Vesalius SCALpel™ : Stomach, small intestine, appendix (see also: abdominal folios)

Secretions

- endocrine
  - gastrin: antral G cells
    - trophic effect on mucosal cells -> hyperplasia
    - 2 forms: big (G34) and little (G17)
      - G34 lo potency, longer half life, active in basal acid output (BAO)
      - G17 hi potency, primarily during stimulated acid output
        - 90% of gastrin produced is G17
  - somatostatin: D cells body and antrum
    - stimulated by antral acid
  - intrinsic factor
- histamine: enterochromaffin-like (ECL) cells: fundus and body
- acid (parietal cell), pepsinogen (chief cell): fundus and body, acid converts pepsinogen to pepsin
- mucous
  - gel of water and glycoprotein
  - mechanical barrier
  - impede ion/acid movement into mucosa
  - increased production stimulated by: vagus, cholinergic, prostaglandins
  - decreased production: anticholinergics, NSAIDs, h. pylori
- mucosal barrier: mucous, HCO_3-, motility

stimulation of acid production by parietal cells

- 3 receptors: histamine, ACH, gastrin: stimulate common proton pump
  - exchange H^+ for K^+
- neural: vagus, ACH
- humoral: gastrin, histamine
- synergy: acid production amplified if more than one receptor occupied
- blockade of one makes others much less responsive (vagotomy decreases gastrin-stimulated acid production)

two types of acid secretion: basal and stimulated

- BAO
  - ~2mEq/h, 10% of max
  - vagal tone, ambient gastrin and histamine
  - vagotomy decreases BAO 75-90%
  - H2 blockade decreases BAO 80-90%
- stimulated
  - cephalic, gastric, intestinal phases
  - concurrent, not necessarily sequential
  - cephalic phase
    - smell etc. -> vagal stim -> ACH
    - inhibited by vagotomy or atropine

gastric phase
food -> gastrin, histamine
protein/aa's stimulate gastrin production
alkalinization stimulates gastrin
mechanical distention causes vagal stimulation
inhibition
vagotomy
antrectomy: eliminates G cell mass
antral acidification stimulates somatostatin release which inhibits G cell release of gastrin
increased gastrin: ZE, G-cell hyperplasia, retained antrum
bombesin stimulates release of antral gastrin, not from ZE
MEN I with ZE and hyperpara, treat hyperpara first
intestinal phase
chyme entering duodenum, completes small particle digestion
elicits small acid secretory response
duodenal acidification -> secretin -> block gastrin receptors
motility: solid emptying linear, liquid exponential, proportional to volume
ZE speeds emptying

Duodenal ulcer

decreasing since 60s, before H2 blockers, M now = F
incidence of DU 10y younger than GU
h. pylori
abnormal acid secretion, barrier breakdown, smoking 2X risk
Gm- rod, slow growing, converts urea to ammonia, produce urease
oral-fecal transmission, humans primary reservoir
>50% of world pop infected/colonized (30% US)
most asymptomatic, nearly all have antral gastritis
more common: old, Hispanic, African, lower social status
found in 90% of DU, 80% of GU & chronic atrophic gastritis
5-7X increased risk PUD, recurrence markedly reduced by elimination
2-6X risk gastric adenoCa, lymphoma, MALT
h. pylori organisms protected by mucous in antrum (pH 7 beneath mucous)
increased gastrin, decreased somatostatin breaks down mucin
active Dx: urea breath test: 13C-labeled urea ingested, urease from h. pylori splits off C, detected in breath
endoscopic bx, clo test
stool antigen, indicates active infection
passive: serologic, saliva or urine for IgG antibody to h. pylori (can't differentiate past from active infection)
endoscopic bx, examine for organisms
DU greater acid than normal, increased parietal cell mass, increased sensitivity to stimulation
loss of inhibitory signals, decreased sensitivity to antral acidification, decreased D cells

& somatostatin, decreased negative feedback
NSAIDS: 2nd most common cause, 10-20X risk with daily use
associated risks: elderly, co-morbid conditions, h. pylori infection
damages mucosal barrier, decreases mucosal prostaglandins
ulcers 1-2 cm from pylorus rarely malignant
more distal ulcers: ZE, malignancy, drug-induced, Crohn's
most gastrinomas in duodenum; pancreas 2nd most common (gastrinoma triangle)
other causes of elevated gastrin: renal failure, post antrectomy retained antrum, short bowel syndrome (decreased gastrin metabolism), vagotomy (alkaline antrum causes G cell hyperplasia)

DU treatment

eradicate h. pylori, rarely need chronic Rx
20-40% recurrenc when Rx with PPI alone
triple Rx: PPI (omeprazole), amoxicillin/clarithromycin
failure due to non-compliance
cures 90%, reinfection 0.5%/y
surgical indications (limited)
medical intractability, complications: perforation , obstruction, bleeding (more common complication than perforation)
paradoxical aciduria: late gastric outlet obstruction -> hypovolemia
kidneys conserve Na, excrete H & K
vagotomy decreases stimulation of parietal cells
incomplete vagotomy most likely cause of recurrent ulcer
G cell hyperplasia post vagotomy, but does not cause acid hypersecretion
antrectomy decreases antral gastrin secretion
truncal vagotomy eliminate vagal stimulation down to right colon
20% gastric outlet problems without drainage procedure
parietal cell vagotomy less complications, 2% recurrence
perforation:
shock, > than 24h patch only
selective non-op management (stable, no peritonitis, contained)
chronic pyloric stricture
dilatation works short-term
truncal vagotomy and antrectomy if necessary
difficult duodenum vagotomy and gastro-J
gastric lymphoma: Rx surgical resection
bleeding
resuscitate IV, RBC, warm lavage (cold inhibits clotting), EGD
endoscopy > 75% success stopping bleeding
visible vessel high rate of rebleeding
surgery
shock, repeat bleed, > 6U/24h, recurrent bleed, readmission
duodenal cancer assoc w FAP/Gardner's, VonRecklinhausen
tricobezoar surgery, phytobezoar enzyme Rx

Duodenum, **polyp/cancer**

polyposis
- FAP: multiple, 300X risk duodenal Ca
  - duodenal Ca is the second most common malignancy in FAP, associated death despite proctocolectomy
  - complete clearance of duodenal polyps in FAP requires resection, scope surveillance not effective
- isolated villous adenoma usually around ampulla

Gastric ulcer

incidence stable, older 55-65, mechanism unclear
risks: NSAID/ASA, alcohol, tobacco, h. pylori (in 80%), chronic and atrophic gastritis, presence of acid
NSAID inhibition of prostaglandin alters mucosal barrier
normal acid secretion v DU hypersecretion
types (Johnson classification):
- 1 anywhere in body proximal to antrum, lesser curve, normal acid secretion, 60% of GUs , (association with blood type A)
- 2 body plus DU (subset of DUs), high acid, 20%, decreasing incidence
- 3 pre-pyloric/channel, (subset of DUs), high acid, 20%
- 4 high lesser curve, adjacent to GE jct, subtype of 1, lo acid, <10%, difficult to treat
- 5 drug-related (ASA, NSAID), anywhere in stomach, Rx stop drug

triple therapy like DU, EGD & multiple bx perimeter and base to R/O malignancy
- increased chance of malignancy with large (10%)

medical Rx highly successful (90%), need for surgery < 10%
rescope 6w after completion of medical Rx lookinf for healing (malig ulc can also show signs of healing)
surgical indications: giant ulcer (>3cm), < 50% healing, non-compliance, early recurrence, complication (bleeding, perforation, obstruction)
- type 1: antrectomy (removes major site of h. pylori colonization), Billroth I, no vagotomy (normal acid) (ulcer excision, parietal cell vagotomy?)
- type 2: antrectomy with ulcer, Billroth I, vagotomy (parietal cell vagot?)
- type 3: " " " or II, no parietal cell vagotomy (outlet obstruction)
- type 4: extended antrectomy with ulcer bx or excision, Billroth II
- type 5: depending on location V&P or V&A
- bleeding excise ulcer
- perforation: pts usually older, sicker, higher mort (40% v 10% for DU)
- controversy: resection or closure
  - distal gastrectomy + truncal vagotomy (type 2 and 3, hi acid)
  - biopsy ulcer if not resected, eliminate h. pylori
  - highly selective vagotomy not indicated

hypertrophic polyps in 50% of pts with h. pylori and atrophic gastritis
- multiple polyps associated with increased cancer risk

adenomatous polyps marker for whole stomach risk; remove all

Acute gastritis (acute gastric mucosal lesion [AGML]/stress ulcer/erosive gastritis/hemorrhagic gastritis, acute mucosal ischemia)

multiple superficial erosions fundus, mostly body, bleeding
acid and activated pepsin in the presence of hypoperfusion/mucosal ischemia
pepsin is inactivated at pH4.5 (prior question of increased nosocomial pneumonia from gastric bacterial colonization with titrating gastric pH up, particularly with carafate, not supported by recent studies)
stress: burn, trauma, prolonged ICU stay (@ 24-48h)
Cushings: head trauma/surgery, single ulcer stomach or duodenum
Curlings: burn, gastric erosions frequently extending to duodenum, diffuse
multiple factors: acid necessary, mucosal ischemia/loss of barrier, ischemia/reperfusion injury, injury at epithelial level

Rx
prevention: adequate resuscitation to prevent ischemia/reperfusion
neutralize acid, H2 blockers highly effective, or pH titration (more difficult)
reverse coagulopathy, maintain O_2 sat, lavage
endoscopy effective for discrete lesions
persistent or diffuse bleed, next step angio/vasopressin via left gastric, embolize bleeding vessels, 80% effective
if non-op measures fail, surgery: do less than total gastrectomy (40% mortality)
devascularize all but short gastrics, oversew, truncal vagotomy

Dieulafoy's lesion (described 1896)

tortuous submucosal artery with overlying ulceration (mechanical, no inflammation)
not associated with h. pylori
also found in esophagus, small intestine, colon and rectum
Endoscopic Rx: hemoclip (most effective, also successful for colonic Dieulafoy's), heater probe, ethanolamine injection 78% permanent hemostasis
angioembolization
surgery last resort
(bleeding scan not indicated for hematemesis, scope)

Gastric malignancy

adeno 90%, lymphoma < 5%, sarcoma (GIST) 1-3%
gastric adeno: 2nd leading cause of death worldwide; US decreased to '80s, increasing again
most present as advanced
increasing incidence proximal and GE jct, 50%, worse prognosis
risks: h. pylori (distal lesions mostly), Asian/diet, chronic gastritis, adenomatous polyps, pernicious anemia, prior partial gastrectomy > 20y, Menetriers, family hx, smoking

Dx/staging:
- EGD/Bx,
- CT chest/abdomen/pelvis (good for bulky tumor and mets, poor for T and N staging)
- endoscopic ultrasound (EUS) best for T & N staging
- PET use evolving; laparoscopy best for Dx of peritoneal disease
- tumor depth correlates with nodal disease

Surgical Rx
- preop chemorads (5FU bolus) increases R0 (negative margin) resection rate (another source says it does not?)
  (no change 5y survival with chemo/rad?)
- minimum of 15 nodes must be examined
- only 30% eligible for curative resection, staging laparoscopy IDs mets in 30%
- op mort directly related to extent of resection
- 5cm margin necessary (submucosal spread)
- resect directly involved adjacent organs (liver, spleen, pancreas), no prophylactic resection
- perigastric LNs along named vessels (celiac, common hepatic, splenic)
- resect greater and lesser omentum
- distal stomach: subtotal gastrectomy (total rarely necessary), Billroth II, loop with entero-enterostomy (Braun) or Roux-y limb > 50cm (prevent bile reflux)
- mid-stomach: total gastrectomy, Roux-y, D2 lymph node dissection
- proximal: total, distal esophagectomy (extended gastrectomy), Roux reconstruction

stage	TNM	5y survival
Ia	T1N0	60-95%
Ib	T1N1, T2N0	44%
II	T1N2, T2N1, T3N0	29%
III	T2N2, T3N1/2, T4N0	13%
IV	M1	3%

palliative
- metastasis or peritoneal seeding: no resection for cure, no change survival
- palliative surgery only for bleeding or obstruction refractory to other Rx
  - Endoscopic laser, radiotherapy, stent, feeding tube
  - resection preferable to bypass

GIST

origin: intestinal pacemaker cells of Cajal
most common GI tract sarcoma
formerly called leiomyoma/leiomyosarcoma
asymptomatic until grow large
found anywhere in the GI tract, most common in stomach, unpredictable behavior,

bleeding common
malignant potential: size > 5-10 cm, mitotic index > 5-10m/10 HPFs;
less than these criteria < 2% recurrence, Gleevac not indicated
exceeding both criteria 85% recurrence v 10-15% if only one
metastasis only proof of malignancy: local recurrence, peritoneum, liver
hallmark C-Kit positive (membrane-bound tyrosine kinase receptor; receptor activating mutation)(immunohistochemistry stain)
positive in 90-95%, predicts response to Gleevac
1-3% of gastric neoplasms, 50% of GISTS occur in stomach
occasional adjacent organ involvement, resection of adjacent involved structures may be curative
malig spread hematogenously (not lymphatics) to liver, lung
complete wedge resection with 1cm margin depending on location
operate without biopsy
larger may require more formal gastrectomy
soft friable, take care not to rupture
rare LN met, lymph node dissection not necessary
Gleevac/imatinib: oral tyrosine kinase inhibitor
approved for recurrent and metastatic
not recommended for surgically resectable
outcome (likely to change with Gleevac use)
lo grade and < 5cm 90% 5y w resection alone
hi grade and > 5cm 30% (50-60% if only hi grade or only > 5cm)
metastatic <10%

Gastric carcinoid

1 sporadic: normal gastrin, large, solitary
can metastasize causing carcinoid syndrome (flushing, hypotension, bronchoconstriction)
partial gastrectomy and LN dissection
2 with achlorhydria/pernicious anemia: increased gastrin, multiple small tumors in body
70% of gastric carcinoids
lo malignant potential
nonfunctional: gastric carcinoids produce little 5 hydroxytryptamine, but lack the enzyme to convert to active serotonin, therefore serum serotonin and 5HIAA are normal
treat increased gastrin with antrectomy, multiple <1cm regress
H2 blockers and PPIs have no role in treatment
3 associated with MEN1 & ZE: increased gastrin, multiple small carcinoids, low malig potential
measure chromogranin A in all carcinoid pts, useful for monitoring
(small intestine most common site of carcinoid, 50% distal ileum, 70% metastatic at Dx)
(colonic carcinoid rare, usually large, R colon, older pt 60-70y)
(rectal carcinoids more commonly identified; syndrome rare with colonic, appendiceal, rectal carcinoids)

Gastric lymphoma

MALT: mucosa-associated lymphoid tissue
- associated with h. pylori, antigenic response to infection
- monoclonal B cell proliferation
- lo grade (can transform to hi grade), LN/marrow involvement rare
- treat h. pylori with triple Rx gives 80% remission rate
- focused wedge for hi-grade MALT

> 50% of all primary GI lymphomas occur in stomach, age > 50, increasing worldwide
most associated with systemic lymphoma
hi-grade lymphoma (non-h. pylori related)
- resection, chemo, radiation all have roles
- primary resection or as salvage after chemo
  - resect like adeno, submucosal spread, frozen section margin
  - local perigastric lymphadenectomy only
- gastric lymphoma with extragastric disease chemo +/- RT, systemic Rx
- survival
  - IE stomach only 90%
  - IIE-1 stomach and local LNs 82%
  - IIE-2 stomach and distal LNs 40%

Post-gastrectomy syndrome

occurs in 25% of gastrectomy patients, ~1% disabling
causes remain obscure
avoid reoperation, leads to more complications
- only after all other approaches fail

Bariatric surgery

100lb over ideal weight, BMI > 35-40kg/m^2 (wt. kg/ht. in m^2)
12X reduction life expectancy
consequences of morbid obesity:
- hypoxia from sleep apnea
- DVT from polycythemia
- pulmonary hypertension
- right heart failure
- diabetes
- GERD

BMI> 35Kg/M^2, metabolic syndrome= medical necessity
50% of morbidly obese have GERD, 20% severe; gastric bypass alone treats as effectively as Nissen in non-obese
Roux-Y gastric bypass most effective:15-30cc pouch, 75-150cm Roux limb
acute complication, leaking Roux-Y gastrojejunostomy most serious, <2% incidence
- older, heavier (>50Kg/M^2) with comorbid conditions higher risk

present as sepsis: early increased respiratory rate/respiratory failure, tachycardia (>120), hypotension; elevated WBC, oliguria late
R/O PE, hypovolemia, bleeding
gastrografin UGI, CT poor (22%) sensitivity
reexplore for hemodynamic instability, resp failure
primary repair often fails, leave large drains

metabolic consequences:
protein-caloric deficiency
anemia: Fe absorption requires acid and exposure to dietary Fe
abdorbed mainly in duodenum and proximal jejunum
B12: total body store 200 micrograms, daily need 2 mcg; deficiency late, anemia, glossitis, numbness, tingling hands and feet, mental status changes, check @ 3-6mo, then Q6mo-1y
folate: anemia, rarer (folate abdorbed proximal small intestine)
thiamine: absorbed duodenum and prox jejunum, deficiency results in beriberi
cardiac: failure not reported in bariatric population
neurologic: related to emesis; symmetric numbness, tingling ant thighs progressing to bilat lower ext weakness/paralysis (axonal degeneration)
Ca^{++}: preferentially absorbed duodenum, prox jejunum; also D and other fat-soluble vits. (A,D,E,K)
laparoscopic gastric bypass higher incidence of small bowel obstruction
3 common sites
herniation through or scarring at mesocolon (retrocolic Roux-Y)
behind Roux limb (Petersen hernia)
jejuno-jejunal anastomosis
lower incidence with antecolic Roux limb
symptoms (chronic abdominal, periumbilical pain) mandate exploration, 2% negative lap
most can be repaired laparoscopically
vertical banded gastroplasty associated with severe reflux
lap band: gastric prolapse most common complication
50% expected wt loss

Small intestine

Crohns: 50% I-C, 30% small bowel alone (highest recurrence), 20% colon alone
smoking detrimental (v. UC where may be beneficial)
marked lymphangiectasia
bloody diarrhea rare
steroids for acute, not chronic; AZA, 6MP for chronic
prednisone for small intestine, sulfasalazine for colon
TPN maintains body mass, speeds closure of hi output fistula
60% of small intestine tumors in ilium, 50% benign
obstruction, intussusception manifestations
Peutz Jegher's hamartomas low malignant potential: STK 11 mutation

carcinoid: appendix most common, 75% near tip, 3% mets
    ilium next, most likely to metastasize (35%)
    rectum least common
    bronchus, ovary
    30% multiple or presence of another tumor
    > 2cm -> 90% mets
    cutaneous flush most common manifestation
    anti-serotonin agents: methysergide, cyproheptadine, p-chlorophenylalanine, somatostatin/octreotide
    streptozotocin, 5FU may help
^{99m}Tc lights up gastric mucosa in Meckel's
blind loop: stasis, bacterial overgrowth
    pain, diarrhea, steatorrhea (bile salt deconjugation), amenorrhea, wt. loss
    B12 breakdown by BT -> megaloblastic anemia
return of small intestinal motility post op (migrating motor complex/MMC) 6-24h
risk factors for small intestine cancer: celiac sprue, Crohn's, FAP, Peutz-Jegher's
    (scleroderma not a risk factor)
    celiac associations: lymphoma, esophageal, small bowel adenocarcinoma
heat does not trigger visceral pain

Appendix

emesis before pain with appendicitis
GALT (gut-associated lymphoid) tissue -> immunoglubulins, process thymic independent lymphocytes
appendicitis: young obstruction of lumen by lymphoid hypertrophy, older fecolith 30%
    not more common in pregnancy, most 2nd trimester
    open more wd. infection, laparoscopic more intraabdominal infection

Retroperitoneum

retroperitoneal fibrosis
    2/3 idiopathic
    drugs: methysergide, ergotamine, hydralazine, methyldopa, beta blockers
    IVP best diagnostic test
mesenteric tumors: malignant at the root, benign at the periphery
    locally aggressive
retroperitoneal sarcoma: 10% 5y survival
peritoneal dialysis can remove: NH3, Ca, Fe, Pb, Li

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