Small Intestine

Presley Regional Trauma Center
Department of Surgery
University of Tennessee Health Science Center
Memphis, Tennessee
Intussusception

- About 5% occur in adults
- Occurs when one segment of bowel telescopes into an adjacent segment
- Can result in obstruction and ischemic injury to the intussuscepting segment
Etiology

• Of adult cases, 90% are associated with pathologic processes.

• Tumors, benign or malignant, act as the lead point of intussusception in more than 65% of adult cases.
Etiology

- A significant proportion of cases have been reported to occur after abdominal surgery for lesions other than neoplasm
  - 20% related to the suture line
  - 30% to adhesions
  - 60% to intestinal tubes
Types

- Enteric
- Ileocolic
- Ileocecal
- Colonic
Diagnosis

- Radiographic features are not specific.
- Plain films reveal evidence of partial or complete obstruction.
- A sausage-shaped soft tissue density may be seen, outlined by two strips of air.
- It has been suggested that sonography may be useful in diagnosis.
- The mainstays of diagnosis are contrast studies or CT scan.
Because of the high incidence of tumors, surgery has generally been recommended.

Reduction by hydrostatic pressure, which is the standard of care in pediatric cases, is not usually attempted in adults.

Clear indications for operation include long length and wide diameter of the intussusception, presence of a lead point, or evidence of bowel obstruction.
Mesenteric Ischemia
AMI

- Morbidity and mortality associated with AMI remain unchanged over the past several decades
- High index of suspicion is the key to diagnosis
- Prompt intervention is paramount to minimize morbidity and mortality
Pathophysiology

- Embolic occlusion of mesenteric circulation (usually the SMA)
- Acute thrombosis of the mesenteric circulation
- Intense splanchnic vasoconstriction
  - NOMI
  - low-flow state or profound hypotension
- Mesenteric venous thrombosis
Clinical Evaluation
Presentation - Embolic

- Sudden onset of mid-abdominal pain
- Described as being out of proportion to physical findings
- Associated with immediate bowel evacuation
- Abdominal pain + fever + heme-positive stool
Presentation - Thrombosis

- Sudden onset of mid-abdominal pain out of proportion to physical findings
- History of chronic post-prandial abdominal pain
- History of significant weight loss
Presentation - NOMI

- Pain is not as sudden
- More diffuse
- Waxes and wanes
Presentation - MVT

• Nonspecific abdominal complaints
  – diagnosis challenging

• Nausea, vomiting, diarrhea, abdominal cramping and non-localized pain

• Symptoms are not acute
Risk Factors

- Embolic occlusion
  - recent cardiac events
  - MI
  - Afib
  - mural thrombus
  - mitral valve disease
  - left ventricular aneurysm
  - previous embolic disease
Risk Factors

- Thrombotic occlusion
  - other manifestations of diffuse atherosclerotic disease
  - CAD
  - PAD
  - carotid stenosis
Risk Factors

• NOMI
  – more common among severely ill ICU patients
  – on vasopressors
  – on dialysis with excessive fluid removal

• MVT
  – history of previous venous thrombosis or PE
  – hypercoagulable state
  – OCPs or estrogen use
There are no basic lab or radiographic studies diagnostic for AMI

- WBC, lactate, D-dimer, AST
- Thumbprinting (plain films)

These studies can only help confirm the diagnosis when it is suspected on the basis of H&P
CTA

• Confirm the diagnosis of AMI

• Useful for visualizing the origins of the celiac artery and SMA

• Secondary, tertiary and smaller branches are less well defined

• Can potentially overestimate the degree of critical stenosis

• Plays a valuable role in diagnosing MVT
Contrast Angiography

- Gold standard for imaging the visceral vessels
- Useful for visualizing the main trunks as well as several orders of distal branches
- Should include AP and lateral views of the celiac artery, SMA and IMA
- Provides important therapeutic options
Contrast Angiography

- Origins of celiac artery and SMA are best seen on lateral views
- Middle and distal SMA and IMA are best seen on AP view
- Delayed views are useful in evaluating for NOMI
Angiographic Patterns

• SMA is most likely to be site of embolic disease because it takes off from main axis of aorta at a less sharp angle

• Celiac and IMA arise from aorta perpendicularly

• Emboli usually lodge distal to the middle colic branch and jejunal branch
Angiographic Patterns

- Thrombus usually forms at atherosclerotic plaque
- At the origin of the mesenteric vessel
- Complete absence of flow in the mesenteric vessel
Angiographic Patterns

- Patients with NOMI typically exhibit evidence of vasospasm

- A small SMA trunk is seen, with very few branching vessels visible and the branches that are seen show a characteristic tapering to point of occlusion

- Best seen on AP projection
Management

• Goal of surgical treatment is twofold
  – restore normal pulsatile flow to the SMA
  – resect any nonviable intestine

• Revascularization precedes resection

• Approach varies depending on underlying cause
NOMI

- Management is largely non-operative
- Treatment of the underlying precipitating cause is the key therapeutic intervention
- Optimization of resuscitation, improvement of CO, elimination of pressors
- Selective catheterization of the SMA with direct intra-arterial infusion of papaverine may be employed as adjunctive therapy
• Mainstay of therapy is anticoagulation

• Thrombolytic therapy has also been employed
Second-look Laparotomy

• Essential part of management

• The most reliable means of determining viability of marginally perfused bowel after revascularization

• Should be preceded by adequate fluid resuscitation and correction of acid-base imbalance
Second-look Laparotomy

- Decision should be made during the first exploration
- Should be adhered to no matter what the patient’s condition is 24 to 48 hours later
Determination of Bowel Viability

• If diffuse bowel necrosis exists and is not salvageable – close
  – 50 cm of viable bowel is required if ileocecal valve is present, 100 cm is preferable

• If bowel is salvageable – blood flow is evaluated by assessing pulses or doppler signals in SMA
Intraoperative Evaluation

• SMA pulses are assessed by palpating the root of the mesentery

• A doppler may also be used to listen to the quality and character of the arterial signal at the root of the mesentery

• It is important to palpate distally as well as proximally to rule out an embolus
Patterns
Differentiation

- The different causes of AMI are associated with different classic patterns of bowel ischemia

- Must be distinguished from one another

- Venous = diffusely edematous, congested and dilated

- Arterial = contracted (early), dilated, edematous with frank necrosis (late)
Differentiation

- Embolic = small bowel and proximal colon are affected, proximal jejunal segment and transverse colon spared

- Embolus usually lodges just past middle colic artery and jejunal branches of SMA

- SMA origin = entire small bowel + ascending and transverse colon affected
  - thrombotic occlusion
Intra-op Bowel Viability

- Approximately 10 to 20 minutes after revascularization, viability should be assessed.
- Waiting until after revascularization makes it possible to preserve bowel length.
- Frankly necrotic areas, normal areas and marginally perfused areas.
Technical Points

- Need *high index of suspicion*
- Dx + Identify cause
- Restore flow
- Determine bowel viability
- Post-op resuscitation and stabilization
- Second-look
Small Bowel Malignancies
Epidemiology

- Rare
- < 5% of all GI tract tumors
- Adenocarcinomas, lymphomas or carcinoids
- Increasing number of GISTs
GISTs

- The most common nonepithelial cell tumors of the small bowel
- Approximately 25% arise in the small bowel
- Diagnosed equally in men and women, with a median age at onset of 64 years
- Arise from the interstitial cell of Cajal, the pacemaker cells of the GI tract situated between the intramural neurons and the smooth muscle cells
GISTs

- Characterized by presence of activating c-kit mutations, a transmembrane receptor tyrosine kinase involved in the regulation of cell proliferation, apoptosis and differentiation
- >95% express kit (CD117) mutations
- Allows for distinction of GISTs from histologically similar mesenchymal tumors of the small bowel including leiomyomas, leiomyosarcomas, and schwannomas
GISTs

• Those that do not express c-kit mutations may express a mutation in another tyrosine kinase receptor, platelet-derived growth factor receptor-α

• Present in approximately 5 to 7% of GISTs, these activating mutations also result in abnormal cellular proliferation
GISTs

- Characterized by indolent clinical symptoms including vague abdominal pain, weight loss, and occult gastrointestinal bleeding

- Although acute hemorrhage, perforation, or obstruction may lead to an emergency presentation, GISTs may grow to a massive size prior to surgical presentation
GISTs

• Usually they grow insidiously as extraluminal masses from their submucosal origin in a noninvasive manner, characteristically pushing adjacent organs away from the expanding mass.

• Characteristic CT finding is the presence of a large space-occupying mass, occasionally with calcification and hypervascularity and often with evidence of central necrosis and compression of adjacent organs.
GISTs

- All should be considered to be malignant
- Malignant potential is based on two major criteria
  - tumor size
  - mitotic rate
  - biologically aggressive tumors are large with a high mitotic index, whereas tumors with benign features are small and with a low mitotic index
<table>
<thead>
<tr>
<th>RISK CLASSIFICATION</th>
<th>SIZE</th>
<th>MITOTIC RATE</th>
<th>10-YEAR SURVIVAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Any size</td>
<td>&gt;10/50 HPF</td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td>&gt;10 cm</td>
<td>Any rate</td>
<td></td>
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<tr>
<td></td>
<td>&gt;5 mm</td>
<td>&gt;5/50 HPF</td>
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<td>Intermediate</td>
<td>5-10 cm</td>
<td>&lt;5/50 HPF</td>
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<td>6-10/50 HPF</td>
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<tr>
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<td>&lt;5/50 HPF</td>
<td>75%</td>
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<tr>
<td>Very low</td>
<td>&lt;2 cm</td>
<td>&lt;5/50 HPF</td>
<td>80%</td>
</tr>
<tr>
<td>Normal population</td>
<td>—</td>
<td>—</td>
<td>80%</td>
</tr>
</tbody>
</table>

HPF, high power field.
Surgery

- The primary therapeutic option with the goal being complete resection
- Pre-op biopsy is controversial, and a presumed Dx is enough to warrant surgery if the disease appears resectable
- At operation, WLE of the primary tumor with resection of adherent organs is appropriate to attain curative resection
• 25 to 35% of cases occur within the small bowel

• The distribution pattern is marked by relative sparing of the duodenum and equal frequency in the jejunum and ileum
Criteria

- No evidence of lymphoma outside the GI tract
- On PE, there should be no superficial adenopathy and chest radiograph should reveal no mediastinal adenopathy
- Peripheral blood cell counts must be normal
- No evidence of splenic/hepatic involvement
- At laparotomy, disease must be restricted to the primary tumor with MLN involvement
Presentation

- The majority present with abdominal pain that is nonspecific and unlocalized
- Malabsorption, obstruction, and evidence of a palpable mass may be present
- Although rare, perforation is a more common presentation for gastrointestinal NHL than for adenocarcinoma
Diagnosis

- Most will be demonstrable on CT scan, as these may grow to be quite large
- CT will demonstrate the mass, marked luminal dilatation, bowel wall thickening, and displacement of neighboring loops
- To make a tissue diagnosis, biopsies must be obtained from the submucosa, as the overlying mucosa often demonstrates no evidence of tumor infiltration
Like tumors elsewhere in the small bowel, lymphomas are typically diagnosed late, with almost half of patients presenting as stage III or IV disease.

Unlike other solid tumors of the GI tract, the TNM system does not apply to staging of GI NHL.

Staging is based on site involvement.
<table>
<thead>
<tr>
<th>STAGE</th>
<th>EXTENT OF DISEASE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Tumor confined to the gastrointestinal tract, either as single primary site or multiple noncontiguous lesions</td>
</tr>
<tr>
<td>II</td>
<td>Tumor extends from primary gastrointestinal site, either to lymph nodes or direct invasion. Confined to below the diaphragm</td>
</tr>
<tr>
<td>IIE</td>
<td>Tumor penetrates serosa to involve adjacent structures</td>
</tr>
<tr>
<td>II₁</td>
<td>Local nodal involvement</td>
</tr>
<tr>
<td>II₂</td>
<td>Distant nodal involvement</td>
</tr>
<tr>
<td>III</td>
<td>Evidence of supradiaphragmatic disease</td>
</tr>
<tr>
<td>IV</td>
<td>Disseminated disease above and below the diaphragm</td>
</tr>
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</table>
What To Do

• Decisions regarding the management of small-bowel lymphomas that do not require emergent surgical management should be made in a multidisciplinary setting

• Need input from surgeons, medical oncologists, and pathologists

• There is currently no definitive consensus regarding standard first-line therapy for small-bowel lymphomas
Indolent malignant neuroendocrine tumors that arise from the enterochromaffin cells at the base of the crypts of Lieberkühn

- Comprise 30 to 35% of small-bowel neoplasms
- Found slightly more often in men
- Mean age of presentation is 60 years
- Frequently asymptomatic
Carcinoid

- When symptomatic, typically present with pain or obstructive symptoms
- Because they are typically slow growing, Sx may be present for 2 to 20 years prior to Dx
- Ulceration is rare, so GIB is uncommon
- Patients present with carcinoid syndrome in up to 40% of cases
Risk

• Tumor size is proportional to the risk for metastatic spread at initial diagnosis and must be considered in directing surgical strategies

• Small-bowel lesions often remain asymptomatic long enough to allow not only lymph node spread but also hepatic metastasis
Risk

• For lesions < 1 cm, there is a 20 to 30% incidence of nodal and hepatic spread
• Tumors 1 to 2 cm in size have nodal spread in 60% to 80% and hepatic disease in 20%
• The rate of nodal and hepatic metastasis for tumors > 2 cm is greater than 80% and 40 to 50%, respectively
Management

• These figures must guide the choice of operation

• Whereas a small lesion < 1 cm may be adequately treated with local excision

• Anything larger must be presumed to be metastatic and a wide resection with lymphadenectomy and careful examination of the liver is necessary
Adenocarcinoma

- 80% occur in duodenum or proximal jejunum
- Present with nausea, emesis, pain, weight loss, bleeding, SBO depending on location and size
- EGD is the diagnostic modality of choice, with diagnostic rates of 85 to 90%
Adenocarcinoma

- Aggressive surgical resection
- Whipple
- Segmental resection with a wide mesenteric resection
- Contiguous organs are resected en bloc as necessary
- Diagnosis is often delayed
Summary

- Small-bowel tumors, both benign and malignant, are uncommon.
- Although the small bowel accounts for 75% of the length and 90% of the mucosal surface of the GI tract, < 5% of primary GI malignancies arise from the small intestine.
- Recent data have reported an increase in the incidence of small-intestinal tumors.
Summary

- Small-intestinal tumors may originate from cells of epithelial origin (adenomas, adenocarcinomas, or carcinoids), lymphatic tissues (lymphomas), or mesenchymal or neural elements (GISTs, leiomyomas, lipomas, hemangiomas, neuromas, and a wide variety of sarcomas).

- The small intestine is also a rare site for metastasis from other primary tumors.