Overview

• Background
• Anatomy
• Pathology
• Radiological Workup
• Selected Cases
Nonvariceal GI Bleeding

• **Upper GI vs. Lower GI bleeding**
  – **UGI bleeding**
    • 5-8x more common than LGIB (gastritis, ulcers)
    • endoscopy initial diagnostic evaluation in stable pts
      – can identify bleeding source 95% of time
      – Tx electrocautery, sclerotherapy, banding
    • angiography reserved when endoscopy impossible or inconclusive; unstable pts
Acute Lower GI Bleeding

- 300,000 admissions/year in US
- 80% colonic in origin
- endoscopy often difficult/impossible
- radiology provides important role in management of acute LGIB for diagnosis and treatment
Clinical Information for GI bleeding

- what orifice blood is coming from
- hemodynamic stability
- resuscitative measures already taken
- NGT, Foley in place
- endoscopy
- coagulopathies/ corrective measures
- hx GI surgery
- treatment plan following localization
Vascular Anatomy

• Celiac Axis
  – liver, spleen, stomach, duodenum
  – arises at T12-L1 interspace
  – 1st branch is left gastric artery
    • supplies gastric fundus and GE junction, anastomoses with right and short gastrics
  – 2nd branch is splenic artery
  – 3rd branch is common hepatic artery
  – dorsal pancreatic artery may arise from celiac, hepatic, or splenic arteries in 10%
  – inferior phrenic arteries in proximity
Vascular anatomy con’t

• Celiac artery con’t
  – conventional branching in 70%
  – any of celiac branches can arise directly from aorta, or with exception of the left
gastric from the SMA
Anatomy

• **Celiac Axis**

- **left gastric**
- **right gastroepiploic**
- **GDA**
- **common hepatic**
- **splenic**
Vascular Anatomy con’t

• **Superior Mesenteric Artery**
  - duodenum, small bowel, colon to splenic flexure
  - arises at L1 1-20 mm below celiac
  - 1\textsuperscript{st} branch usually inferior pancreaticoduodenal artery
  - 2\textsuperscript{nd} branch middle colic
  - jejunal and ileal branches
  - right colic
  - ileocolic
  - appendiceal (ileocolic or distal SMA)
Anatomy

- Superior Mesenteric Artery
  - jejunal branches
  - middle colic
  - right colic
  - ileal branches
  - ileocolic
Vascular Anatomy con’t

• **Inferior Mesenteric Artery**
  – *left* and sigmoid colon, proximal rectum
  – arises left side of distal AA at L3
  – *1st* branch is left colic
  – sigmoid branches
  – superior rectal is terminal branch

• **Internal Iliac Arteries**
  – *middle* and *inferior rectal arteries arise off anterior division*
Anatomy

- **Inferior Mesenteric Artery**

  - left colic
  - sigmoid branches
  - superior rectal
Vascular Collateral Pathways

- **Celiac to SMA**
  - Arc of Buehler
  - pancreaticoduodenal arcades
- **SMA to IMA**
  - middle colic to left colic
  - Arc of Riolan
  - marginal artery of Drummond
- **IMA to Internal Iliac**
  - via superior hemorrhoidal
- **Rectal arcades**
Vascular Anatomy con’t

- **Stomach**
  - *fundus* primarily via *left gastric*
  - *short and posterior* gastrics
  - *body* by *gastroepiploic artery* along *greater curvature*
  - *lesser curvature* by *left and right* gastrics
  - *antrum and pylorus* supplied by *right gastroepiploic*, *right gastric*, and *pancreaticoduodenal arteries*
Vascular Anatomy con’t

• Duodenum
  – 1\textsuperscript{st} and 2\textsuperscript{nd} portions from GDA and its branch the superior pancreaticoduodenal artery
  – 3\textsuperscript{rd} and 4\textsuperscript{th} portions from SMA and its branch the inferior pancreaticoduodenal artery
Etiologies of Acute UGIB

- gastritis
- PUD
- Gastroesophageal varices
- Mallory-Weiss tear
- iatrogenic
- AVM / angiodysplasia
- tumor
- aneurysm / PSA
• What is a Dieulafoy lesion?

a) iatrogenic injury
b) congenital malformation
c) acquired / degenerative
d) related to severe burns
Dieulafoy Lesion

- Rare (<5%) cause of gastric bleeding
- Congenital
- Single large tortuous arteriole in submucosa, around 10x normal diameter
- 95% gastric fundus; can occur anywhere in GI tract
- Hemorrhage from erosion in overlying mucosa likely from pulsation
- Treatment with endoscopy

http://www.gcgeorge.net/2008/07/18/
Etiologies of Acute LGIB

- **Large Bowel Origin**
  - diverticulosis
  - angiodysplasia / AVM
  - colon Ca
  - polyps
  - IBD, other colitides
  - rectal disease
  - vasculitides
  - aortoenteric fistula
Etiologies of Acute LGIB

• Small Bowel Origin
  – AVM
  – leiomyoma
  – ulcers
  – small bowel varices
  – IBD
  – diverticulosis
  – tumors
  – Meckel’s diverticulum
Potential ABO Angiography Question

- Angiography performed in a patient with chronic intermittent lower GI bleed demonstrates the following:
  - Angiodysplasia

Hastings, G. S. Radiographics 2000;20:1160-1168
Nuclear Scintigraphy

- stable patient with intermittent hemorrhage, bleeding scan initially performed prior to angiography
- both $^{99m}$Tc RBC and $^{99m}$Tc colloid used
- can detect bleeding rates as low as 0.1 ml/min
- most centers will proceed to angio if bleeding scan positive
- scans not usually helpful in UGIB
Nuclear Scintigraphy

- most LGIB intermittent, thus chances of detecting site of hemorrhage enhanced by radiopharmaceutical with long T1/2
- scans best for acute LGIB; chronic low volume blood loss rarely benefit
- agent of choice $^{99m}$Tc RBC
  - sensitivity upwards of 90%
• **In Vitro Procedure**
  - 1-3 ml anticoagulated blood added to vial with stannous chloride
  - *sodium hypochlorite* added to oxidize extracellular *tin*
  - *mixture of citric acid, sodium citrate, and dextrose* added
  - then $^{99m}$Tc pertechnetate introduced; after 20 minutes cells re-injected
    - *labelling efficiency* > 95%
Imaging

- *initial rapid perfusion sequence* 2-3 second abdominal and pelvic images over 30-60 seconds
- *static images* then obtained at 5 minute intervals for 60 minutes, thereafter images taken at 15-60 minute intervals
- *or continuous dynamic computer acquisition*, results viewed in cine format
- *6, 12, 24 hour delayed images* obtainable
**$^{99m}Tc$ RBC scintigraphy**

- **Imaging con’t**
  - free technetium not bound to RBC
  - excreted by kidneys and gastric mucosa
  - and passes into bladder, small bowel, colon
99m Tc RBC Scintigraphy

- **Positive Scan Findings**
  - *initial focus of activity, which must increase and change position over time*
  - *if activity remains in same location, consider static vascular abnormality*
  - *blood is irritant to intestine, movement of tracer activity often rapid and bidirectional*
  - *earlier in study that bleeding is seen, more accurate is degree of localization*
Positive $^{99m}$Tc RBC Scan

http://brighamrad.harvard.edu/Cases/bwh/hcache/126/full.html
\textit{99m Tc Sulfur Colloid}

- **Uncommonly used**
  - inexpensive, easy prep, readily available
- **Colloid clears rapidly from intravascular space via RES**
  - good contrast between background and extravasated isotope
  - disadvantage as bleeding must be actively occurring during short time colloid is intravascular (\( t \frac{1}{2} \) 2.5 to 3.5 minutes)
  - liver and spleen activity can obscure flexures
$^{99m}$Tc Bleeding Scans

- occasional confusion of bladder activity within rectosigmoid bleed can be resolved with postvoid or lateral pelvic images
- interfering genital activity can also be confused for bleeding site; oblique or lateral views helpful
- important to watch for free technetium or pertechnetate artifacts
$^{99m}\text{Tc RBC: Free Pertechnetate?}$

http://gamma.wustl.edu/gi007te177.html
Nuclear Medicine Meckel’s Scan

• Meckel’s Diverticulum
  – congenital diverticulum; vestigial remnant of omphalomesenteric (vitelline) duct
  – 2% of population
  – 96% lesions will remain asymptomatic
  • complications include hemorrhage, obstruction, intussusception, volvulus
  – most common presentation is with painless rectal bleeding
  – virtually all cases of bleeding Meckel’s involve ectopic gastric mucosa +/- ulcer
Meckel’s Scan

- Imaging based on visualization of ectopic gastric mucosa via intravenous $^{99m}Tc$ pertechnetate
- Dose administered, sequential anterior abdominopelvic images obtained for 45-60 minutes
- Positive scan shows focal increased activity in RLQ or midabdomen
Meckel’s Scan

- sensitivity and specificity around 90%
- sensitivity can be increased by
  - cimetidine to block release of pertechnetate from gastric mucosa
  - pentagastrin to enhance mucosal uptake of pertechnetate
  - glucagon to decrease small bowel activity
Positive $^{99m}$Tc Pertechnetate Scan

http://jnm.snrmjournals.org/cgi/content-nw/full/49/5/776/FIG4
Mesenteric Angiography

- positive in only around 50% of cases
- should begin with selective injection of most likely source vessel supplying site of bleeding
  - celiac for upper GI source
  - SMA for small bowel and right colon
  - IMA for sigmoid and rectum
Mesenteric Angiography

• bleeding not identified on first injection, next most likely artery should be selected

• celiac injection should be included for LGIB when SMA or IMA injections are negative as middle colic artery is replaced to dorsal pancreatic artery in 1-2% of patients

• occasional internal iliac artery injections needed with occluded IMA
Mesenteric Angiography

- filming should be rapid 3-6 frames per second during arterial phase, then slower during portal venous phase
- visualization of portal venous phase mandatory as bleeding can be due to varices or venous thrombosis
- IV glucagon can help decrease artifact from bowel gas / peristalsis
Mesenteric Angiography

- **Positive Angiographic findings**
  - extravasation of contrast into bowel lumen
  - “pseudovein sign” of contrast within gastric rugae
  - extravasation should appear during arterial phase, persist during venous phase, and change over time
  - additional signs of vascular abnormalities include caliber changes, tumor vascularity, aneurysms / PSA, AV shunting etc.
Mesenteric Angiography

- **Digital images should be inspected in both subtracted and unsubtracted modes**

- **False positive exams**
  - barium in pre-existing diverticula, bowel gas, densely enhancing veins, hyperemic bowel mucosa, adrenal blush

- **False negative exams**
  - injection of inadequate volumes of contrast, failure to include all vascular bed in FOV, wrong artery selected
Endovascular Intervention

- **Vasopressin Infusion (historical)**
  - Pituitary hormone causing smooth muscle constriction and water retention
  - Could control bleeding when injected into proximal SMA, IMA
  - Best for diffuse mucosal hemorrhage or bleeding from small caliber arteries
  - Usually started with 0.2 U/min, increased up to 0.4 U/min; once bleeding stopped, continuous infusion, ICU monitoring, taper 24-48 hrs
  - Complications including arrhythmias, coronary and digital ischemia
Endovascular Intervention

• Transcatheter Embolization
  – now used almost exclusively due to rapid and definitive results
  – basic objective is to decrease arterial pressure and flow to point that hemostasis can occur, without creating symptomatic ischemia
  – steel or platinum microcoils, large particles, gelfoam pledgets
Common Embolic Agents

Boston Scientific VortX® coil

Boston Scientific Contour® PVA particles

Transcatheter Embolization

- General rule is identification of bleeding source prior to embolization
  - Exceptions
    - empiric left gastric artery embolization in patients with endoscopic evidence of fundal or GE junction lesions
    - empiric GDA embolization in patients with endoscopic evidence of duodenal lesions
  - Bowel should only be embolized superselectively due to risk of ischemia
    - ideally just proximal to terminal arcade or immediately adjacent to mucosal surface
Transcatheter Embolization

- technically successful in >90% of cases; rebleeding occurs around 20%
- pts should be evaluated for development of ischemia
  - delayed ischemic colonic strictures have been reported
- may pass melanotic stools long after bleeding has stopped
Transcatheter Embolization

- **Causes of failed embolization**
  - failure to recognize collateral supply
  - incomplete occlusion
  - failure to recognize spasm
  - failure to recognize/correct coagulopathy

- **Complications**
  - non target embolization
  - ischemia
  - aneurysm rupture
Provocative Angiography

• Around 5% of patients will multiple admissions / transfusions for LGIB, however repeat radiologic and endoscopic exams are negative

• Adding pharmacologic agents (anticoagulants, vasodilators, fibrinolytics) during standard angiographic examinations to induce a prohemorrhagic state
Provocative Angiography

- 1st described by Rosch in 1982
  - 3 pts given 50 mg tolazoline, 10,000 U heparin, and combination of 50 mg tolazoline with 60,000 U streptokinase
    - all three pts had successful provocation
  - 1st large series by Kovat in 1987
    - increase in diagnostic yield for demonstration of extravasation at angio from 32% to 65% in patients who received heparin +/- tolazoline and streptokinase and who had bled in previous 12 hrs
Provocative Angiography

- Duke study in 2001 by Ryan et al
  - involved 17 provocative angiograms in 16 patients using a protocol with tolazoline, heparin, and tPA
  - all pts had previous negative workups
  - identified site of bleeding in 37.5% of patients, and found 2 additional vascular abnormalities
  - no procedural complications reported
Provocative Angiography

• Various studies have reported a success rate at provoking hemorrhage of between 29-80%
  – Reasons for variable success
    • lack of standardized regimen
    • different combinations of drugs/dosing
    • different duration in time from active bleeding
    • referral patterns
    • operator experience
Provocative Angiography

• Contraindications
  – similar to peripheral thrombolysis
    • Absolute
      – TIA within 2 months, CVA within 6 months
      – intracranial neoplasm
      – craniotomy within 3 months
      – mobile left heart thrombus
    • Relative
      – recent major surgery, trauma, CPR
      – uncontrolled HTN
      – endocarditis
      – pregnancy and postpartum period
      – severe cerebrovascular disease
Provocative Angiography

• **Future**
  – *need for large scale study*
  – *optimal protocol has not yet been established*
Case #1

- 73 year old female on chronic NSAIDS with 6-8 day history of nausea, black emesis, melanotic stools found down at home and brought to ED
  - BP 80/40, Hct 23, NG lavage +
  - endoscopy with large clot in duodenal bulb and 2nd portion of duodenum
Case #1
Case #2

- 46 year old male presented to ED with nausea and syncopal episode.
  - vitals stable, found to have Hgb 5.7, Hct 18
  - admitted to MICU, transfused
  - large volume hematemesis
  - endoscopy with large duodenal ulcer in bulb with adherent clot 4-5 cm in diameter
Case #2
• **Sent back to MICU, Hct stabilized over next several days**
  – 5 days later, presented with repeat episode of large volume *hematemesis*
Case #2 con’t
Case #3

• 67 year old male previously healthy with acute onset BRBPR
  – syncopal event at urgent care center
  – transferred to regional medical center, initial NM RBC scan negative
  – second RBC scan positive in ascending colon; angio negative
  – transferred to Duke for elective colonoscopy
  – over weekend, repeat RBC scan performed
Case #3 con’t
Case #3 con’t

- back to MICU; continued to have episodic BRBPR
- colonoscopy demonstrated extensive diverticulosis with multiple polyps in cecum and transverse colon
- surgery consulted; decision made to proceed with provocative arteriogram
Case #3 con’t
Case #3 con’t
References

- Ryan JM et al. “Nonlocalized lower gastrointestinal bleeding: provocative bleeding studies with intraarterial tPA, heparin, and tolazoline. JVIR. 2001 Nov; 12 (11), 1273-7