The Role of US in Chronic Mesenteric Ischemia

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Mesenteric Ischemia

• Anatomy

• Presentation

• Diagnostic tools

• Treatment
Celiac Artery

- Arises for the abd aorta just caudal to the diaphragm at the level of L1.

- Three branches from the common trunk: left gastric, splenic, and common hepatic arteries.

- Variations of the true “trifurcation” can exist
  - most frequently, the common hepatic arises from the SMA
• Arises a few cm distal to the celiac trunk

• Its origin is crossed by the neck of the pancreas and the splenic vein.

• Superior mesenteric vein (SMV) runs parallel to the artery, usually along it right border.
• Located 3 - 4 cm above the aortic bifurcation – just to the left of midline.

• Usually arises at the level of L3 vertebral body.

• Main branch typically divides into the left colic artery and the sigmoidal branches.
Arc of Riolan / Marginal Artery of Drummond
Mesenteric Ischemia

- Mesenteric ischemia occurs when perfusion of the visceral organs fails to meet the metabolic requirements.

- 17% of patients have evidence of critical stenosis in 1 of 3 visceral vessels and have no symptoms of mesenteric ischemia.
Chronic Mesenteric Ischemia

- Life-threatening problem
- Can lead to Death
  - bowel infarction
- Prevalence is low
- Severe malnutrition
CMI: Pathophysiology

- Supply can’t meet demand

- Normally, intestinal blood flow increases 30 minutes after meal

- Hyperemic response lasts b/t 4 and 6 hours

- Marked increase in end-diastolic flow velocities in the SMA, with little velocity changes in the celiac.
CMI: Pathophysiology and Etiology

• Arterial stenosis → attenuated hyperemic response

• Imbalance b/t supply and demand

• “mesenteric angina”
• Direction of flow is based on the location of the significant stenosis.

• usually do not become symptomatic unless two of the three visceral vessels have significant stenosis

• Exception: It is possible to become symptomatic with an isolated dz if the collateral pathways are insufficient

• Atherosclerosis = leading cause of visceral artery occlusive disease
Other causes associated with CMI:

- Fibromuscular disease
- Aortic dissection
- Isolated SMA dissection
- Neurofibromatosis
- Rheumatoid arthritis
- Takayasu’s arteritis

- Giant cell arteritis
- Polyarteritis nodosa
- Radiation injury
- Lupus
- Drugs (ie, cocaine, ergots)
Clinical presentation

• Usual pt: cachectic, middle-aged woman with long smoking history with abd pain and weight loss.

• F > M, older

• The abd pain is either dull or colicky

• The abd pain often involves the midepigastric region

• Pain occurs 15 to 30 min after eating and lasts 1–3 hours.
Clinical presentation

- Pain may be absent due to adaptive strategies to relieve or reduce it.
  - Eat less, Eat slow, certain foods

- Net effect of abd pain is food fear and weight loss

- Weight loss due to inadequate intake rather than an absorption problem
  - MALNUTRITION

- Evidence of systemic vascular disease
• Common things are Common…
  – EGD, colonoscopy, U/S, and CT

• Foremost in the DDx of abd pain with weight loss is an intra-abdominal CANCER until proven otherwise.

• Diagnosis of CMI requires the proper clinical scenario, a confirmatory imaging study, and the exclusion of other potential causes of abd pain
Diagnostic Imaging: Mesenteric Duplex U/S

• Mesenteric duplex U/S = excellent screening tool

• Sensitivities and Specificities: close to 90%

• In fact, a negative duplex scan essentially excludes the diagnosis of CMI or visceral artery occlusive disease

• Excellent surveillance tool after treatment
Limitations

- Obesity (they don’t have it....)
- Bowel Gas
- Prior abdominal surgeries (look for scars)
- Non-fasting state
- Breathing issues
Protocol

• Liquids only for dinner the night before
• No carbonated drinks 24 hr prior
• Simethicone night before and in AM
• NPO after MN
• Scan early

• *No smoking or chewing gum*
The Set-up

- Patient is supine

- Head elevation or Reverse Trendelenburg
  - Any position change really

- Low frequency transducer (2-5 MHz)

- Start below xiphoid process
The Exam

- Transverse and longitudinal (sagittal) views
  - Aorta
  - Celiac (Hepatic, Splenic)
  - SMA
  - IMA

- Grayscale images

- Record PSV/EDV at ostium, proximal, mid and distal

- Note direction of flow
## Normal findings

<table>
<thead>
<tr>
<th></th>
<th>SMA</th>
<th>CELIAC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-prandial (fasting)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSV</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>EDV</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Flow reversal</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Post-prandial (food challenge)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSV</td>
<td>Marked increase</td>
<td>No change</td>
</tr>
<tr>
<td>EDV</td>
<td>Marked increase</td>
<td>No change</td>
</tr>
<tr>
<td>Loss of flow reversal</td>
<td>Yes</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Normal PSV</strong></td>
<td>110-177 cm/sec</td>
<td>50-160 cm/sec</td>
</tr>
</tbody>
</table>

*IMA: high resistance like fasting SMA*
Abnormal findings

• Color bruit

• Retrograde flow
  – Hepatic
  – Proximal SMA

• Post-stenotic turbulence

• IMA occlusion
Abnormal findings

- Celiac
  - PSV $\geq 240 \text{ cm/s}$ consistent with $\geq 70\%$ stenosis
  - EDV $\geq 100 \text{ cm/s}$

- SMA
  - PSV $\geq 275 \text{ cm/s}$ consistent with $\geq 70\%$ stenosis
  - EDV $\geq 70 \text{ cm/s}$
Normal Celiac

CA

AO
Color flow images of celiac axis

“Seagull Sign”

Low-resistant waveform because it is supplying flow to the liver, stomach, and spleen
Abnormal Celiac
Median Arcuate Ligament Syndrome

• Chronic abdominal pain after eating
• weight loss
• abdominal bruit
• Vomiting
• Delayed gastric emptying
• Younger patients
DIAPHRAGM, INFERIOR VIEW

- Xiphoid process
- Costal cartilage
- Central tendon
- Costal part of diaphragm
- Esophageal (opening) hiatus
- Aortic hiatus
- Foramen for the inferior vena cava
- Median arcuate ligament
- Lumbar part of diaphragm
- Medial arcuate ligament
- Lateral arcuate ligament
- Right crus of diaphragm
- Quadratus lumborum m.
- Psoas m.
Median Arcuate Ligament

- Normal Anatomy
  - Celiac artery
  - Median arcuate ligament of diaphragm

- Median arcuate ligament compressing celiac artery
Median Arcuate Ligament Syndrome

- Increase in PSV during expiration and normal during inspiration
  - PSV > 300 or > 3:1 (E:I)

- Erect positioning can help normalize

- ~ 13% to 50% of asymptomatic individuals have compressive features of the celiac artery during expiration
Normal SMA
SMA stenosis
Diagnostic Imaging: CTA

- Replacing angiography and duplex imaging
- CT: universally available and far less technician dependent
- Less Invasive compared to angio
Diagnostic Imaging: CTA
Diagnostic Imaging: angiography

• Traditional “gold standard” diagnostic study

• Confirms duplex findings; operative planning; facilitates therapeutic interventions

• Presence of well-developed collaterals b/t the visceral vessels supports the diagnosis of mesenteric ischemia.

• Look for visceral artery aneurysms in the collateral branches; these are presumably flow-related aneurysms.
Diagnostic Imaging: angiography
Indications for Revascularization

• All CMI pts should undergo revascularization

• Goals of tx:
  • reduce pain
  • prevent bowel infarction
  • restore nutritional status

• Significant disease in all 3 are at a high-risk for bowel infarction

• May need nutritional support (TPN)
Endo vs Open Treatment

• The Debate continues…

• Endo has become 1\textsuperscript{st} line therapy in many hospitals

• **Advantages** of endo: shorter hospitalization, reduced M&M, and improved quality of life

• **Disadvantages** of endo: inferior patency rates, repeat procedures
Endo considerations

• Brachial vs femoral approach?

• Will need ASA/plavix

• Contrast (CKD?)

• Risk of Perforation/Dissection

• Bridge to open revascularization?
Celiac Stent
SMA Stent
SMA stent
• Most recommend open revascularization for:

A. Younger, good-risk pts

B. Those whose dz is not amenable to the endo approach for anatomic reasons (e.g. flush aortic occlusion of the SMA, can’t cross lesion, long segment)

C. Those with recurrent, refractory stenoses after endovascular therapy.
Surgical Considerations

• Several ongoing issues in regards to open revascularization that remain unresolved.

1. Type of revascularization

2. Number of vessels to be revascularized

3. Optimal conduit
Antegrade Bypass
Antegrade SMA bypass
Retrograde bypass
Endarterectomy

- Requires RP exposure
- Risk of intimal flap, occlusion

- Aortic disease for clamp
- Technically difficult
Follow up

- All require long-term follow up

- Pts are seen at 6-month intervals and grafts interrogated with mesenteric duplex.

- Recurrent symptoms merit urgent or emergent eval with duplex U/S or CTA
Role of Duplex after stent or graft

- Different criteria after stent
  - 300 cm/s, 400 cm/s??

  \[ \geq 70\% \text{ ISR} \quad \text{SMA stent } \geq 445 \text{ cm/s} \]
  \[ \text{Celiac stent } \geq 289 \text{ cm/s}^{**} \]

- Some propose getting baseline right after stent

**Soult et al. Duplex ultrasound criteria for in-stent restenosis of mesenteric arteries. JVS. Nov 2016**
Role of Duplex after stent or graft

– Follow trend

– Post stenotic turbulence

– Flow dampening

– Graft velocity < 40 cm/s

– Any concern for stenosis should prompt angiogram
Outcomes

- Technical success rates: 90% endo; 100% open repair

- Perioperative Mortality:
  - Endo: 3%
  - Open: 8% (*worse disease*)

- Length of stay: 1 endo; 12 open

- Patency:
  - Endo: 70% at 1 year
  - Open: 80% at 5 years

- Survival rate: 70% at 5 years for both.
Treatment of CMI

• Prior to 2002
  • 67% open / 33% Endo
• Now
  • 67% Endo / 33% open

• Recommendation
  • Good endo anatomy or poor risk
    STENT
  • Poor ENDO anatomy and Good risk
    OPEN
Questions???

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