Gastrointestinal Bleeding in Recipients of Left Ventricular Assist Devices

Michael A. Grasso, MD, PhD
Senior Talk
October 29, 2007
Case Report

- 60y male w/ ICM s/p CABG and AICD
  - No prior h/o GIB
  - Presented with heart failure

- Admitted to the CCU
  - Failed medical management
  - A nonpulsatile LVAD was implanted

- Refractory GIB developed
  - POD 6, 17, 18, 44, 58, 62, 90

- GIB resolved after cardiac transplantation [4]
Heart Failure

- A condition in which the heart can't pump enough blood to keep up with demand [1]
- Affects roughly 5 million people in the U.S.
- Approximately 1 million hospital admissions per year
- Roughly 300,000 deaths per year
Etiology & Medical Treatment

Coronary artery disease accounts for 2/3's of the cases of heart failure

- Other causes include hypertension, diabetes, valvular disease, arrhythmias, infection, thyroid disease, infiltrative disease

Traditional therapy

- Stage A: ACE-I, Statin
- Stage B: Add Beta blockers
- Stage C: Add Diuretics, Digoxin, Hydralazine/Imdur
- Stage D: Add IV Inotrops
Ventricular Assist Devices (VAD)

- For end-stage heart failure refractory to medical management

- Mechanical pumps
  - Provide circulatory support
  - Take over the function of the damaged ventricle

- Indications
  - Bridge to cardiac transplant
  - Bridge to myocardial recovery
  - Destination therapy
VAD Technical Variations

- **Location**
  - Paracorporeal
  - Intracorporeal

- **Support**
  - Left ventricle (LVAD)
  - Right ventricle (RVAD)
  - Both ventricles (BiVAD)

- **Flow mechanism**
  - Pulsatile
  - Nonpulsatile
VAD Mechanisms of Flow

- **Pulsatile**
  - Displacement mechanism
  - Pump a discrete volume at regular intervals

- **Nonpulsatile**
  - Rotor or axial mechanism
  - Continuous flow
Nonpulsatile VAD Characteristics

- Advantages [2]
  - Compact design
  - Mechanical simplicity

- Concerns about pulseless circulation
  - Adequate perfusion
  - Gastrointestinal bleeding (case study)
Arteriovenous Malformations (AVMs)

- Also known as angiodysplasias and vascular ectasias
- Frequently found in the gastrointestinal tract
  - Most common gastrointestinal vascular malformation
  - 1% estimated prevalence
  - May also appear elsewhere
- Most lesions clinically silent
  - Minority cause bleeding
AVM Characteristics

- **Vascular Malformations**
  - Dilated, tortuous, thin-walled vessels
  - Located in the mucosa and submucosa
  - Lined by endothelium
  - Little or no smooth muscle

- **Appearance during endoscopy**
  - Cherry red, 5 to 10 mm, fern-like pattern
  - Associated with synchronous lesions 20% of the time
  - The colon is the most common site
AVM Pathogenesis

- Mechanism not well understood [3]
  - Venous obstruction or hypoperfusion
  - Venous dilation
  - Propagates proximally to capillary bed
  - Precapillary sphincter becomes incompetent
  - Results in an arteriovenous communication
GI AVM Associations

- Age
- Chronic kidney disease
  - Platelet dysfunction, vascular overload
- Von Willebrand disease
  - Platelet dysfunction
- Aortic stenosis (± von Willebrand)
  - Low pulse pressure (Heyde syndrome) [5]
  - Damage to VWB factors passing through AV
- Scleroderma, portal HTN, & Turner syndrome
Summary

- **Case Study**
  - Refractory GIB in nonpulsatile LVAD recipients

- **Background**
  - Heart failure, VADs, and AVMs

- **Hypothesis suggest by Letsou et al. [4]**
  - Empiric observation in 3 of 21 patients
  - Nonpulsatile ventricular assist devices may contribute to GI bleeding from AVMs
  - Nonpulsatile → low pulse pressure → AVM formation
  - Similar to the Heyde syndrome [5]
Study Methods

- Retrospective analysis of 53 consecutive intracorporeal LVAD recipients
  - Nonpulsatile: VentrAssist, HeartMate II, & Jarvik 2000
  - Pulsatile: Novacor and HeartMate XVE
  - Excluded 1 patient who died within 4 hours of implantation

- The primary endpoint was clinically evident GI bleeding, confirmed by endoscopy

- Analyzed data by odds ratio, Fischer's exact test, logistic regression, and the t test
## Results: Baseline Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Nonpulsatile (n=25)</th>
<th>Pulsatile (n=27)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implant age in years</td>
<td>52 ±15</td>
<td>54 ±16</td>
<td>0.495</td>
</tr>
<tr>
<td>Male</td>
<td>16 (64%)</td>
<td>19 (70%)</td>
<td>0.633</td>
</tr>
<tr>
<td>Caucasian</td>
<td>16 (64%)</td>
<td>17 (63%)</td>
<td>0.843</td>
</tr>
<tr>
<td>Pre-implant screening colonoscopy</td>
<td>6 (24%)</td>
<td>4 (15%)</td>
<td>0.411</td>
</tr>
<tr>
<td>Days on device</td>
<td>112 ±119</td>
<td>254 ±251</td>
<td>0.013</td>
</tr>
<tr>
<td>Ischemic cardiomyopathy</td>
<td>9 (36%)</td>
<td>13 (48%)</td>
<td>0.386</td>
</tr>
<tr>
<td>Aortic stenosis (AV ≤ 1.5 cm²)</td>
<td>1 (4%)</td>
<td>1 (4%)</td>
<td>0.957</td>
</tr>
<tr>
<td>Chronic kidney disease (Cr ≥ 1.5 mg/dl)</td>
<td>9 (36%)</td>
<td>6 (22%)</td>
<td>0.248</td>
</tr>
</tbody>
</table>
## Results: Post-LVAD GI Bleeding

<table>
<thead>
<tr>
<th></th>
<th>Nonpulsatile (n=25)</th>
<th>Pulsatile (n=27)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>GI bleeding from AVM</td>
<td>1 (4%)</td>
<td>2 (7%)</td>
<td>0.607</td>
</tr>
<tr>
<td>All GI bleeding</td>
<td>2 (8%)</td>
<td>6 (22%)</td>
<td>0.162</td>
</tr>
</tbody>
</table>
Results: Pre-Implant Colonoscopy

- The 10 subjects received pre-implant colonoscopies
  - Cancer screening for patients over 50
  - 7 had pathologic findings
    - 4 polyps
    - 2 diverticulosis
    - 1 colitis
  - 3 went on to develop post-implant GI bleeding
  - No association ($p = 1.000$)
Discussion

- Letsou et al. suggested an association between nonpulsatile LVADs and GI AVMs [4]
  - We found no statistical association between nonpulsatile LVADs and AVMs [7]
  - Ironically found more bleeding in the pulsatile group, but this was not statistically significant

- Only age was found to be an independent predictor of GI bleeding (p = 0.001)
Study Limitations (Both Studies)

- Did not consider residual ejection fractions
  - Device recipients may still have pulsatile aortic pressures if their ventricles remain ejecting

- Only considered clinically evident AVMs
  - Hematemesis, hematochezia, melena, guaiac positive stools, iron deficiency anemia

- Did not control for confounding factors
  - CKD, VWD, AS, portal HTN, etc.

- Small, retrospective
Discussion, Continued

- Colorectal disease in transplant recipients [6]
  - Anticoagulation and immunosuppression
  - Increased rate of gastrointestinal malignancy, infection, and bleeding

- Screening colonoscopies did not help predict those who would develop GI AVMs
  - May want to expand screening to patients with...
    - Prior bleeding events
    - Coagulopathy
    - Chronic kidney disease
    - Liver disease
    - Unexplained anemia
    - Aortic stenosis
    - Gastrointestinal disease
    - Connective disease
Conclusions

- Nonpulsatile LVADs were not associated with an increase in GI AVMs or GI bleeding

- The limited number of pre-implant colonoscopies was not predictive of post-implant GI bleeding

Take-home points
- Nonpulsatile LVADs are safe to use (w/ respect to risk of GI bleeding)
- May want to expand endoscopic screening criteria for transplant candidates
Acknowledgements

- Erika D. Feller, MD
- Erik N. Sorensen, PhD
- Jonathan M. Fenkel, MD
- Eric M. Goldberg, MD
References


