Innominate Artery Reconstruction: Primary and Hybrid Indications

Margaret C. Tracci, M.D., J.D.
University of Virginia

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Disclosures

• None
History: Surgical Treatment of Supraaortic Disease

- 1950 Murray: Retrograde common carotid endarterectomies for syphilitic arteritis
- 1953 Bahnson: Aorto innominate bypass with pediatric aortic homograft
- 1954 Davis: Innominate artery endarterectomy (right anterior thoracotomy)
- 1958 DeBakey: Prosthetic aorto-innominate bypass
- 1960 Wylie: Series of innominate endarterectomies
- 1964 Parrott: Subclavian artery transposition
- 1964 Diethrich: Carotid-subclavian bypass
Indications: Innominate Artery Reconstruction

Underlying Pathology

- Atherosclerotic Disease (most common)
- Takayasu’s Arteritis
- Radiation Arteritis
Atherosclerotic Disease

- Majority of lesions
- Tends to present with thromboembolic events
- Distribution of lesions:

<table>
<thead>
<tr>
<th>Authors (Year)</th>
<th>No. of Patients</th>
<th>IA</th>
<th>LC</th>
<th>RC</th>
<th>LS</th>
<th>RS</th>
<th>Multiple (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crawford et al (1969)</td>
<td>299</td>
<td>66 (26)*</td>
<td>61 (37)*</td>
<td>24 (19)*</td>
<td>202 (133)*</td>
<td>59 (29)*</td>
<td>24</td>
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<tr>
<td>Kieffer et al (1995)</td>
<td>148</td>
<td>148</td>
<td>47</td>
<td>27</td>
<td>60</td>
<td>52</td>
<td>84</td>
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<tr>
<td>Azakie et al (1998)*</td>
<td>94</td>
<td>94</td>
<td>26</td>
<td>29</td>
<td>20</td>
<td>30</td>
<td>68</td>
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<tr>
<td>Takach et al (I) (2005)*</td>
<td>157</td>
<td>150</td>
<td>38</td>
<td>48</td>
<td>26</td>
<td>48</td>
<td>—</td>
</tr>
<tr>
<td>Takach et al (II) (2005)*</td>
<td>391</td>
<td>—</td>
<td>17 (left + right)</td>
<td>374 (left + right)</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

**Abbreviations:** IA, Innominate artery; LC, Left common carotid artery; LS, Left subclavian artery; RC, Right common carotid artery; RS, Right subclavian artery.

* Series of patients being treated for innominate artery disease.
* Patients with innominate artery of multivessel disease.
* Patients with single vessel disease. Authors did not distinguish between left- and right-sided lesions.
* Numbers in parentheses represent complete occlusions.
<table>
<thead>
<tr>
<th>Criterion</th>
<th>Definition</th>
</tr>
</thead>
</table>
| Age at disease onset  
≤40 yrs | Development of symptoms or findings related to TA at age ≤40 yrs           |
| Claudication of extremities      | Development and worsening of fatigue and discomfort in muscles of 1 or more extremity while in use, esp. upper extremities |
| Decreased brachial artery pulse  | Decreased pulsation of 1 or both brachial arteries                         |
| BP difference >10mmHg arms       | Difference of >10mm Hg in systolic BP between arms                         |
| Bruit over subclavian arteries or aorta | Bruit audible on auscultation over 1 or both subclavian arteries or abdominal aorta |
| Arteriographic findings         | Arteriographic narrowing or occlusion of entire aorta, its primary branches, or large arteries in proximal upper or lower extremities, not caused by arteriosclerosis, fibromuscular dysplasia or similar causes, changes usually focal or segmental |
Takayasu’s Arteritis: Medical Management

Steroids/immunosuppressives remain mainstay of tx

- Initially 50-60% will respond to steroids
- App. 50% of non-responders will respond to methotrexate
- 25% will not respond to medical therapy
- Over 50% of initial responders will have relapse

Difficult to assess disease activity

- Imaging: Gadolinium-enhanced MRI
  - 94% correlation with active disease, BUT 56% positive during periods of clinical remission
  - May be a role for PET
- ESR and CRP poorly correlated with MR assessment of disease activity
Radiation Arteritis

- Oncology
  - Head and neck malignancies (50%)
  - Breast (30%)
  - Lymphoma (19%)

- Pathology
  - Subintimal fibrosis
  - Degeneration of endothelial and elastic layers
  - Myointimal proliferation in large, muscular arteries
  - Injury to adjacent structures: lymphatics, musculature, esophagus

- Present with both embolic and ischemic symptoms
Indications for Supraaortic Reconstruction

**Symptomatic Disease**

**Embolic**
- Amaurosis
- TIA/CVA
- Upper extremity emboli

**Occlusive**
- Upper extremity claudication
- Tissue loss
- Global ischemia

**Asymptomatic Disease**

**Hybrid Indication**
- Aneurysmal disease involving arch

**Coronary Disease**
- Coronary steal (IMA graft)
- Anticipated CABG and severe stenosis/occlusion of the innominate

**Anticipation or salvage of:**
- Axillary origin graft
- Hemodialysis access

**Miscellaneous**
- Need for reliable brachial blood pressure monitoring
- “Critical stenosis” of common carotid or innominate (controversial)
Options for Surgical Reconstruction

• Direct Reconstruction
  • Ascending aortic-based bypass graft
  • Innominate artery endarterectomy

• Extrathoracic Reconstruction
  • Carotid-carotid bypass
  • Carotid-subclavian bypass
  • Subclavian artery transposition
Direct Reconstruction: Patient selection

• **Comorbidities/condition**
  • Must be reasonable risk for major operation
  • Increased mortality with:
    • Creatinine $\geq 2.0$
    • Thrombophilia
    • Radiation arteritis
  • Coronary Artery Disease
    • Need CABG? Coronary Steal?

• **Anatomy**
  • Careful examination of ascending aorta and arch
    • Bypass: Examine for calcification/thrombus of ascending
    • Endarterectomy: Ensure appropriate anatomy for placement of partial-occluding clamp, particularly between innominate and left common carotid
(From Mayo Foundation for Medical Education and Research, copyrighted and all rights reserved; with permission.)
Hemi- or Minithoracotomy
Mini sternotomy tips

- Patient supine, head to left, vertical shoulder roll
  - Facilitates “hockey-stick” right supraclavicular extension
- Incision from sternal notch to 3rd interspace
- Posterior sternum swept with finger from sternal notch down
- Sternotomy saw used to incise to the 3rd interspace
- Sternotomy completed with either an “J” or a “T”-type
- Care taken to avoid injury to IMA
- Careful hemostasis at sternal edges
  - May use bone wax
- Use pediatric sternal retractor
Innominate Artery: Opening the Pericardium
Innominate Artery Graft
Innominate Endarterectomy
## Outcomes: Innominate Reconstruction

<table>
<thead>
<tr>
<th>Author</th>
<th># Pts</th>
<th>Stroke</th>
<th>Death</th>
<th>5-yr Stroke-free</th>
<th>10-yr Stroke-free</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kieffer</td>
<td>148</td>
<td>3.4</td>
<td>5.4</td>
<td>88</td>
<td>80</td>
</tr>
<tr>
<td>Takach</td>
<td>113</td>
<td>2.7</td>
<td></td>
<td></td>
<td>94 (FF)</td>
</tr>
<tr>
<td>Berguer</td>
<td>100</td>
<td>6</td>
<td>8</td>
<td>87</td>
<td>81</td>
</tr>
<tr>
<td>Azakie</td>
<td>94</td>
<td>3</td>
<td>4</td>
<td>97</td>
<td>99 (FR)</td>
</tr>
<tr>
<td>Rhodes</td>
<td>58</td>
<td>7</td>
<td>2.3</td>
<td></td>
<td>79 (ASO)</td>
</tr>
<tr>
<td>Carlson</td>
<td>34</td>
<td></td>
<td>6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Outcomes

- 157 Consecutive patients with Innominate Artery or multivessel disease

<table>
<thead>
<tr>
<th>Group</th>
<th>Mortality</th>
<th>Stroke</th>
<th>10yr FF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transthoracic (113)</td>
<td>2.7%</td>
<td>2.7%</td>
<td>94.4%</td>
</tr>
<tr>
<td>Extrathoracic (44)</td>
<td>2.3%</td>
<td>6.3%</td>
<td>60.3%</td>
</tr>
</tbody>
</table>

- Takach et al, 2005
What is Right for Your Patient?

Considerations:
• Disease Etiology
• Patient Characteristics
• Anatomy
Etiology: Atherosclerotic Occlusive Disease

• Anatomy
  • What needs to be revascularized?
  • What is the condition of the ascending aorta?
  • What is the anatomy of the SAT?

• Patient age/comorbidities
  • Is this patient high risk for direct reconstruction?
  • Mean age of patients in large series: 54-61 yrs
  • Weigh patency vs morbidity/mortality concerns
  • Patients tend to be older with significant comorbidities
Etiology: Takayasu’s Arteritis

• Is disease adequately medically treated?
  • Typically chronic ischemic presentation
  • Better outcomes with quiescent disease

• How young and healthy is your patient?
  • Demographics: typically younger (25 Asia/US, 41 Europe) and fewer comorbidities than patients with atherosclerotic occlusive disease
  • More likely to tolerate direct reconstruction

• What is the anatomy of the lesions?
  • Often tapering lesions not involving origin of vessel
  • May use innominate-based graft rather than ascending aorta for direct reconstruction
Takayasu’s: innominate-based graft
Takayasu’s: innominate-based graft
Etiology: Radiation Arteritis

- Patient comorbidities vary widely depending on underlying disease
- Difficult dissection, loss of planes
- Increased risk for sternal infections
Hybrid Indications

- Aneurysmal Disease Involving the Aortic Arch
  - Remains a major surgical challenge.
  - Hybrid approaches have been introduced in recent years
    - Most combine open, transthoracic arch debranching with endovascular aneurysm exclusion where anatomy would require coverage of multiple supraaortic trunks either to fully exclude the aneurysmal portion or to achieve adequate proximal or distal endograft landing zones. (Hughes)
    - Recognition of the significant morbidity and mortality associated with traditional aortic arch replacement or transthoracic debranching has driven the development of “minimally invasive” approaches involving mini-sternotomy. (Sakopoulos)
    - Total extrathoracic approach is possible in some if not all cases
Total Extrathoracic Arch Debranching
Summary

• Transthoracic treatment of innominate disease is a good, durable option for a selected group of patients
  • Younger, appropriate anatomy, careful assessment of comorbidities
• Extrathoracic reconstructions provide good patency with lower morbidity and mortality
  • When either etiology or patient age/comorbidities render transthoracic approach unappealing
• The etiology of innominate disease is important
  • Affects evaluation and preoperative management
  • May dictate best treatment course
Questions?