Contemporary Management of Acute Type B Aortic Dissection

Bradley G. Leshnower MD
Assistant Professor of Surgery
Division of Cardiothoracic Surgery
Emory University School of Medicine

Georgia Vascular Society
5th Annual Scientific Sessions
September 9, 2017
Disclosures

• Medtronic: Speaker
• Cardiac Surgeon with Endovascular Skills
Acute Type B Aortic Dissection (aTBAD) Definitions

• **Complicated**
  – Rupture
    • Contained or “Impending”
    • Periaortic hematoma
    • Irregular aortic contour
  – Malperfusion
    • Clinical
      – Absent pulse
      – Claudication
      – Acute renal failure with normal sized kidneys
    • Radiographic
      – Renal,
      – Massive TL compression
  – Morphologic evolution
    • Rapid expansion in diameter
    • Change in false lumen status

• **Uncomplicated**
  – “High risk” features
Impending Rupture
Contained Rupture
aTBAD Definitions

• **Complicated**
  – Rupture
    • Contained or “Impending”
    • Periaortic hematoma
    • Irregular aortic contour
  – Malperfusion
    • Clinical
      – Absent pulse
      – Claudication
      – Acute renal failure with normal sized kidneys
    • Radiographic
      – Renal
      – Massive TL compression
  – Morphologic evolution
    • Rapid expansion in diameter
    • Change in false lumen status

• **Uncomplicated**
  – High risk uncomplicated
Radiographic Malperfusion

Renal

Massive TL compression
aTBAD Definitions

• **Complicated**
  – Rupture
    • Contained or “Impending”
    • Periaortic hematoma
    • Irregular aortic contour
  – Malperfusion
    • Clinical
      – Absent pulse
      – Claudication
      – Acute renal failure with normal sized kidneys
    • Radiographic
      – Renal,
      – Massive TL compression
  – Morphologic evolution
    • Rapid expansion in diameter
    • Change in false lumen status

• **Uncomplicated**
  – High risk uncomplicated
IRAD: Acute Type B Aortic Dissection (aTBAD)

- IRAD-All patients with the diagnosis of aTBAD
  - Mortality at 3 years: 24.9%
  

- IRAD-Open Surgical Results for complicated aTBAD
  - Overall In-Hospital Mortality: 29.3%
    - Malperfusion: 27.8%
    - Rupture: 62.5%
  - Surgery < 48 hours: 39.2%
  - Surgery > 48 hours: 18.1%
  - LOS for survivors: 26 days
  
Open DTA repair in aTBAD
Principles of TEVAR in aTBAD

• Cover primary intimal tear
  – Eliminate antegrade flow into the false lumen

• Expand true lumen to restore adequate inflow to the distal aorta
  – Stent entire thoracic aorta if necessary
Aortic Remodeling in Type B Aortic Dissection

• Relocate the dissection flap back to its native position against the false lumen wall

• True Lumen
  – Expansion

• False Lumen
  – Thrombosis
  – Obliteration
IVUS for TEVAR in aTBAD

- **MANDATORY!**
- Confirms True and False Lumen
- Identify Primary Intimal Tear
- Identify Large Secondary Thoracic Intimal Tears
- Aorta/branch vessel sizing
- Decreases contrast use
aTBAD and Malperfusion: Algorithm

1. Cover primary tear site

2. Evaluation and treatment of persistent malperfusion
   - Measure femoral pressures
   - IVUS/Aortograms
   - Extend TEVAR to celiac
   - Adjunctive stenting
     • Celiac/SMA
     • Renals
     • Infrarenal stents
     • Ileofemoral stents
   - Open surgical revascularization
aTBAD and Rupture

- Must cover primary tear site
- Must cover site of rupture
- Be prepared to cover entire thoracic aorta from LCCA to celiac
TEVAR for Complicated aTBAD: Results
TEVAR for Complicated aTBAD

PENN 2004-2007

- n=35 patients

Indications:
- Rupture: 51.4%
- Malperfusion: 48.6%

Distal Stenting
- Infrarenal Aorta: 11.4%
- Rena/Celiac: 11.4%
- Ileofemoral: 20%
TEVAR for complicated aTBAD

- Mortality
  - 30 day: n=1 (2.8%)
  - 1 year: n=2 (5.7%)

- Morbidity
  - CVA: n=1 (2.8%)
  - Paraplegia
    - Transient: n=2 (5.7%)
    - Permanent: n=1 (2.8%)
  - Renal Failure: n=1 (2.8%)

TEVAR: Optimal therapy for complicated aTBAD

- Results of a New Surgical Paradigm: Endovascular Repair for Acute Complicated Type B Aortic Dissection

Wilson Y. Szeto, MD, Michael McGarvey, MD, Alberto Pochettino, MD, G. William Moser, CRNP, Andrea Hoboken, BS, Katherine Cornelius, BSN, RN, Edward Y. Woo, MD, Jeffrey P. Carpenter, MD, Ronald M. Fairman, MD, and Joseph E. Bavaria, MD

Divisions of Cardiovascular Surgery and Vascular Surgery, Department of Surgery, and the Department of Neurology, University of Pennsylvania Medical Center, Philadelphia, Pennsylvania

Background. Conventional open repair of acute complicated type B aortic dissection is associated with significant morbidity and mortality. This study examined the results of thoracic endovascular aortic repair (TEVAR) in acute type B aortic dissection complicated with rupture or malperfusion syndrome.

Methods. From 2004 through 2007, 35 patients (22 men) with acute complicated type B aortic dissection were treated with TEVAR. Indications included rupture in 18 (51.4%) and malperfusion syndrome in 17 (48.6%). Type I or II, Siewert extrasternal, 3, both 0. Three types of endograft devices were used (mean per patient, 1.9 devices). Intravascular ultrasound imaging was used in 15 patients (43.4%). In patients with malperfusion syndrome, distal adjacent procedures to expand the true lumen included infrarenal aortic stents in 4, mesenteric/renal stents in 4, and iliofemoral stents in 7. Follow-up was 93.9% during a period of 18.3 months (range, 3 to 47 months).

Results. The mean age was 58.6 ± 13.4 years. Technical success (coverage of the primary tear site) was achieved in 34 patients (97.1%). Coverage of the left subclavian artery was required in 25 patients (71.4%). Thirty-day mortality was 2.8%. One-year survival was 93.4 ± 4.6%. Complications included permanent renal failure (2.8%), stroke (2.8%), spinal cord ischemia (transient [5.7%], permanent [2.8%]), and vascular access (14.2%). The mean intensive care unit and hospital stay were 4.7 ± 2.6 and 16.7 ± 12.0 days, respectively.

Conclusions. Endovascular repair of acute complicated type B aortic dissection is associated with low morbidity and mortality and has emerged as the surgical therapy of choice.

TEVAR optimally addresses complicated aTBAD.
EMORY
TEVAR for
Complicated aTBAD

- 2012-2015
- 51 patients
- Mortality
  - 30 day: 3.9%
  - 1 year: 5.8%
- Morbidity
  - CVA: 3.9%
  - Transient Paraparesis: 5.9%
  - Permanent Paraplegia: 0%
  - Renal failure: 0%
- 11 reinterventions
  - Open: n=6
  - Endovascular: n =5

Aortic Remodeling After Endovascular Repair of Complicated Acute Type B Aortic Dissection

Bradley G. Leshower, MD, Yazan M. Duwayri, MD, Edward P. Chen, MD, Chun Li, MD, Carl A. Zehner, BA, Jose N. Binongo, PhD, and Ravi K. Veeraswamy, MD

Division of Cardiothoracic Surgery, and Vascular and Endovascular Therapy, Emory University School of Medicine, Atlanta; and Rollins School of Public Health, Emory University, Atlanta, Georgia

Background. Thoracic endovascular aortic repair (TEVAR) is the optimal therapy for complicated acute type B aortic dissection (aTBAD). This study examined clinical outcomes and aortic remodeling parameters after TEVAR for patients with complicated aTBAD.

Methods. From January 2012 to December 2015, 51 patients underwent TEVAR for complicated aTBAD. Preoperative and postoperative imaging studies were analyzed for sizes of the true lumen (TL) and false lumen (FL) and for the FL thrombosis status at five locations in the thoracic and abdominal aorta.

Results. In-hospital and 1-year mortality rates were 3.9% and 5.8%, respectively. The incidence of stroke and paraparesis were 3.9% and 3.8%, respectively. In DeBakey 3a patients, TEVAR resulted in complete FL thrombosis and/or obliteration in 75% of patients. In DeBakey 3b patients, TEVAR resulted in complete FL thrombosis and/or obliteration in 100% of patients in the proximal descending thoracic aorta and 78% in the mid portion of the descending thoracic aorta. The infrarenal FL remained patent in 78% of patients. TEVAR stabilized the size of the proximal descending thoracic aorta pre-TEVAR 43 ± 7 cm vs post-TEVAR 39 ± 7 mm; p = 0.07). However, significant aortic expansion was observed in all other downstream aortic segments. TEVAR resulted in a significant expansion in the TL volume (pre-TEVAR 99 ± 53 cm³ vs post-TEVAR 185 ± 70 cm³; p < 0.01) and total aortic volume (pre-TEVAR 314 ± 97 cm³ vs post-TEVAR 391 ± 120 cm³; p = 0.02) while inhibiting expansion of FL volume (pre-TEVAR 215 ± 67 cm³ vs post-TEVAR 204 ± 79 cm³; p = 0.91).

Conclusions. TEVAR for complicated aTBAD results in low 30-day and 1-year mortality rates, with higher reintervention rates than observed with open operations. TEVAR is effective in thrombosing and stabilizing the size of the thoracic FL. The abdominal aortic FL remains patent and must be carefully scrutinized for long-term aneurysm formation.

Aortic Remodeling with Extended TEVAR
Aortic Remodeling: TEVAR Induces Thoracic FL Thrombosis

**Table 5. Postoperative False Lumen Status at Hospital Discharge at Aortic Segments in Patients With Acute DeBakey 3b Aortic Dissection (n = 27)**

<table>
<thead>
<tr>
<th>Aortic Segment</th>
<th>Patent</th>
<th>Partial Thrombosis</th>
<th>Complete Thrombosis</th>
<th>Complete Obliteration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prox DTA</td>
<td>5 (19%)</td>
<td>4 (14%)</td>
<td>15 (56%)</td>
<td>3 (11%)</td>
</tr>
<tr>
<td>Mid DTA</td>
<td>6 (22%)</td>
<td>9 (33%)</td>
<td>9 (33%)</td>
<td>3 (11%)</td>
</tr>
<tr>
<td>Hiatus</td>
<td>18 (67%)</td>
<td>6 (22%)</td>
<td>1 (4%)</td>
<td>2 (7%)</td>
</tr>
<tr>
<td>Celiac</td>
<td>21 (77%)</td>
<td>5 (19%)</td>
<td>1 (4%)</td>
<td>0</td>
</tr>
<tr>
<td>Infrarenal</td>
<td>23 (86%)</td>
<td>4 (14%)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Mid DTA — midpoint of the descending thoracic aorta; Prox DTA — proximal descending thoracic aorta.

**Table 7. Postoperative False Lumen Status at 12 or More Months at Different Aortic Segments in Patients With Acute DeBakey 3b Aortic Dissection (n = 18)**

<table>
<thead>
<tr>
<th>Aortic Segment</th>
<th>Patent</th>
<th>Partial Thrombosis</th>
<th>Complete Thrombosis</th>
<th>Complete Obliteration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prox DTA</td>
<td>0</td>
<td>0</td>
<td>4 (22%)</td>
<td>14 (78%)</td>
</tr>
<tr>
<td>Mid DTA</td>
<td>0</td>
<td>4 (22%)</td>
<td>4 (22%)</td>
<td>10 (56%)</td>
</tr>
<tr>
<td>Hiatus</td>
<td>3 (17%)</td>
<td>9 (50%)</td>
<td>4 (22%)</td>
<td>2 (11%)</td>
</tr>
<tr>
<td>Celiac</td>
<td>5 (28%)</td>
<td>11 (61%)</td>
<td>2 (11%)</td>
<td>0</td>
</tr>
<tr>
<td>Infrarenal</td>
<td>14 (78%)</td>
<td>4 (22%)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Mid DTA — midpoint of the descending thoracic aorta; Prox DTA — proximal descending thoracic aorta.
Aortic Remodeling: Impact of TEVAR on Aortic Diameter

Table 3. Aortic Diameters at Different Aortic Segments in Patients With Acute DeBakey 3b Aortic Dissection

<table>
<thead>
<tr>
<th>Aortic Segment</th>
<th>Preoperative (n = 32)</th>
<th>Hospital Discharge (n = 27)</th>
<th>Postoperative: 6 months (n = 19)</th>
<th>Postoperative: ≥12 months (n = 18)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prox DTA</td>
<td>43 ± 9</td>
<td>43 ± 9</td>
<td>40 ± 8</td>
<td>39 ± 7</td>
<td>0.07</td>
</tr>
<tr>
<td>Mid DTA</td>
<td>35 ± 4</td>
<td>36 ± 6</td>
<td>37 ± 6</td>
<td>39 ± 6</td>
<td>0.007</td>
</tr>
<tr>
<td>Hiatus</td>
<td>32 ± 5</td>
<td>33 ± 6</td>
<td>37 ± 7</td>
<td>39 ± 8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Celiac</td>
<td>30 ± 4</td>
<td>31 ± 4</td>
<td>33 ± 4</td>
<td>35 ± 5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Infrarenal</td>
<td>25 ± 4</td>
<td>25 ± 4</td>
<td>26 ± 3</td>
<td>28 ± 4</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

All data are means ± SD in millimeters.

Mid DTA = midpoint of the descending thoracic aorta; Prox DTA = proximal descending thoracic aorta.
TEVAR for complicated aTBAD

- Low Morbidity and Mortality
- Aortic Remodeling
- Stented Thoracic aorta
  - TL Expansion
  - FL obliteration
  - Stabilization of Aortic diameter
- Abdominal aortic
  - Patent FL
  - Aortic Growth

CAREFUL SURVEILLANCE IS WARRANTED
Emory  Complicated aTBAD Case
Case 1

• 51 yo presented to an OSH with an acute onset of sharp back and abdominal pain.
• CT scan: Acute Type B Aortic Dissection
• PE :
  – Neuro: Somnolent
  – ABD: Soft, NT,ND
  – Pulses: Femoral pulses non Palpable
  – Anuric
• Labs:
  – Cr. 2.5
  – Platelets 67K
  – Lactate 4.0
Hybrid OR

- Open exposure of R CFA: Pulseless
- 5 Fr L CFA Sheath
- BP’s:
  - R Radial: 121/58
  - R CFA: 41/37
  - L CFA 58/43
Conduct of operation

- **IVUS**
  - Lunderquist and Pigtail in TL
  - Sizing: Zone 2 Aorta 30mm
- **TEVAR**: Valiant 32 x 32 x 200
  - Magnified Arch aortogram
  - Decrease SBP <90mm Hg
  - Deployment bare metal over LSA
- **BP**
  - R Radial: 119/55
  - R CFA: 84/51
Conduct of operation

- TEVAR: 34 x 30 x 150
- IVUS to mark Celiac
- No AORTOGRAM
- R Radial 116/52
- R CFA: 101/52
- L CFA: 99/51
- AORTOGRAM
  - Normal renal perfusion

MALPERFUSION RESOLVED
Postoperative Course

• Immediately increased SBP>150
• Immediate urine output in foley
• Extubated in OR
  – Not moving legs!
• STAT lumbar drain in OR
• Moved legs 1 hour later in ICU
• CSF drainage for 3 days, MAP>100
• DC on POD#11
  – Normal neurologic exam, Cr. 1.8
  – Palpable DP pulses
• 1 month Postop CTA

1 month Postop CTA
Management of aTBAD in 2017

• Complicated
  – TEVAR: GOLD STANDARD

• Uncomplicated
  – Medical Management vs TEVAR

CONTROVERSIAL!
What is the data on Uncomplicated TBAD (uTBAD)?

- What is the data on OMT for uncomplicated TBAD?
  - Natural History Data

- What is the data on TEVAR for uncomplicated TBAD?
  - ADSORB (acute)
  - INSTEAD (chronic)
Uncomplicated aTBAD

- Medical Management
  - In hospital mortality: 6.4% (n=1480)
  - Long Term Survival
    - 1 year: 83-100%
    - 5 years: 70-89%

From the Department of Intensive Care, San Salvatore Hospital, Pescia, Italy; Department of Vascular Surgery, Hospital San Camillo Forlanini, Rome, Italy; Department of Vascular Surgery, Hospital Santa Maria Mammolo, Perugia, Italy; Department of Cardiovascular Surgery, Inghiltera, University Hospital, Rome, Switzerland; Department of Cardiovascular Surgery, University of Barcelona, Barcelona, Spain; Department of Cardiovascular, University of Rostock, Rostock, Germany; Department of Cardiology, Hospital Clínico San Carlos, Madrid, Spain; and the Department of Cardiovascular Surgery, AZ Istituto di Medicina, Bergamo, Italy. Dr. De Rango was not a member of the Expert Panel, but participated in the literature review, results analysis, and editing of the paper. The literature search was partially sponsored by an educational grant provided by Medtronic, Inc. Dr. Reisman has been a consultant for Gore, Boston, and Medtronic. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

Manuscript received July 24, 2013; revised manuscript received October 30, 2013; accepted November 8, 2013.

The objective of this paper is to present a consensus of cardiovascular, vascular, and interventional specialists in an attempt to define reliable criteria for definitions and treatment of type B aortic dissection. As part of this objective, a comprehensive review of available literature regarding medical, surgical, and endovascular treatment of type B aortic dissection has been conducted. The expert panel is aware that this consensus document can provide a proposal for strategies, but that the final decisions about when an intervention is justified
Natural History of OMT for auTBAD

- MGH
- 1999-2011
- 298 pts auTBAD
- OMT

- Mean F/U: 4.3±3.5 yrs
- OMT failure: 58.4%
  - Death: 38% (119 pts)
  - Aortic related interventions: 29% (87 pts)
Natural History of OMT for auTBAD

Less than half (41%) enjoyed intervention-free survival at 6 years.
Those who ultimately required intervention had significant survival advantage.
EMORY TEVAR for TBAD

- 2000-2016
- 398 patients
- “De Novo” Acute TBAD

The Impact of Thoracic Endovascular Aortic Repair on Long-Term Survival in Type B Aortic Dissection

Xiaoying Lou, MD, Edward P. Chen, MD, Yazan M. Duwayri, MD, Ravi K. Veevaswamy, MD, William D. Jordan, Jr, MD, Carl A. Zehner, BS, and Bradley G. Leshnower, MD

Background. Currently, optimal medical therapy is first-line therapy for uncomplicated acute type B aortic dissection (aTBAD) despite poor long-term outcomes. This study examines the impact of thoracic endovascular aortic repair (TEVAR) in the acute and chronic phases on short-term and long-term survival of patients presenting with aTBAD.

Methods. A review of the Emory aortic database from 2000 to 2016 identified 398 patients diagnosed with aTBAD. At index hospitalization, complicated patients underwent TEVAR (TEVAR [thoracic endovascular aortic repair in the acute phase] = 80) and uncomplicated patients received optimal medical therapy (n = 318). Uncomplicated patients were divided into subgroups based on final treatment (1) TEVAR [thoracic endovascular aortic repair in the chronic phase], n = 87; (2) open aortic repair (n = 59); and (3) optimal medical therapy (n = 172). Kaplan-Meier curves assessed long-term mortality.

Results. The mean age of patients was 57 ± 12 years. In the uncomplicated group, 146 patients (45.9%) patients failed optimal medical therapy and underwent open repair (n = 59) or endovascular repair (TEVAR, n = 87).

Despite a heightened awareness and improved surgical, endovascular, and medical therapies, type B aortic dissection (TBAD) remains a lethal disease with poor long-term survival. Thoracic endovascular aortic repair (TEVAR) has revolutionized the treatment of complicated acute TBAD (aTBAD), and it is currently the recommended therapy for patients with aTBAD who present with malperfusion or rupture. TEVAR has also been shown to be effective in the treatment of aneurysms in patients with chronic TBAD by promoting false lumen thrombosis. However, a lack of clarity persists regarding the optimal therapy for patients presenting with aTBAD without life-threatening complications. Historically, uncomplicated aTBAD patients have been treated with aggressive antihypertensive regimens, a strategy termed optimal medical therapy (OMT). Optimal medical therapy has produced excellent inhospital and 1-year outcomes. However, the incidence of OMT failure requiring surgical or endovascular intervention is high, and long-term survival with OMT alone remains poor.

The disappointing long-term results with OMT combined with emerging data regarding the efficacy of TEVAR in remodeling the dissected aorta have led to the investigation of the use of TEVAR for uncomplicated aTBAD. Proponents of this strategy argue that TEVAR is highly effective in remodeling the aorta in the acute phase of TBAD, and that will reduce the incidence of false lumen aneurysm formation and aortic-related mortality in the chronic phase of the disease. However, the efficacy of aortic remodeling with TEVAR in the
Acute de novo TBADs presenting between 2000-2016 (N = 398)

Complicated
- TEVAR within 14 days of presentation (aTEVAR: N = 80)

Uncomplicated
- Optimal medical management (N = 318)
  - Open surgery (OPEN: N = 59)
  - TEVAR (cTEVAR: N = 87)
  - Optimal medical management (OMT: N = 172)
In-hospital mortality at index hospitalization

<table>
<thead>
<tr>
<th></th>
<th>aTEVAR (N = 80)</th>
<th>Uncomplicated (N = 318)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-hospital mortality</td>
<td>5.0% (4/80)</td>
<td>5.0% (16/318)</td>
<td>0.549</td>
</tr>
</tbody>
</table>

Data presented as % (count/total).
Kaplan-Meier Survival Curve
All aTBAD pts based upon definitive treatment received

Survival Probability vs Time (Years)

<table>
<thead>
<tr>
<th>Survival (%)</th>
<th>1 Year</th>
<th>3 Years</th>
<th>5 Years</th>
<th>8 Years</th>
<th>10 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>aTEVAR (N = 80)</td>
<td>93.6 (68)</td>
<td>89.7 (43)</td>
<td>89.7 (18)</td>
<td>84.1 (5)</td>
<td>84.1 (2)</td>
</tr>
<tr>
<td>OPEN (N = 59)</td>
<td>96.6 (55)</td>
<td>91.2 (51)</td>
<td>83.5 (43)</td>
<td>69.8 (27)</td>
<td>62.5 (15)</td>
</tr>
<tr>
<td>cTEVAR (N = 87)</td>
<td>95.2 (78)</td>
<td>88.7 (65)</td>
<td>77.2 (52)</td>
<td>62.5 (30)</td>
<td>50.4 (22)</td>
</tr>
<tr>
<td>OMT (N = 172)</td>
<td>91.2 (150)</td>
<td>84.0 (111)</td>
<td>79.5 (78)</td>
<td>75.1 (31)</td>
<td>66.4 (16)</td>
</tr>
</tbody>
</table>

p-value (by log-rank test) | 0.446 | 0.421 | 0.466 | 0.421 | 0.302
Kaplan-Meier Survival Curve
All intervention groups from time of intervention

<table>
<thead>
<tr>
<th>Survival (%)</th>
<th>1 Year</th>
<th>3 Years</th>
<th>5 Years</th>
<th>8 Years</th>
<th>10 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>aTEVAR (N = 80)</td>
<td>93.6 (68)</td>
<td>89.8 (42)</td>
<td>89.8 (18)</td>
<td>84.2 (5)</td>
<td>84.2 (2)</td>
</tr>
<tr>
<td>OPEN (N = 59)</td>
<td>81.4 (46)</td>
<td>75.3 (36)</td>
<td>73.0 (31)</td>
<td>67.0 (13)</td>
<td>67.0 (6)</td>
</tr>
<tr>
<td>cTEVAR (N = 87)</td>
<td>87.1 (71)</td>
<td>78.7 (54)</td>
<td>69.1 (38)</td>
<td>50.3 (18)</td>
<td>46.8 (12)</td>
</tr>
</tbody>
</table>

p-value (by log-rank test) | 0.090 | 0.069 | 0.036 | 0.021 | 0.018 |
Kaplan-Meier Intervention-free Survival Curve
Uncomplicated aTBAD patients from time of presentation

<table>
<thead>
<tr>
<th>Survival Probability</th>
<th>Time (Years)</th>
<th>1 Year</th>
<th>3 Years</th>
<th>5 Years</th>
<th>8 Years</th>
<th>10 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncomplicated (N = 318)</td>
<td>75.4 (234)</td>
<td>58.4 (160)</td>
<td>49.4 (108)</td>
<td>38.9 (46)</td>
<td>30.9 (27)</td>
<td></td>
</tr>
</tbody>
</table>
Conclusions

- Complicated aTBADs undergoing TEVAR have excellent early (95%) and long-term outcomes (>80% survival at 10 years).

- The natural history of uncomplicated aTBADs treated with OMT:
  - Short term mortality: 5%
  - 46% required intervention in the chronic phase
  - Intervention-free survival: ~50% at 5 years and ~30% at 10 years.
Conclusions

TEVAR at the index hospitalization may confer a survival advantage and serve as optimal therapy for both complicated and uncomplicated acute TBADs.

A more aggressive endovascular approach to uncomplicated TBADs is warranted to improve long-term survival.
EMORY ATBAD ALGORITHM 2017

Complicated
- Malperfusion
- Rupture

Emergent TEVAR

Uncomplicated

High Risk
- Intractable Pain
- Intractable HTN
- Total Aortic Diameter ≥ 40 mm
- FL > 22 mm

TEVAR (24-72 hrs)

Low Risk
- Pain free
- BP controlled
- No change in size or morphology on serial imaging

OMT
Contemporary Management of Acute Type B Aortic Dissection

Bradley G. Leshnower MD
Assistant Professor of Surgery
Division of Cardiothoracic Surgery
Emory University School of Medicine

Georgia Vascular Society
5th Annual Scientific Sessions
September 9, 2017
Contemporary Management of Chronic Type B Dissection
TEVAR for Chronic TBAD
Issues in 2017

• Efficacy dependent upon aortic remodeling
  – Rigid dissection flap
  – Retrograde FL perfusion
• Lack of a dissection-specific device
• Patient selection
  – Age and comorbidities
  – Anatomy
• Management of the distal LZ
• Limited Data
Cleveland Clinic

- 2000-2007
- 76 patients
  - Aneurysm: n=47 (62%)
  - Pain: n=15 (20%)
  - Rapid growth: n=9 (12%)
  - Malper/rupture: n=5 (7%)
- Age: 61± 5 years
- Mean f/u: 24 ± 26 months
TEVAR Details

- DeBakey 3a n=30
- DeBakey 3b n=46
- Age of Dissection: 25 months
- LSA Coverage: 39%
- Preop LSA revasc: 10%
- Device oversized 10-15%
- Short segment coverage
  - Primary tear coverage only

Gore TAG n=32
MDT Talent n=3
Cook TX2 n=27
Morbidity and Mortality

- Respiratory failure n=7
- Limb ischemia n=1
- Stroke n=1
- Paraplegia n=0

- Periop mortality n=4
  - Malperfusion n =1
  - Stroke n=1
  - Retrograde type A n=1
  - Unknown n=1

- Late mortality n=12
  - Ruptured type A n=1
  - Unknown n=3
  - Non-aortic related n=8
Aortic remodeling

- Decrease of 3.9mm (p<0.001) in Thoracic aortic diameter in the stent grafted aorta in both 3a and 3b patients

- Increase in ABD aorta in 3b patients of 6.2 mm (p<0.05)

- Total FL thrombosis
  - 3a n =78%
  - 3b n=13%
CCF: TEVAR in Chronic TBAD

• Safe procedure
  – Low perioperative morbidity and mortality
• Excellent treatment for 3a patient
• Aortic remodeling
  – Effective in FL thrombosis in the thoracic aorta
  – ABD FL remains patent
  – Decrease in Thoracic aortic size
  – Increase in ABD aortic size
• 22% aortic reintervention rate
  – >50% TEVAR extensions
• 2005-2012
• Chronic DeBakey III Aneurysms
  – Open n=58
  – TEVAR n=31
• Periop morbidity and mortality
• Aortic remodeling
• Mean f/u: 21 ± 20 months
<table>
<thead>
<tr>
<th>Variable</th>
<th>TEVAR (n = 31)</th>
<th>Open (n = 58)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>67 ± 10</td>
<td>57 ± 12</td>
<td>&lt;0.001&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Sex (Male)</td>
<td>18 (58%)</td>
<td>44 (76%)</td>
<td>0.14</td>
</tr>
<tr>
<td>Hypertension</td>
<td>24 (77%)</td>
<td>54 (93%)</td>
<td>0.04&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Prior CVA</td>
<td>3 (10%)</td>
<td>5 (8.6%)</td>
<td>1</td>
</tr>
<tr>
<td>Preop renal failure</td>
<td>2 (6%)</td>
<td>4 (6.9%)</td>
<td>1</td>
</tr>
<tr>
<td>COPD</td>
<td>13 (42%)</td>
<td>19 (32%)</td>
<td>0.35</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>3 (10%)</td>
<td>2 (3.4%)</td>
<td>0.34</td>
</tr>
<tr>
<td>Prior proximal aortic surgery</td>
<td>10 (32%)</td>
<td>20 (35%)</td>
<td>0.81</td>
</tr>
<tr>
<td>DeBakey type III</td>
<td>31 (100%)</td>
<td>58 (100%)</td>
<td></td>
</tr>
<tr>
<td>De novo</td>
<td>21 (68%)</td>
<td>44 (76%)</td>
<td>0.80</td>
</tr>
<tr>
<td>Residual DeBakey type I</td>
<td>10 (32%)</td>
<td>14 (24%)</td>
<td>0.80</td>
</tr>
<tr>
<td>Aneurysm size</td>
<td>6.1 ± 1.0</td>
<td>6.8 ± 0.9</td>
<td>&lt;0.001&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>CSF drain</td>
<td>14 (45%)</td>
<td>54 (96%)</td>
<td>&lt;0.001&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup> p ≤ 0.05.

COPD = chronic obstructive pulmonary disease; CSF = cerebrospinal fluid; CVA = cerebrovascular accident; TEVAR = thoracic endovascular aortic repair.
TEVAR details

- DeBakey 3a n=12
- DeBakey 3b n=19
- Age of Dissection: 47 months
- Length of coverage: 22±4 cm
- LSA Coverage: 55%
- Preop LSA revasc: 42%
- Aortic reinterventions: n=4
<table>
<thead>
<tr>
<th>Variable</th>
<th>TEVAR (n = 31)</th>
<th>Open (n = 58)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>0</td>
<td>6 (10.3%)</td>
<td>0.08</td>
</tr>
<tr>
<td>Stroke</td>
<td>0</td>
<td>2 (3.4%)</td>
<td>0.53</td>
</tr>
<tr>
<td>Paraplegia</td>
<td>0</td>
<td>7 (12.1%)</td>
<td>0.04a</td>
</tr>
<tr>
<td>Dialysis dependent renal failure</td>
<td>0</td>
<td>6 (10.3%)</td>
<td>0.08</td>
</tr>
<tr>
<td>Tracheostomy</td>
<td>0</td>
<td>8 (13.8%)</td>
<td>0.04a</td>
</tr>
<tr>
<td>ICU LOS (days)</td>
<td>$2 \pm 1$</td>
<td>$13 \pm 16$</td>
<td>&lt;0.001a</td>
</tr>
<tr>
<td>Hospital LOS (days)</td>
<td>$7 \pm 3$</td>
<td>$21 \pm 16$</td>
<td>&lt;0.001a</td>
</tr>
</tbody>
</table>

*a p ≤ 0.05.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Thoracic (only)</th>
<th>Thoracic + Abdominal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Series (n = 31)</td>
<td>25 (81%)</td>
<td>2 (6%)</td>
</tr>
<tr>
<td>CD3a (n = 12)</td>
<td>12 (100%)</td>
<td>N/A</td>
</tr>
<tr>
<td>CD3b (n = 19)</td>
<td>13 (68%)</td>
<td>2 (11%)</td>
</tr>
</tbody>
</table>

CD3a = chronic DeBakey type IIIa aneurysm; CD3b = chronic DeBakey type IIIb aneurysm; N/A = not applicable.
PENN TEVAR in Chronic TBAD

• Safe procedure
  – Low morbidity and mortality
  – Equivalent aortic related mortality to Open at 5 years
• Aortic remodeling
  – TL Expansion
  – FL Reduction
  – Stabilizes total aortic diameter
• 3a patients
  – Total FL thrombosis 100%
• 3b patients
  – Highly effective in Thoracic FL thrombosis
  – ABD FL remains patent
Duke

- 2005-2013
- Chronic DeBakey 3B Aneurysms n=32
- Age: 58 ± 12 years
- Median f/u: 54 months
- No TAAA
  - Aortic diameter at celiac axis : 3.5 ± 0.5 cm
TEVAR details

- DeBakey 3a n=0
- DeBakey 3b n=32
- Age of Dissection: 32 mos
- Length of coverage: 22±6cm
- LSA Coverage: 81%
- Preop LSA revasc: 19%
Morbidity & Mortality

• Mortality: n=0
• Stroke: n=0
• Paraplegia: n=0
• Retrograde type A: n=2 (6.3%)
  – No mortalities
• Aortic reintervention: n=5 (15%)  
• Median LOS: 3 days
Aortic remodeling

- 89% ≥ 1 cm decrease in Thoracic aortic size
- 15% Total FL thrombosis
- 44% Total Thoracic FL thrombosis
- 15% FL thrombosis along stent graft
- 25% Retrograde FL perfusion along stent graft
DUKE TEVAR for Chronic TBAD

• Safe
  – Low morbidity, no mortality

• Highly effective remodeling procedure for patients DeBakey 3B patients with DTAA (not TAAA)

• Recommendations/Observation
  – Cover all Thoracic FL fenestrations
  – Total FL thrombosis observed when all viscerals originate from the TL and < 3 distal fenestrations
TEVAR for CTBAD in 2017

What do we know?

• Technically feasible
• Low perioperative morbidity & mortality
• Excellent therapy for DeBakey IIIa
• Efficacy is variable for DeBakey IIIb
• Length of aortic coverage:
  – Cover all Thoracic FL fenestrations
  – Cover to the celiac artery
TEVAR for CTBAD in 2017
What we do not know?

• Ideal Anatomy
  – DTAA not TAAA
  – ? Number of FL viscerals and distal fenestrations
• Management of distal LZ
• Management of retrograde FL perfusion

Management of Distal LZ: Controversies

• Graft size at distal LZ
  – TL size
  – Total aortic diameter

• Balloon rupture of dissection flap
  – Goal
    • Expand endograft to oppose the flap to outer FL wall
    • Achieve a distal seal
    • Eliminate retrograde FL perfusion
“Knickerbocker” Technique
EMORY
TEVAR for Residual DeBakey I
with 7.6cm DTAA using
“Knickerbocker” Technique
Case Presentation

• 52 yo male morbidly obese truck driver s/p Asc/Hemiarch for and Acute DeBakey 1 aortic dissection in 2009
• Lost to follow up
• Presents with chest pain radiating to his back to an OSH
• PMH: HTN, Morbid obesity, DM, CHF, Stage II CKD
• 5’7”, 343 lbs
Case presentation

- 7.6 cm TAAA
- Tapers down to 4.2 cm at Celiac
- Non dissected Proximal LZ
- Atrophic L Kidney
- Poor Open candidate due to body habitus, risk of pulmonary and renal failure
Procedure

• L Carotid-Subclavian Bypass
• Proximal LSA embolization with 16mm Amplatz plug
• TEVAR
  – Prox LZ: Zone 2 Aorta 34 mm
  – Distal LZ: Celiac: Aorta 42 mm
• Valiant 40 x 40 x 200, 46 x 46 x 200
• Balloon rupture ≈ 4cm cephalad to celiac
Balloon Rupture of Dissection Flap
Postop CT scans

Arterial

Delayed venous
Management of Retrograde FL perfusion

• Mechanical occlusion of retrograde FL perfusion
  – Candy-Plug Technique
  – Covered stent grafts in the FL
EMORY
False Lumen Embolization in Chronic Complicated TBAD
History of Present Illness

• 64 yo female presented to an OSH with acute onset of chest and back pain associated with a syncopal episode

• PMH
  – HTN
  – COPD

• CT Scan
Preoperative CT
Diagnosis and Treatment Plan

• Ruptured Acute Type B Aortic Dissection with L Hemothorax
• Transferred to Emory
• On arrival to Emory
  – Pain Free
  – Hemodynamically stable on IV esmolol
  – Physical exam unremarkable
  – 2+ palpable pulses in all four extremities
Conduct of operation

- Hybrid OR
- Awake, totally percutaneous TEVAR
  - Avoids risk of rupture with induction of general anesthesia
  - Allows real time neuromonitoring for spinal cord ischemia
- Bilateral femoral arterial access
- IVUS
  - Confirm TL wire placement
    - L Fem: TL
    - R Fem: Unable to access TL
- Right radial artery access
  - 4 Fr Pigtail
Conduct of operation

• Proximal landing zone
  – Zone 2
  – Non-dissected aorta
  – Aortic diameter: 32mm
  – Must cover LSA in rupture

• Distal landing zone
  – 1cm cephalad to celiac artery
  – Aortic diameter: 34 mm

• Valiant 34 x 34 x 200, 36 x 36 x 200
Post-operative course

- Neurologically intact
- SBP > 150
- L Chest tube placed on POD#2
  - 1.5L of dark blood
  - Hemodynamically stable
- CT scan on POD#4
  - Retained small left hemothorax
- VATS on POD#7
- DC home on POD#11
Post-op visit at 1 month

• Chief complaint: 5/10 interscapular back pain
• PE
  – Normal
  – 2+ palpable pulses in all four extremities
• CT Scan
CT scan - 1 month postop

Arterial phase

Delayed venous phase
CT Scan - 1 month postop

6.1 cm
CT Scan - 1 month postop

6.1cm
Diagnosis

• Rapidly expanding 6.1 cm DTA Aneurysm
  – 1 cm growth in 1 month
• No antegrade FL filling
• Retrograde FL filling
• Options
  – Open DTA Repair with TEVAR explant using HCA
  – Endovascular FL Embolization
    • Placement of a covered stent graft into the FL to eliminate retrograde FL perfusion of the DTA
FL Embolization procedure

• Gain TL and FL access
• Perform Proximal aortogram
  – Rule out antegrade FL filling
• Perform Distal aortogram in FL to confirm retrograde filling
• Place a covered stent graft with an iliac plug into the FL
  – Cook Flex AAA converter 36 x 82
  – 16 x 30 ZIP Iliac plug
FL Embolization
FL Embolization
Post FL Embolization CT Scan
Retrograde FL perfusion

Post FL Embolization
TEVAR for Chronic TBAD 2017

- DeBakey 3a: Non-inferior to Open surgery
- DeBakey 3b with DTAA: Excellent results
- DeBakey 3b with TAAA: Unclear efficacy
  - Evolving adjunct procedures to manage the distal LZ and retrograde FL perfusion are improving results
Contemporary Management of Acute Type B Aortic Dissection

Bradley G. Leshnower MD
Assistant Professor of Surgery
Division of Cardiothoracic Surgery
Emory University School of Medicine

Georgia Vascular Society
5th Annual Scientific Sessions
September 9, 2017
Is there a role for prophylactic TEVAR in uncomplicated aTBAD?
ADSORB

- Prospective randomized trial of BMT vs BMT+TEVAR (Gore TAG) for uncomplicated aTBAD
- 17 European centers 2008-2010
- Treatment within 14 days of onset of symptoms
ADSORB: Methods

• Enrollment: 61 patients
  – BMT n=31
  – BMT + TEVAR n=30
  – 3 patients crossed over from BMT to TEVAR group
  – 2 patients withdrawn from TEVAR group
    • Consent issue: n=1
    • Proximal LZ inadequate: n=1

• TEVAR group
  – Proximal LZ: 2cm
  – Treatment length: ≥ 15 cm (Physician discretion)
ADSORB: Methods

• Composite Primary Endpoint at 1 year
  – Incomplete or no FL thrombosis along the length of the stent graft, excluding distal 2cm
  – Increase in total aortic diameter of ≥ 5mm
  – Aortic rupture

• CT scans per protocol at DC/1, 3 and 12 months, then q 6months x 3 years

• Intention to treat analysis
ADSORB: Results

• Baseline demographics equivalent
• 14 patients overall failed the primary endpoint due to inadequate/no imaging

Table 3. Per cent of false lumen thrombosis by treatment group and on intention to treat basis.

<table>
<thead>
<tr>
<th></th>
<th>TAG+BMT</th>
<th>BMT</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composite endpoint</td>
<td>15/30(50.0%)</td>
<td>31/31(100.0%)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>No false lumen thrombosis</td>
<td>13/30(43%)</td>
<td>30/31(97%)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Aortic dilatation</td>
<td>11/30(37%)</td>
<td>14/31(45%)</td>
<td>.500</td>
</tr>
<tr>
<td>Aortic rupture</td>
<td>0/30(0%)</td>
<td>0/31(0%)</td>
<td>—</td>
</tr>
</tbody>
</table>

All p-values derived from two-sample chi-square test.
ADSORB: Results
Per Protocol Analysis

• 1 yr follow up imaging: 23 pts in each group

• Composite Primary Endpoint at 1 year
  – Incomplete/no FL thrombosis along the length of the stent
    • BMT: 21/23 (91.3%) NO THROMBOSIS
    • TEVAR: 4/23(17.4%) NO THROMBOSIS
  – Aortic rupture
    • Zero in either group
    • Zero 30 day deaths in either group
    • 1 yr mortality:
      – TEVAR n=1 (Cardiac arrest, no autopsy)
      – BMT n=0
  – Increase in total aortic diameter of ≥ 5mm
Figure 2. Maximum true lumen by treatment group during follow up. At 1 year, the true lumen expanded in the TAG+BMT group, but did not so in the BMT group ($p < .001$).
Figure 3. Evolution of the false lumen by treatment group during the one year follow up. At 1 year, the false lumen decreased in size in the TAG+BMT group but did not so in the BMT group (p < .001).
Figure 4. Aortic diameter was similar at baseline and the difference at 1 year did not reach statistical significance ($p < .062$).
ADSORB: Conclusions

• The addition of TEVAR to BMT significantly increased the freedom from the composite primary endpoint

• TEVAR is more effective than BMT in promoting positive aortic remodeling
  – TL expansion
  – FL thrombosis and shrinkage

• Larger RCT with longer follow-up necessary to determine whether TEVAR provides a survival benefit over BMT in patients with uncomplicated aTBAD
Is there a role for prophylactic TEVAR in uncomplicated aTBAD?

• Risk
  – Periprocedural morbidity & mortality
  – Potential adverse downstream false lumen remodeling
  – Cost (TEVAR)

• Benefit
  – Improve long-term survival in patients with aTBAD
  – Prevent aneurysmal degeneration of the TAAA
  – Induce aortic remodeling
Uncomplicated aTBAD: Questions

• Do all Uncomplicated aTBAD’s have similar long term outcomes?
  – Approximately 20-40% will require surgery within 5 years

• Are there clinical or morphologic features of aTBAD’s which predict unfavorable outcomes?
• Is there a role for “prophylactic” TEVAR in uncomplicated aTBAD?
IRAD: Impact of Refractory Pain and Hypertension in aTBAD

- 1996-2004
- Uncomplicated n=296
- Uncomplicated with refractory back pain and/or hypertension: n=69
  - Endovascular: 39%
  - Open: 36%
  - Medical: 25%
IRAD Significance of Refractory HTN and Pain

Medical + Open+Endovascular Therapy

Uncomplicated: 4.0%
Refractory HTN/Pain: 17.4%
\[ p = 0.0003 \]

Medical Therapy

Uncomplicated: 1.5%
Refractory HTN/Pain: 35.6%
\[ p = 0.0003 \]
IRAD Significance of Refractory HTN and Pain: Conclusions

- In-hospital mortality significantly higher with medical management
  - 2/3rd deaths due to aortic rupture
- Refractory pain/HTN independent predictor of in-hospital mortality: OR 3.31 (1.04-10.45, p=0.04)
- Open or endovascular surgery improved outcomes over medical management for refractory pain/HTN
Radiographic predictors of Aneurysmal Degeneration/Mortality

- **Initial aortic diameter of $\geq 40\text{mm}$ and/or a patent false lumen is predictive of aortic enlargement $\geq 60\text{mm}$**
  

- **Patent false lumen** is an independent risk factor for increasing aortic diameter
  

- **Partially thrombosed false lumen** is an independent predictor of mortality
  

- **False lumen diameter $\geq 22\text{mm}$** in the proximal DTA correlates with aneurysmal change and mortality
  
“High Risk” Uncomplicated aTBAD

- Refractory HTN and Pain
- False lumen $\geq 22$ mm
- Total aortic diameter of DTA $\geq 40$ mm

- False lumen status: unclear
Acute Uncomplicated TBAD

• Controversial
• Medical Therapy
  – Excellent short term outcomes
  – Poor long term outcomes
    • High rate of aneurysm formation
    • Low rate intervention-free survival
• TEVAR
  – High risk features
  – ? All acute type B’s
  – RCT needed
Management of Acute Type B Aortic Dissection

Bradley G. Leshnower MD
Assistant Professor of Surgery
Division of Cardiothoracic Surgery
Emory University School of Medicine
Aortic Dissection:
Incidence

- Worldwide: 5-30 cases/1,000,000 people/year
- U.S: 2-8 cases/1,000,000 people/year
- 2/3 type A, 1/3 type B
- **Acute Type B**
  - 30% complicated, uncomplicated 70%
• “…emergency stent grafting with life-threatening complications of acute type B aortic dissection may save many lives and that this could well become the most clinically valuable application of thoracic aortic stent-grafting in the future.”

• “In patients with uncomplicated acute type B aortic dissection, (medical management) constitutes a benchmark that will be difficult to surpass or even match by endovascular stent-graft treatment”

D. Craig Miller MD
Adverse events among all patients undergoing intervention

<table>
<thead>
<tr>
<th></th>
<th>aTEVAR (N = 80)</th>
<th>OPEN (N = 59)</th>
<th>cTEVAR (N = 87)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-hospital mortality</td>
<td>5.0% (4/80)</td>
<td>16.9% (10/59)</td>
<td>2.3% (2/87)</td>
<td><strong>0.003</strong></td>
</tr>
<tr>
<td>Paraplegia</td>
<td>0.0% (0/80)</td>
<td>3.4% (2/59)</td>
<td>2.3% (2/87)</td>
<td>0.308</td>
</tr>
<tr>
<td>Paraparesis</td>
<td>2.5% (2/80)</td>
<td>1.7% (1/59)</td>
<td>1.1% (1/87)</td>
<td>0.833</td>
</tr>
<tr>
<td>Stroke</td>
<td>7.5% (6/80)</td>
<td>1.7% (1/59)</td>
<td>0.0% (0/87)</td>
<td><strong>0.009</strong></td>
</tr>
<tr>
<td>Renal failure</td>
<td>1.3% (1/80)</td>
<td>10.2% (6/59)</td>
<td>4.6% (4/87)</td>
<td>0.054</td>
</tr>
</tbody>
</table>

Data presented as % (count/total).
Classification

DeBakey

Type A

Type B

Stanford

IIIa

IIIb

IIIA

IIIb

Frank Criado, MD
Definitions

• Acute: < 2 weeks
• Subacute: 2 weeks – 2 months
• Chronic: > 2 months

New IRAD Definitions

- Hyperacute: 0-24 hrs
- Acute: 2-7 days
- Subacute: 8-30 days
- Chronic: > 30 days

Type B Aortic Dissection

- Acute
  - Complicated
  - Uncomplicated

- Chronic
  - Complicated
  - Uncomplicated

FDA Approval for Endovascular Therapy for all subgroups