Aggressive Resection/Reconstruction of the Aortic Arch in Type A Dissection:  Con

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University of Pittsburgh
Presenter Disclosures
Thomas G. Gleason, MD


Unlabeled/unapproved uses disclosures: none.
Classically 3 (4?) phases of the reconstruction

1) Circulation management
2) Root reconstruction
3) Arch reconstruction

? 4) Descending stabilization ?
Acute type A dissection: new paradigm

1) Rapid transport and treatment
2) Sinus segment repair/root replacement
3) EEG monitoring to direct HCA
4) Hemiarch replacement using RCP
5) Antegrade graft perfusion
6) Routine use of TEE

Mortality stats

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>30-day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9/104 (8.6%)</td>
<td>7/104 (6.7%)</td>
</tr>
<tr>
<td>Preop. stroke</td>
<td>5/11 (45%)</td>
<td></td>
</tr>
<tr>
<td>Postop. stroke</td>
<td>1/5 (20%)</td>
<td></td>
</tr>
<tr>
<td>Without preop. stroke</td>
<td>4/93 (4.3%)</td>
<td></td>
</tr>
</tbody>
</table>

Presented at the 121st American Surgical Association
Penn experience with TAAD and hemiarch

Log rank, \( P = .375 \)

Log rank, \( P = .046 \)

Patients at risk:
- DeBakey I
- DeBakey II

Survival
- Time (years)

Freedom From Distal Aortic Re-intervention
- Time (years)

Acute Type A Aortic Dissection

University of Pennsylvania (RCP favored) n=629/ 20 yrs

- Hospital Mortality: 13.2%
- Postop Stroke: 5.1%
- Hemiarch Replacement: 95.1%
- Total Arch Replacement: 4.3%

Emory University (MHCA/ ACP favored) n=346/ 10 yrs

- Hospital Mortality: 14.5%
- Deep HCA: 20.3%
- Moderate HCA: 9.8%
- PND: 10.4%
- Hemiarch Replacement: 90.7%
- Total Arch Replacement: 9.3%

*Ann Thorac Surg* 2014;97:1991-7
*Ann Thorac Surg* 2013;96:2135-41
Acute Type A Aortic Dissection

IRAD Registry \( n=974 \)
- Hospital mortality: 23.6%
- Postop Stroke: N/A
- All Neurological Deficit: 22.7%
- Total Arch Reconstruction: 9.4%

Japan Adult Cardiovascular Database \( n=4128 \)
- Hospital Mortality: 8.6%
- Postop Stroke: 10.7%
- ACP: 11.2%
- RCP: 9.7%

*Circulation.* 2006 Nov 21;114(21):2226-31
*Circ J* 2014;78:2431-38
IRAD data

Hemi Arch, Complete Arch and Partial Arch

In-Hospital Death

Linear Trend p=0.013

Frequency (%)


Frequency (%)


IRAD data: Hemi vs Total

STS/EACTS Latin America Cardiovascular Surgery Conference 2017

Acute Type 1 Aortic Dissection

German Registry for Acute Aortic Dissection Type A: GERAADA, n=2137
- Hemi Arch Reconstruction: 46%
- Total Arch Reconstruction: 16.2%
- Ascending Reconstruction Alone: 37.7%
- Stroke Rate: N/A
- Hemiplegia/ hemiparesis: 9.4%
- Coma: 8.6%
- 30 Day Mortality: 17%

Influence of operative strategy for the aortic arch in DeBakey type I aortic dissection: Analysis of the German Registry for Acute Aortic Dissection Type A

Jerry Easo, MD,a Ernst Weigang, MD, PhD,b Philipp P. F. Hölzl, MD,a Michael Horst, MD,a Isabell Hoffmann, MS,c Maria Blettner, MS, PhD,c and Otto E. Dapunt, MD, PhD,a for the GERAADA study group

Mortality

18.7% hemiarch \hspace{1cm} p=0.067

25.7% total arch

Objective: Patients treated with an extensive approach including total aortic arch replacement for acute aortic dissection type A may have a favorable long-term prognosis by treating the residual false lumen. Our goal was to analyze the operative strategy for treatment of type I DeBakey aortic dissection from the German Registry for Acute Aortic Dissection Type A (GERAADA) data.

Methods: A total of 658 patients with type I DeBakey aortic dissection and entry only in the ascending aorta were identified in the GERAADA. Patients in group A underwent replacement of the ascending aorta with hemi-arch replacement. Patients in group B received extensive treatment with total arch replacement or conventional or frozen elephant trunk.

Results: A total of 518 patients in group A and 140 patients in group B were treated. There was an overall 30-day mortality of 20.2% (n = 133). Group A had a slightly lower rate of mortality with 18.7% (n = 97) compared with 25.7% for group B (n = 36), but with no statistical significant difference (P = .067). The onset of new neurologic deficit (13.6% in group vs 12.5% in group B, P = .78) and new malperfusion deficit (8.4% in group A vs 10.7% in group B, P = .53) showed no statistical difference.

Conclusions: On analysis of the GERAADA data, it seems that a more aggressive approach of aortic arch treatment can be applied without higher perioperative risk even in the onset of acute aortic dissection type A. Long-term follow-up data analysis will be necessary to offer the optimal surgical strategy for different patient groups. (J Thorac Cardiovasc Surg 2012;144:617-23)
Cologne Experience

Log Rank (Mantel–Cox) $p = 0.062$

Breslow (Generalized Wilcoxon) $p = 0.059$
Griepp data

Cumulative Probability of Distal Reoperation
- at 1-year: 2%
- at 5-years: 6%
- at 10-years: 16%

Number of study patients at risk for death
- Survival from hospital discharge
- Survival of matched NYS census cohort

Extended Arch Procedures for Acute Type A Aortic Dissection: A Downstream Problem?

Steven L. Lansman, MD, PhD, † Joshua B. Goldberg, MD, † Masashi Kai, † Ramin Malekan, MD, † and David Spielvogel, MD, †

Current discussion regarding the management of acute type A aortic dissection is focused on whether to perform a standard hemiarch resection or perform an extended repair, in hopes of improving long-term outcomes by avoiding late, distal aortic sequelae. Critical to this discussion is an estimation of the short-term risks of an extended procedure and the magnitude of the late “downstream problem.” Extension of the hemiarch to a total arch plus frozen elephant trunk does not improve survival; carries some increased perioperative risk, not the least of which is paraplegia; but decreases late aortic events, the most common of which is reoperation on the distal aorta. However, these reoperations are low frequency, primarily elective, low-risk events and it should be noted that extended index repairs do not eliminate or necessarily decrease the incidence of late reoperations. Routine extension of the index procedure puts 100% of patients at risk in order to protect a minority that may benefit. Therefore, it is important to select patients at high risk for reoperation if an extended repair is to be performed. Predictors that may identify this high-risk group include the size and location of the entry tear, aortic and luminal dimensions, degree of luminal flow and thrombosis, and the presence of a connective tissue disorder. Timing may also be important and, in patients at high risk for late events, early complications may be minimized by strategies that delay an extension of the proximal repair until the subacute period.

Semin Thoracic Surg 00:1 – 4 © 2018 Elsevier Inc. All rights reserved.

Keywords: aorta, arch, frozen elephant trunk, type A dissection

Abbreviation: ATAAD, acute type A aortic dissection

He points out that 80-90% of late re-interventions are elective with relatively low risk (4-12%).
Long-term survival not significantly affected by treatment distal arch
“Tear-oriented” surgery

Acute DeBakey type I aortic dissection

“Tear-oriented surgery”
Graft replacement was decided by the location of the entry tear.

Total arch replacement was considered in condition described below if patients’ condition was permitted

- Enlarged aortic arch
- Sever dissection involving supra-aortic orifices
- Younger patients
- Patients with connective tissue disorder

Hemiarch
Partial arch

Total arch replacement

Outcomes were the same...

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**Survival**

<table>
<thead>
<tr>
<th></th>
<th>TAR</th>
<th>Non-TAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-year survival</td>
<td>88.6 ± 4.2 %</td>
<td>83.8 ± 4.4 %</td>
</tr>
<tr>
<td>10-year survival</td>
<td>81.8 ± 7.6 %</td>
<td>76.5 ± 5.8 %</td>
</tr>
</tbody>
</table>

\[ P = 0.54 \]

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**Reintervention**

<table>
<thead>
<tr>
<th></th>
<th>TAR</th>
<th>Non-TAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-year</td>
<td>94.9 ± 3.5 %</td>
<td>90.9 ± 3.6 %</td>
</tr>
<tr>
<td>10-year</td>
<td>91.7 ± 4.6 %</td>
<td>83.3 ± 5.3 %</td>
</tr>
</tbody>
</table>

\[ P = 0.20 \]
Freedom from distal aortic events: Okita group

False lumen patency impacting late outcome

Reoperation rate

Only 11% required reoperations

Bologna Hemi vs. Total

Log rank: p = 0.89

Hiroshima Hemiarch vs. FET

Survival

Patient at risk (FET)
65 50 43 38 25 14

Patient at risk (AHR)
55 33 20 12 7 4

Event free

Patient at risk (FET)
65 49 40 33 23 12

Patient at risk (AHR)
55 31 18 11 7 4

Meta-analysis

Aortic Events

B

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>PR Events</th>
<th>Total</th>
<th>Weight</th>
<th>Risk Ratio</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SE</td>
<td>log(RE)</td>
<td></td>
<td>IV, Fixed, 95% CI</td>
<td>IV, Fixed, 95% CI</td>
</tr>
<tr>
<td>Kim et al. (2011)</td>
<td>1.1086</td>
<td>0.7476</td>
<td>16.3%</td>
<td>3.03 [0.70, 13.12] *</td>
<td></td>
</tr>
<tr>
<td>Ryalski et al. (2014)</td>
<td>1.0953</td>
<td>1.0263</td>
<td>8.7%</td>
<td>2.99 [0.40, 22.35] *</td>
<td></td>
</tr>
<tr>
<td>Shi et al. (2013)</td>
<td>-0.1054</td>
<td>1.303</td>
<td>5.4%</td>
<td>0.90 [0.07, 11.57] *</td>
<td></td>
</tr>
<tr>
<td>Sun et al. (2011)</td>
<td>2.2083</td>
<td>1.1067</td>
<td>7.4%</td>
<td>9.10 [1.04, 79.63] *</td>
<td></td>
</tr>
<tr>
<td>Uchida et al. (2009)</td>
<td>1.1378</td>
<td>0.5273</td>
<td>32.8%</td>
<td>3.12 [1.11, 8.77] *</td>
<td></td>
</tr>
<tr>
<td>Zhang et al. (2013)</td>
<td>1.141</td>
<td>0.5573</td>
<td>29.4%</td>
<td>3.13 [1.05, 9.33] *</td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>100.0%</td>
<td>3.14 [1.74, 5.67] *</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Chi² = 1.85, df = 5 (P = 0.87); I² = 0%
Test for overall effect: Z = 3.78 (P = 0.0002)

Early survival

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>PR Events</th>
<th>Total</th>
<th>Weight</th>
<th>Risk Ratio</th>
<th>M-H. Fixed, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easo et al. (2012)</td>
<td>97</td>
<td>518</td>
<td>36 140</td>
<td>54.4%</td>
<td>0.73 [0.52, 1.02]</td>
</tr>
<tr>
<td>Kim et al. (2011)</td>
<td>14</td>
<td>144</td>
<td>6 44</td>
<td>8.8%</td>
<td>0.71 [0.29, 1.74]</td>
</tr>
<tr>
<td>Ohshuto et al. (2002)</td>
<td>5</td>
<td>64</td>
<td>8 24</td>
<td>11.2%</td>
<td>0.23 [0.09, 0.65]</td>
</tr>
<tr>
<td>Ryalski et al. (2014)</td>
<td>18</td>
<td>139</td>
<td>4 14</td>
<td>7.0%</td>
<td>0.45 [0.18, 1.15]</td>
</tr>
<tr>
<td>Shi et al. (2013)</td>
<td>3</td>
<td>71</td>
<td>5 64</td>
<td>4.4%</td>
<td>0.71 [0.18, 2.87]</td>
</tr>
<tr>
<td>Shiono et al. (2006)</td>
<td>7</td>
<td>105</td>
<td>2 29</td>
<td>3.0%</td>
<td>0.97 [0.21, 4.41]</td>
</tr>
<tr>
<td>Sun et al. (2011)</td>
<td>4</td>
<td>66</td>
<td>7 148</td>
<td>4.1%</td>
<td>1.28 [0.39, 4.23]</td>
</tr>
<tr>
<td>Uchida et al. (2009)</td>
<td>2</td>
<td>55</td>
<td>3 65</td>
<td>2.6%</td>
<td>0.79 [0.14, 4.55]</td>
</tr>
<tr>
<td>Zhang et al. (2013)</td>
<td>4</td>
<td>74</td>
<td>5 88</td>
<td>4.4%</td>
<td>0.95 [0.27, 3.41]</td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>1236</td>
<td>636</td>
<td>100.0%</td>
<td>0.69 [0.54, 0.90]</td>
<td></td>
</tr>
</tbody>
</table>

Renal failure

B

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>PR Events</th>
<th>Total</th>
<th>Weight</th>
<th>Risk Ratio</th>
<th>M-H. Fixed, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SE</td>
<td>log(RE)</td>
<td></td>
<td>IV, Fixed, 95% CI</td>
<td>IV, Fixed, 95% CI</td>
</tr>
<tr>
<td>Kim et al. (2011)</td>
<td>31</td>
<td>144</td>
<td>13 44</td>
<td>50.6%</td>
<td>0.73 [0.42, 1.27]</td>
</tr>
<tr>
<td>Shi et al. (2013)</td>
<td>4</td>
<td>71</td>
<td>7 84</td>
<td>16.3%</td>
<td>0.68 [0.21, 2.22]</td>
</tr>
<tr>
<td>Shiono et al. (2006)</td>
<td>13</td>
<td>105</td>
<td>5 20</td>
<td>19.9%</td>
<td>0.72 [0.28, 1.85]</td>
</tr>
<tr>
<td>Sun et al. (2011)</td>
<td>2</td>
<td>66</td>
<td>1 148</td>
<td>1.9%</td>
<td>4.48 [0.41, 48.60]</td>
</tr>
<tr>
<td>Uchida et al. (2009)</td>
<td>1</td>
<td>55</td>
<td>3 65</td>
<td>7.0%</td>
<td>0.39 [0.04, 3.68]</td>
</tr>
<tr>
<td>Zhang et al. (2013)</td>
<td>1</td>
<td>74</td>
<td>2 86</td>
<td>4.6%</td>
<td>0.59 [0.06, 6.43]</td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>515</td>
<td>458</td>
<td>100.0%</td>
<td>0.75 [0.49, 1.14]</td>
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</tbody>
</table>

Heterogeneity: Chi² = 2.57, df = 5 (P = 0.77); I² = 0%
Test for overall effect: Z = 1.36 (P = 0.17)

Stroke

C

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>PR Events</th>
<th>Total</th>
<th>Weight</th>
<th>Risk Ratio</th>
<th>M-H. Fixed, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SE</td>
<td>log(RE)</td>
<td></td>
<td>IV, Fixed, 95% CI</td>
<td>IV, Fixed, 95% CI</td>
</tr>
<tr>
<td>Ryalski et al. (2014)</td>
<td>11</td>
<td>139</td>
<td>1 14</td>
<td>16.3%</td>
<td>1.11 [0.15, 7.96]</td>
</tr>
<tr>
<td>Shiono et al. (2006)</td>
<td>8</td>
<td>105</td>
<td>3 29</td>
<td>43.5%</td>
<td>0.74 [0.21, 2.60]</td>
</tr>
<tr>
<td>Sun et al. (2011)</td>
<td>1</td>
<td>66</td>
<td>4 148</td>
<td>22.8%</td>
<td>0.56 [0.06, 4.92]</td>
</tr>
<tr>
<td>Zhang et al. (2013)</td>
<td>1</td>
<td>74</td>
<td>2 88</td>
<td>16.9%</td>
<td>0.59 [0.06, 6.43]</td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>384</td>
<td>279</td>
<td>100.0%</td>
<td>0.73 [0.38, 1.78]</td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Chi² = 0.26, df = 3 (P = 0.97); I² = 0%
Test for overall effect: Z = 0.68 (P = 0.50)

Freedom from distal reoperation

Residual distal dissected aorta

Distal Aortic Problems

Years After Surgery

Percent Freedom from Reoperation

P = .9

Freedom from distal reoperation

Extent of reconstruction over 17 year experience

<table>
<thead>
<tr>
<th>Extent of replacement</th>
<th>Cases</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ascending aorta only</td>
<td>65</td>
<td>36%</td>
</tr>
<tr>
<td>Ascending aorta and hemiarch</td>
<td>97</td>
<td>54%</td>
</tr>
<tr>
<td>Ascending aorta and total arch</td>
<td>11</td>
<td>6%</td>
</tr>
<tr>
<td>Ascending, arch and proximal descending</td>
<td>6</td>
<td>3%</td>
</tr>
</tbody>
</table>

8.9% out of 179 cases over 17 years had more than hemiarch

16% risk of reoperation at 10 years
Late reoperation risk low
Freedom from distal reoperation

Log rank 6.22  p = 0.012

Reoperation correlates with hypertension
Number of TAAD repairs by site: STS data

(A total of 640 arranged in descending order by number of cases)
UPMC focus: neurologic outcomes

Stroke rate-reduction and standardization to improve overall outcomes

1. Rapid transport to incision to CPB
2. Central cannulation
3. Neurocerebral protection including liberal use total arch/carotid replacement
4. Reduce use of blood products
Neurocerebral Protection/ Perfusion Protocol

1. 100% use EEG/SSEP monitoring
   Steroids, lidocaine, MgSO₄, mannitol use
   DHCA initiation 4 min after electrocerebral silence (ECS)

2. Standardized cannulation:
   aortic arch tear status and carotid malperfusion

3. Central aortic cannulation is default

4. RSCA cannulation for bad intra-arch tears

5. RCP for Hemiarch reconstruction (DHCA <30 min)

6. ACP for Total Arch reconstruction (DHCA >30 min)

7. Common carotid replacement when dissected
Indications for Total Arch

- 1° or 2° Arch Tear
- Carotid Dissection
- Circumferential Arch Dissection
- Aneurysmal Arch
Arch Reconstruction

Hemiarch with RCP 64%

Total arch with ACP 36%

Complete Common Carotid Replacement in 33 patients using separate neck counter incisions
Innominate, RCC or LCC grafting during cooling
2° arterial inflow
No interruption of ACP

Custom 3-branched brachiocephalic graft separately perfused
Outcomes with standardized protocol

Hospital mortality  9.1%
Postop stroke       3.4%

Consecutive Acute Type A Dissection Repairs  n=264 (2007-2014)

## Outcomes

### Hemi (64%) versus Total Arch (36%) Reconstructions*

<table>
<thead>
<tr>
<th></th>
<th>Hemiarch N= 167</th>
<th>Total Arch N= 92</th>
<th>Overall</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postop CVA</td>
<td>6(4%)</td>
<td>3(3%)</td>
<td>9(3.5%)</td>
<td>1.000</td>
</tr>
<tr>
<td>Hospital Mortality</td>
<td>11(7%)</td>
<td>13(14%)</td>
<td>24(9%)</td>
<td>0.071</td>
</tr>
<tr>
<td>30 Day mortality</td>
<td>14(8%)</td>
<td>13(14%)</td>
<td>27(10%)</td>
<td>0.201</td>
</tr>
<tr>
<td>1-yr mortality</td>
<td>23(15%)</td>
<td>21(27%)</td>
<td>44(19%)</td>
<td><strong>0.033</strong></td>
</tr>
<tr>
<td><strong>No Intraop use</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRBC</td>
<td>52%</td>
<td>50%</td>
<td>51%</td>
<td>0.796</td>
</tr>
<tr>
<td>FFP</td>
<td>63%</td>
<td>80%</td>
<td>69%</td>
<td><strong>0.003</strong></td>
</tr>
<tr>
<td>Platelets</td>
<td>41%</td>
<td>45%</td>
<td>42%</td>
<td>0.600</td>
</tr>
<tr>
<td>Intraop Factor VII</td>
<td>61(37%)</td>
<td>54(59%)</td>
<td>115(44%)</td>
<td><strong>0.001</strong></td>
</tr>
</tbody>
</table>

*5 patients with limited Debakey II dissections required neither hemi nor total arch; all survived without stroke.
Value of Neurocerebral Monitoring

- 15% EEG/SSEP changes
  - Changes prompt intraop adjustments and immediate postop CTA with immediate neurointervention when feasible

- EEG/SSEP independent predictor of postop CVA
  - OR 8.7, 95% CI [2.26 - 34.8]  p=0.002

Negative Predictive Value 98.2%
Multivariate Predictors of Hospital Mortality

<table>
<thead>
<tr>
<th>Predictor</th>
<th>OR [95% CI]</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-op CVA</td>
<td>21.3 [6.2-73]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Intra-op EEG Change</td>
<td>5.2 [1.6-16.5]</td>
<td>0.005</td>
</tr>
<tr>
<td>Frozen Trunk</td>
<td>14.5 [3.4-62.3]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Concomitant CABG</td>
<td>6.6 [1.7-24.8]</td>
<td>0.005</td>
</tr>
</tbody>
</table>
## Multivariate Predictors of 1-yr Mortality

<table>
<thead>
<tr>
<th>Predictor</th>
<th>OR [95% CI]</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age ≥65</td>
<td>3.0 [1.3-7.2]</td>
<td>0.013</td>
</tr>
<tr>
<td>Pre-op CVA</td>
<td>12.3 [3.7-41.5]</td>
<td>0.000</td>
</tr>
<tr>
<td>RBC Transfusion ≥5 Units</td>
<td>5.9 [1.8-19.0]</td>
<td>0.001</td>
</tr>
<tr>
<td>Frozen Trunk</td>
<td>14.9 [4.3-52.1]</td>
<td>0.000</td>
</tr>
<tr>
<td>Concomitant CABG</td>
<td>2.8 [1.2-6.9]</td>
<td>0.023</td>
</tr>
</tbody>
</table>
Long-term Survival

Kaplan-Meier survival estimate

Survival in Months

95% CI
Conclusions

1. Expeditious restoration of perfusion and proximal stabilization saves lives.

2. Hemiarch replacement meets the primary goal most of the time.

3. Reoperation rate is low after hemiarch, and the reoperations can be done safely, with low risk in experienced hands.

4. Results with TAAD management have improved over time, particularly in-hospital results--hemiarch remains the most widely used strategy.

5. Late event rates can be reduced by more aggressive approach, but may be at the cost of higher in-hospital mortality and complications.
THANK YOU