
- Intralesional corticosteroid injection
- Strictureplasty
  - Needle-knife
  - Endoscopic scissor
  - Argon Plasma Coagulation (APC)
- Stent therapy: long-term/continuous/gradual dilator
  - Migration
  - Chest pain
  - Not durable
- Increasing literature in benign disease, but all small series
- *For SEMS (all): use in benign disease is **off-label**
- No role for uncovered or partially-covered SEMS
- Only fully-covered stents in benign indications
  - FC-SEPS: FDA approved indication
  - **FC-SEMS: off-label use**
Treatments: Stents

- Stent therapy: concept in benign esophageal strictures
  - *Temporary*, long-term/continuous/gradual dilator
  - Stricture remodeling
  - Initial enthusiasm was tempered by
    - Migration
    - Chest pain
    - Not durable
    - AE fistulas (Rogart, et al., Endoscopy 2007)
- Biodegradable stents
  - Tissue ingrowth
  - Potential for serial stenting without removal
- Caveat: *radiation and chemotx increase stent complications*

PC-SEMS: partially-covered metallic
FC-SEMS: fully-covered metallic
SEPS: fully-covered plastic
Why we don’t use partially covered SEMS in benign disease

Hirdes, et al., *Endoscopy* 2011;43:156
- 4 patients
- PC-SEMS for benign perforation or leak
- Median dwell time 29 days
- Endoscopic removal led to perforation in 4/4
### Treatments: SEPS stents

<table>
<thead>
<tr>
<th>Study</th>
<th>n</th>
<th>Stricture type</th>
<th>Stent type</th>
<th>Duration stenting</th>
<th>Outcome</th>
<th>Migrations Complic’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repici 2004 GIE</td>
<td>15</td>
<td>Mixed</td>
<td>Polyflex SEPS</td>
<td>6 wks</td>
<td>80% dys-free at mean 22 mos</td>
<td>Migr 7% Complic 0</td>
</tr>
<tr>
<td>Evrard 2004 GIE</td>
<td>21</td>
<td>Mixed</td>
<td>Polyflex SEPS</td>
<td>2d-56 wks</td>
<td>80% dys-free at median f/u 21 mos</td>
<td>Migr 52% Airway compr 5%</td>
</tr>
<tr>
<td>Dua 2008 AJG (prosp)</td>
<td>40</td>
<td>Mixed; most anast/corrosive/XRT</td>
<td>Polyflex SEPS</td>
<td>4 wks</td>
<td>40% dys-free at median 53 wk follow up</td>
<td>Migr 22% Death 1 bld Fistula 1 Perf 2</td>
</tr>
<tr>
<td>Oh 2010 DDS</td>
<td>13</td>
<td>Anast 11/13</td>
<td>Polyflex SEPS</td>
<td>6 wks</td>
<td>23% dysph-free @ µ 37 d, r 6-120 d</td>
<td>Migr 30% No major complic’s</td>
</tr>
<tr>
<td>Repici 2010 APT</td>
<td>130</td>
<td>Mixed</td>
<td>Polyflex SEPS</td>
<td>?; med f/u 13 mo</td>
<td>52% symp free at med 13 mo f/u</td>
<td>Migr 24% Maj comp 9%, dth 1%</td>
</tr>
</tbody>
</table>

### Treatments: FC-SEMS stents

<table>
<thead>
<tr>
<th>Study</th>
<th>n</th>
<th>Stricture type</th>
<th>Stent type</th>
<th>Duration Stent/post</th>
<th>Outcome</th>
<th>Migrations + Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kim 2009 Eur Radiol</td>
<td>55 PR</td>
<td>Corrosive 80%; else mixed</td>
<td>Tae-woong Niti-S</td>
<td>1 wk-6 mo/µ 38 mos</td>
<td>38% patency at 6 mos; 33% at 1 yr</td>
<td>Migr 25% Ovgrth 31%</td>
</tr>
<tr>
<td>Senousy 2010 DDS</td>
<td>7 RT</td>
<td>Mixed anast/pep/XRT/PDT</td>
<td>Alimaxx</td>
<td>4-84 d, µ 37 d/µ 172 d</td>
<td>“Clin impvmt dysphagia” 100%</td>
<td>Migr 39% Minor complic only</td>
</tr>
<tr>
<td>Eloubeidi 2011 GIE</td>
<td>19 PR</td>
<td>Mixed</td>
<td>Alimaxx</td>
<td>6-300 d, 64±74d/24-360 d total f/u</td>
<td>30d median symptom free post stent plcmt</td>
<td>Migr 37% No major compl</td>
</tr>
<tr>
<td>Hirdes 2012 GIE</td>
<td>15</td>
<td>Mixed</td>
<td>Wallflex</td>
<td>Med 109 d or to migr/obstr/pain</td>
<td>100% dysph recurs med 15 d post-remvl</td>
<td>Migr 33% Asp pneum 7% Ovgrth 50%</td>
</tr>
</tbody>
</table>
New technology: biodegradable stent

- Biodegradable esophageal stent: Ella-CS
  - Uncovered stent
  - 25mm dia, 60-135mm length
  - Polydioxanone
  - Similar to polyester
  - Degrades by hydrolysis
  - Hydrolysis accelerated by low pH
  - Not removable
  - Radial force begins to deteriorate ~ 5 wks at pH 7 and 37°C in vitro
    - 2/3 at 7 wks
    - 50% at 9 wks

Repici, et al., GIE 2010;72:927

Treatments: biodegradable stents

<table>
<thead>
<tr>
<th>Study</th>
<th>Type</th>
<th>Duration</th>
<th>Outcome</th>
<th>P</th>
<th>Migrations + Complic's</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repici 2010 GIE</td>
<td>Mixed Peptic/</td>
<td>53 wks median</td>
<td>45% dys-free @ 53 wks f/u; med Δ dys</td>
<td>&lt;0.01</td>
<td>Migr 10% Bleeding 1/21</td>
</tr>
<tr>
<td></td>
<td>caustic/anast</td>
<td>follow up</td>
<td>score 3 to 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Van Boeckel 2011</td>
<td>Mixed</td>
<td>166 days median</td>
<td>33% dys-free @ 166 d f/u; med Δ dys</td>
<td>&lt;0.0001</td>
<td>Migr 22% Bleeding 1/18 Obstr 2/18</td>
</tr>
<tr>
<td>CGH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canena 2012 BMC Gastro</td>
<td>Mixed Peptic/anast/XRT</td>
<td>18.5 mo median follow up</td>
<td>30% dys-free @ median f/u 18.5 mo (r 11-21 mo)</td>
<td></td>
<td>Migr 20%</td>
</tr>
</tbody>
</table>
**Treatments: incisional therapy**

Incisional therapy
- For anastomotic strictures
- Needle-knife incision
- Radial incision & cutting
- Scissor incision

**Needle-knife incisional strictureplasty**
- 62 pts previously untreated anastomotic strictures
- Randomized, controlled, prospective: 31:31 Savary:IS
- Not blinded
- Outcomes examined at 1, 3, 6 mos
  - Mean dilations: 2.9 vs 3.3; P = 0.46
  - Success rate (% pts with ≤ 5 dilations / 6 mos): 80.6% vs 67.7%; P = 0.26
Treatments: incisional therapy

Endoscopic radial incision and cutting

- Non-randomized, retrospective
- 54 pts with refractory anastomotic strictures
- Procedure time mean 14 min (r 5-40)
- Outcome
  - DS 0-1
    - 6 mos: 63%
    - 12 mos: 62%
  - Complications
    - Perforation 3.5%
Wrapping it up…

- Change is opportunity
  - New operations create new anatomy and new complications
  - Gastrointestinal surgery presents tremendous opportunities for challenging, novel, high-impact interventional endoscopy
- Novel technologies are advancing our ability to treat previously inaccessible surgical anatomy
- Bariatric surgery complications, ischemic cholangiopathy and other complex biliary anatomy in LDLT and RYHJ biliary reconstruction, and esophageal anastomotic complications will represent major, growing therapeutic challenges for the surgically-focused endoscopist in the foreseeable future