Acute Mesenteric Ischemia (AMI)

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Table of Contents

Definitions
Etiology
Presentation and Diagnosis
Treatment
Surgical Technique

References

Definitions

Definitions

- *Intestinal Ischemia*: Inadequate Blood Supply to Meet Demands of Intestines
    - *Mesenteric Ischemia*: Ischemia of the Small Intestine (Often Used Interchangeably with Intestinal Ischemia)
    - *Colonic Ischemia*: Ischemia of the Large Intestine
- *Splanchnic/Visceral Ischemia*: A Broader Term to Describe Ischemia of the Intestine and Other Solid Organs (Liver, Kidney, Spleen)

Classification/Timing

- *Acute Mesenteric Ischemia (AMI)* – Rapid Onset Over Hours-Days
    - Most Common Cause: Arterial Embolism
- *Chronic Mesenteric Ischemia (CMI)* – Slow Onset Over Weeks-Months
    - Most Common Cause: Arterial Thrombosis/Atherosclerosis
    - *See Chronic Mesenteric Ischemia

Causes

- Arterial Pathology:
    - Arterial Embolism
    - Arterial Thrombosis
- Mesenteric Venous Thrombosis (MVT)
- Non-Occlusive Mesenteric Ischemia (NOMI)

- Other General Causes of Intestinal Ischemia:
  - Incarcerated/Strangulated Hernia
  - Internal Hernia
  - Adhesions
  - Bowel Volvulus
  - Extreme Bowel Distention
  - Vasculitis

Bowel Ischemia [1,2]

- Visceral Perfusion Fails to Meet Metabolic Demand
  - Inadequate Collateral Circulation, Smaller Caliber Vessels, and Longer Duration of Ischemia Increase the Risk of Damage
  - Bowel Autoregulation Can Enhance Oxygen Extraction and Perfusion by Vasodilation
  - Small Intestine Can Compensate for a 75% Reduction in Mesenteric Blood Flow for up to 12 Hours [3]
- Bowel Damage is Caused by Both Ischemic Hypoxia and Reperfusion Injury
- Ischemia Can Progress to Frank Bowel Necrosis and Perforation
- Bowel Mucosa is Affected First Due to Higher Metabolic Demand
- Ischemia Causes the Release of Toxic Byproducts and Oxygen Free Radicals
  - Can Incite a Multisystem Organ Failure

Necrotic Bowel from Mesenteric Ischemia [8]

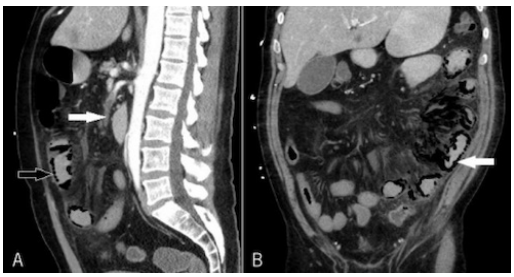
Mortality

- Historically Associated with Exceptionally High Mortality Rates (70-90%) [4,5]
- In-Hospital Mortality Still High But Significantly Decreased (17-21%) [6,7]

Etiology

Arterial Embolism

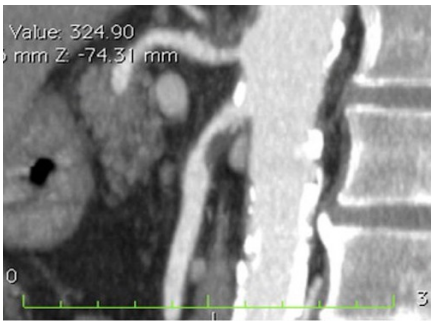
- Most Common Cause of Acute Mesenteric Ischemia (40-50%) [9,10]
- Embolic Source:
  - Heart (Left Atrium, Ventricle, or Valves) – Most Common
  - Aortic Plaques



Mesenteric Ischemia with Embolism on CTA [17]

- Risk Factors: [9,11]
  - Atrial Fibrillation
  - Recent Myocardial Infarction
  - Prosthetic Valves
  - Ventricular Aneurysm
  - Rheumatic Heart Disease
- SMA is at High Risk for Embolism Due to Acute Angle Off Aorta (30-60 Degrees) [12,13]
  - Decreased Angle of Takeoff Compared to Other Mesenteric Vessels
- Most Common Site: SMA **Just Distal to the Middle Colic Artery**
  - SMA Begins to Narrow After the Middle Colic Takeoff
  - Ischemia **Spares the Proximal Jejunum and Transverse Colon**
- 20% are Associated with Concurrent Emboli to Other Structures (Spleen, Kidney, etc.) indicating a Proximal Embolic Source [14]

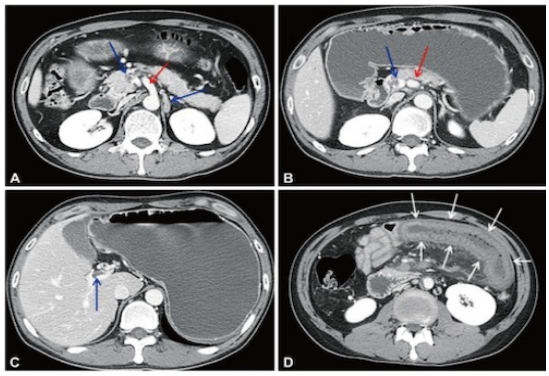
Arterial Thrombosis



Mesenteric Ischemia from SMA Stenosis on CTA [18]

- Second Most Common Cause of Acute Mesenteric Ischemia (20-30%) [9,10]
- Often Have History of Chronic Mesenteric Ischemia with "Food Fear" and Weight Loss
  - *See Chronic Mesenteric Ischemia
  - Due to Prolonged Development, there is Usually Extensive Collateral Formation from the Celiac Artery to Compensate
- Most Common Site: SMA **Origin**
  - Ischemia **Involves the Entire Distribution**
- Symptomatic SMA Thrombosis Most Often Has a Concurrent Celiac Occlusion – Due to Collaterals that Would Otherwise Compensate [15]
- Higher Mortality Than Arterial Embolism

Mesenteric Venous Thrombosis (MVT)

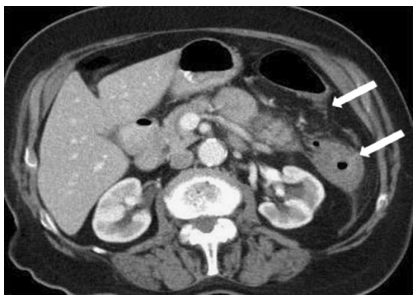


Mesenteric Venous Thrombosis on CTA: SMV Thrombus (Blue Arrows), Intact SMA (Red Arrows), Edematous Jejunum (White Arrows) [19]

- Least Common Cause of Acute Mesenteric Ischemia (5-10%) [9,10]
- Often Associated with Virchow's Triad (Vessel Injury, Blood Flow Stasis, and Hypercoagulability)
- Classification:
  - *Primary*: Idiopathic
  - *Secondary*: From Underlying Process (80-90% – Most Common) [10]
- 50% Have a Prior History of Thrombosis [16]
- Often Vague and Less Dramatic Presentation Over 1-2 Weeks with Bloating, Distention, and Nausea

Non-Occlusive Mesenteric Ischemia (NOMI)

- Third Most Common Cause of Acute Mesenteric Ischemia (20%) [9,10]
- Ischemia Without an Associated Thromboembolic Occlusion
- Risk Factors:
    - Decreased Perfusion from Low Cardiac Output (Most Common Cause)
    - Hypovolemia
    - Shock States
    - Systemic Vasopressors
    - Prior Myocardial Infarction
    - Abdominal Compartment Syndrome
    - Aortic Regurgitation
    - Hepatic or Renal Failure/Hemodialysis
    - Cocaine-Induced Vasoconstriction
- Most Vulnerable Sites: **Watershed Areas**
- Often More Insidious Onset than Arterial Disease
- Highest Mortality Rate – Often Associated with Multiple Organ Failure, Heart Failure, and Sepsis



NOMI with Ischemia at Griffith's Point [20]

Presentation and Diagnosis

Presentation [21,22]

- Abdominal Pain (95% – Most Common Symptom)
    - Sudden and Severe
    - "Pain Out of Proportion" – **Patient Reports Significant Abdominal Pain That Does Not Correlate to Physical Exam Findings with Only Mild Abdominal Tenderness**
- Nausea and Vomiting (35-44%)
- Diarrhea (35%)
- Blood per Rectum (16%)
    - Classically Sudden and Forceful Bloody Diarrhea
- Abdominal Distention
- Fever
- *Clinical Scenarios and History Can Help to Differentiate the Etiology

Diagnosis

- CTA is the Preferred Diagnostic Imaging and Should Be Performed as Soon as Possible [10]
- Poor Diagnostic Studies:
    - Mesenteric Duplex US – Obscured by Bowel Gas in the Acute Setting and More Operator Dependent
    - Plain Film X-Ray
    - Laboratory Studies – May See Elevated Leukocytosis (90%) and Lactate (88%) but Not Specific [23]

Treatment

Initial Managements [10,24,25]

- Aggressive Fluid Resuscitation
- Aggressive Electrolyte Correction
- Nasogastric Decompression
- **IV Heparin Infusion**
    - Not Necessary for NOMI
- Broad-Spectrum Antibiotics (High Risk for Bacterial Translocation and Sepsis with Early Loss of the Mucosal Barrier)
- Indications for Emergent Exploratory Laparotomy: [25]
    - Hemodynamically Unstable
    - Overt Peritonitis
    - Perforation

Definitive Treatment

- *Arterial Embolus*: Open SMA Embolectomy
    - May Consider Endovascular Intervention in Stable and Nonperitoneal Patients
- *Arterial Thrombosis*: Open SMA Bypass
    - May Consider Endovascular Intervention in Stable and Nonperitoneal Patients
- *Mesenteric Venous Thrombosis (MVT)*: IV Heparin Infusion
    - Rescue Options if Continues to Decompensate Despite Anticoagulation: [10]
        - Percutaneous Transhepatic Thrombolysis
        - TIPS with Aspiration or Thrombolysis
        - Arterial Approaches via the SMA
    - Will Also Require Prolonged Anticoagulation at Discharge (6 Months vs Lifelong)
- *Non-Occlusive Mesenteric Ischemia (NOMI)*: Improve Circulatory Support and Catheter-Directed Intra-Arterial Vasodilators to SMA
    - The Focus of Treatment Should be to Correct the Underlying Cause When Possible [10]
    - Vasodilators: Prostaglandin E1 (PGE1), Nitroglycerine, or Papaverine [26,27]

Endovascular Treatment

- Generally Avoided in Acute Mesenteric Ischemia if There is Concern for Bowel Ischemia Requiring an Open Surgical Evaluation [28]
- May Be Preferred if There Are No Signs of Bowel Necrosis and the Expertise is Available with No Contraindications – Evolving [28]
    - Decreased Morbidity and Mortality Over Open Surgery for Arterial Occlusive AMI [29]
- Interventions:
    - *SMA Embolism*:
        - Embolectomy/Percutaneous Aspiration
        - Thrombolysis

- *SMA Thrombosis*:
  - Thrombectomy
  - Thrombolysis
  - Percutaneous Transluminal Angioplasty (PTA)
  - Stenting

Surgical Technique

Exploratory Laparotomy

- Bowel Resection:
  - Resect Areas of Gross Necrosis Before Embolectomy or Revascularization – Risk for Infection After Revascularization
  - Reevaluate Areas of Partial Ischemia After Embolectomy or Revascularization – Preserve as Much Viable Bowel as Possible
  - Massive Gut Necrosis May Be Best Managed By Comfort Care Measures and Evaluation of Underlying Comorbidities and Advanced Directives Should Be Considered Prior to Resection [10]
- Low Threshold for Leaving an Open Abdomen and Second Look in 24-48 Hours to Reassess Bowel Viability if Questioned [30-32]

Exposure of the SMA

- The SMA May or May Not Have a Palpable Pulse and May Be Difficult to Identify
- Anterior Approach:
  - Retract the Transverse Colon Cephalad and the Small Bowel to the Right
  - Palpate the SMA at the Root of the Transverse Colon Mesentery at the Inferior Margin of the Pancreas
  - Carefully Dissect Down to Isolate the Artery
  - Multiple Small Venous Branches from the SMV May Cross Over the SMA and Require Division (SMA Lies to the Left of the SMV)
- Lateral Approach:
  - Take Down the Ligament of Treitz
  - Retract the Entire Small Bowel to the Right
  - Carefully Dissect Down to Isolate the Artery

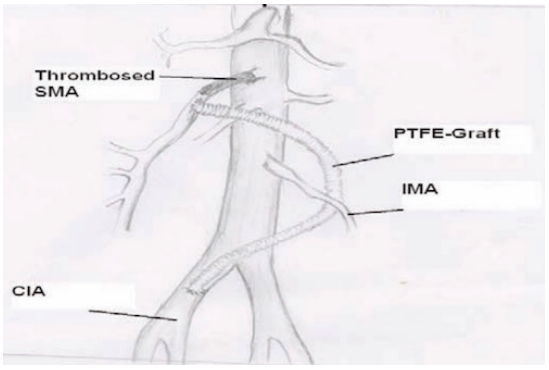
SMA Embolectomy

- Expose the SMA – Through an Anterior Approach
- Obtain Proximal and Distal Control of the Artery
- Make a Proximal Transverse Arteriotomy
- Perform the Embolectomy Using a 3-4 mm Fogarty Balloon Catheter
  - Insert Both Proximally and Distally to Extract Embolus
  - Repeat Passage as Needed to Ensure All Clot is Removed

- Flush with Heparinized Saline
- Close Arteriotomy Primarily with 6-0 Prolene Sutures
- *Rarely May Consider Longitudinal Incision with Patch Angioplasty if Concerned for Small Caliber Vessel and Resulting Stricture

SMA Bypass

- General Technique:
  - Expose the SMA – Through a Lateral Approach
  - Expose the Inflow Site
  - Anastomose the Bypass After Obtaining Proximal and Distal Control at Each Site Sequentially
  - Cover the Graft with an Omental Buttress to Protect and Decrease the Risk of Kinking
- Inflow Bypass Route:
  - **Right Common Iliac Artery to SMA** – The Preferred Route in Emergent Situations
    - Retrograde in "Lazy-C" Configuration
    - Avoids Aortic Cross Clamping and Provides Good Positioning with Minimal Kinking
  - Other Retrograde Sources if Right Common Iliac is Diseased:
    - Left Common Iliac Artery
    - Infrarenal Aorta
  - Antegrade Supraceliac Bypass
    - Technically More Difficult Dissection and Increases the Physiologic Insult from Aortic Cross Clamping
    - Only if Infrarenal Aorta and Iliacs are Diseased
  - May Consider Bifurcated Prosthetic Conduit to Both the Celiac and SMA if Both are Diseased in Select Circumstances – More Often Used in a Chronic Mesenteric Ischemia



SMA Bypass with C-Loop Graft [33]

- Graft Options:
  - Synthetic Graft (Dacron) – Generally Preferred
    - Benefits:
      - Better Patency
      - Better Size Match
      - Easier Handling
      - Kink Resistant
      - Avoid Additional Time Required for Vein Harvesting
    - Generally Avoided in the Setting of Bowel Necrosis or Perforation
  - Autogenous Vein
    - Preferred if Bowel is Necrosed or with Peritoneal Spillage
    - Requires a Vein of Suitable Size and Quality – Most Commonly the GSV
    - Higher Risk of Kinking and Requires Extra Time for Harvesting

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