Surgical Approach to Acute Type A Aortic Dissection

Jehangir Appoo
Libin Cardiovascular Institute
University of Calgary

Aortopathy Rounds
Peter Lougheed Centre, Calgary
June 24, 2015
Outline – Today – Surgical Approach to Aortic Dissection

Results of current gold standard

Unresolved issues with current surgical approach

Emerging techniques Tour the Globe – Far East, Europe, N. America

Very contemporary results – 2012-2015

Technical talk for surgical audience

Share case examples from local experience

Next steps in navigating evolutionary process

Questions
Aortic Dissection

Variable acuity 1%/hr

Variable presentation “Great Masquerader”
Great Masquerader

Signs and symptoms of Aortic Dissection other than chest pain

- SBP difference >20mmHg
- RCA more commonly involved

- Cerebral Ischaemia
- Arm Ischaemia
- Spinal Cord Ischaemia
- Tamponade (intrapericardial rupture)
- Myocardial Infarction
- Intestinal Ischaemia
- Renal Ischaemia
- Leg Ischaemia
- Free Rupture
- Aortic Regurgitation
Contemporary Classification of Aortic Dissection

• 1427 patients
  • 954 male
  • mean age 61.7 years

IRAD – In submission JTCVS
Current “standard of care” for acute Type A Dissection

Tear specific operation
- Resect Intimal Entry Site
- Proximal arch reconstruction
- Circulatory arrest with cerebral perfusion
- Ascending aortic replacement

Proximal Complications
- Root/Valve/Coronary
- Pericardial effusions
We know that surgery is high risk, but what is the risk?

Audience Survey Question 1:

What is the current operative mortality across Canada after surgery for acute Type A Dissection?

A. 10-15%
B. 15-20%
C. 20-25%
D. >25%
Contemporary results of surgery in acute type A aortic dissection: The International Registry of Acute Aortic Dissection experience

Saeed Turencini, MD
Christian A. Anagnost, MD
Vincenzo Raimondi, MD
Trisa Myrthen, MD
Tori Suzuki, MD
Rajender H. Marta, MD
Eduardo Begasse, MD
Jeanne V. Cooper, MS
Dean E. Smith, PhD
Lorenzo Mercante, MD
Alessandro Vignoni, MD
José E. Ol, MD
Michael G. Oost, MD
Eric M. Laskus, MD
Kim A. Eger, MD
On behalf of the International Registry of Acute Aortic Dissection Investigators*

Background: Surgical mortality for acute type A aortic dissection reported in different experiences from single centers or surgeon varies from 7% to 30%. The International Registry of Acute Aortic Dissection, collecting patients from 18 referral centers worldwide, identifies a preoperative risk stratification scheme and a real average surgical mortality for acute type A aortic dissection in the current era.

Methods: A comprehensive analysis was completed of 290 clinical variables and their relationship to surgical outcomes in 526 of 1352 patients enrolled in the International Registry of Acute Aortic Dissection from 1996 through 2001. Excluded cases, categorized according to risk profile, were defined as unstable (group I) in the presence of cardiac tamponade; shock, congestive heart failure; cardiogenic shock; cerebrovascular accident; stroke; coma; myocardial ischemia, infarction, or both; electrophysiological with new Q waves or ST elevation, acute renal failure; or mesenteric ischemia-infarction at the time of the operation. Outside of an unstable condition, patients were categorized as stable (group II).

Results: The overall inhospital mortality was 25.1%. Mortality in group I was 31.4% compared with 19.7% in group II ($P < 0.001$). Independent preoperative predictors of operative mortality were history of aortic valve replacement (odds ratio = 3.12), history of peptic ulcer (odds ratio = 2.71), hypertension as sign of acute type A aortic dissection (odds ratio = 1.95), shock or tamponade (odds ratio = 2.69), preoperative cardiac tamponade (odds ratio = 2.22), and preoperative limb ischemia (odds ratio = 2.10).

Conclusions: The International Registry of Acute Aortic Dissection experience confirms that patient selection plays an important role in determining surgical outcomes in patients with acute type A aortic dissection. Knowledge of significant risk factors for operative mortality can contribute to better management and a more defined risk assessment in patients affected by acute type A aortic dissection.

526 pts 1996 – 2001
Operative Mortality 25%
GERAADA
German Registry for Acute Aortic Dissection Type A

52 centres central European Centres

established 2006 – to disprove IRAD results

Germany, Switzerland, Austria

>3,000 pts
GERAADA Results

2137 pts 2006 - 2010
Presented at NYAATS April, 2014

Mortality 17% (10-35% based on age quartile)
Post op Neurodeficits 17% (includes 7% with preop deficit)

NB: In pts with asc ao tear only, & no neuro deficit total arch replacement significantly increased op mortality (14% → 24%)
20% mortality for a not infrequently seen pathology seems high in modern era of cardiac surgery (lower single digit % for most operations)

In order to improve results, surgical community first needs to understand why patients don’t survive an operation….then can consider technical changes to operation
Preop Risk Factors for Mortality

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &gt; 70y.o</td>
<td>1.7</td>
</tr>
<tr>
<td>Hypotension/Shock/Tamponade</td>
<td>3.0</td>
</tr>
<tr>
<td>Pulse Deficit</td>
<td>2.0</td>
</tr>
<tr>
<td>Abnormal ECG</td>
<td>1.8</td>
</tr>
<tr>
<td>Kidney Failure</td>
<td>4.8</td>
</tr>
<tr>
<td>Limb Ischemia</td>
<td>2.1</td>
</tr>
<tr>
<td>Previous AVR</td>
<td>3.1</td>
</tr>
<tr>
<td>Coma/Stroke/Neuro deficit</td>
<td></td>
</tr>
</tbody>
</table>

IRAD. Circulation 2002
IRAD. Eur J of Vasc and Endovasc Surg 2009
Risk factors (age, shock, malperfusion) are not modifiable in this disease process and don’t usually change decision to operate...if anything increase the urgency to operate

No studies have looked at cause of mortality after surgery
Etiology of Mortality after repair of acute type A aortic dissection: Evidence from the Canadian Thoracic Aortic Collaborative (CTAC)

Multidisciplinary Thoracic Aortic Rounds
May 29, 2015
FMC, Calgary

JJ Appoo
RS McClure
M Boodhwani
A Gupta
I El-Hamamsy
MW Chu
Z Pozeg
F Dagenais
M Ouzounian
CTAC 2015 Etiology of Mortality Type A Dissection

9 Canadian centres

Jan 2007 to Dec 2013

692 type A dissections that had an operation

Reviewed periop mortalities and cause of death adjudicated
CTAC 2015 Etiology of Mortality Type A Dissection

123 mortality charts reviewed

Mortality rate across 9 Canadian sites  17.8%

Recall GERAADA 17% and IRAD 25%

caveat: actual mortality may be higher
Primary Etiology of Mortality:

<table>
<thead>
<tr>
<th>Condition</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke</td>
<td>22%</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td>22%</td>
</tr>
<tr>
<td>Cardiac</td>
<td>25%</td>
</tr>
<tr>
<td>Other organ ischemia</td>
<td>11%</td>
</tr>
<tr>
<td>Multisystem organ failure</td>
<td>12%</td>
</tr>
<tr>
<td>Sepsis</td>
<td>4%</td>
</tr>
<tr>
<td>Other</td>
<td>5%</td>
</tr>
</tbody>
</table>

If we are going to impact rate of mortality, need strategies to deal with stroke, hemorrhage and cardiac dysfunction
Double dagger of Type A Dissection Surgery

In addition to world wide high periop mortality (17-25%),...long term outcome for survivors is questionable
Example of possible (not often) outcome of conventional surgery
51 y.o. Male
Distal Arch Tear
Conventional Surgery Spring 2014– Asc/Open Distal

Pre-op
Intimal tear in distal arch

2 weeks post op
3.8cm descending aorta

3 months post op
5.3cm distal arch/descending aorta

Presents with CP/Back Pain
Given known CT disorder, rapid rate of growth, residual dissected arch, 4 branch arch with dominant left vertebral, redo sternotomy setting

Progressed to urgent thoracotomy & resection of distal arch and descending aorta

Profound Hypothermia
L chest circ arrest
CSF drain for Safi type C aneurysm
Outcomes for survivors of surgery for Type A dissection is unclear

Long-term survival  
~ 50% at 10 years

Patent false lumen  
up to 80% of patients  
more reoperation  
~ 20% at 10 yrs  
~ 50% at 10 yrs for age <45y.o  
worse survival at 10 yrs

Mortality from distal operation  
up to 30%

Fattouch Ann Thorac Surg 2009
Current “standard of care” for acute Type A Dissection

Very good operation
Saves many lives in distressful times

But, is it enough in all cases?

Does it satisfactorily treat the aorta and side branches at risk?
Case Example: 46y.o male flown in from OSH – May 2014

Hemodynamic shock

Abdomen distended, tender
Case Example: 46y.o male flown in from OSH – May 2014

Compromised visceral flow
Renal infarct/malperfusion
Case Example: 46y.o male flown in from OSH – May 2014

Both legs:
- Cold
- Mottled
- Pulseless
- Paralyzed
Our 46y.o patient

This type of patient is seen emergently by cardiac surgeons worldwide.

Is standard “hemiarch” surgery the right operation?

Will visceral, renal, & peripheral malperfusion be resolwe?

Will he survive?
Status of Extended Distal Aortic Repair of Acute Type A Dissection in 2015
Problem:

Long term survival is compromised

Distal aortic problems may be higher than we appreciate
Problem:

Long term survival is compromised

Distal aortic problems may be higher than we appreciate

Immediate op mortality is high:

- IRAD (2005) 25%
- GERAADA (2014) 17%
- US Registry Data (2014) 21%
- CTAC (2015) 18%
Problem:

Long term survival is compromised
Distal aortic problems may be higher than we appreciate

Immediate op mortality is high:
- IRAD (2005) 25%
- GERAADA (2014) 17%
- US Registry Data (2014) 25%
- CTAC (2015) 18%

Question:

Can extended distal aortic repair decrease long term mortality?
Can increase complexity be accomplished without increased periop morbidity?
Problem:

Long term survival is compromised

Distal aortic problems may be higher than we appreciate

Immediate op mortality is high:

IRAD (2005) 25%
GERAAD A(2014) 17%
US Registry Data (Oct.2014) 21%
CTAC 18%

Question:

Can extended distal aortic repair decrease long term mortality?

Can increase complexity be accomplished without increased periop morbidity?

Goal:

Decrease both long term **and** short term mortality
Underappreciated Fact

Primary entry tear located in distal arch or descending thoracic aorta up to 20-30%

Replacing ascending aorta does not satisfy surgical principle of resecting primary entry tear
Proposed Classification according to method of stent deployment and extent of aortic resection:

Frozen Stent Graft

During circulatory arrest without fluoroscopy

Warm Stent Graft

After CPB with fluoroscopy

State of the Art Surgical Management of Acute Type A Aortic Dissection. Canadian Thoracic Aortic Collaborative. In Submission
Global evolving technical approaches to extended distal repair

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
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<tbody>
<tr>
<td>IA</td>
<td>Frozen Stent Graft with Distal Arch Replacement</td>
</tr>
<tr>
<td>IB</td>
<td>Frozen Stent Graft with Proximal Arch Replacement</td>
</tr>
<tr>
<td>IIA</td>
<td>Warm Stent Graft with Proximal Arch Replacement</td>
</tr>
<tr>
<td>IIB</td>
<td>Warm Stent Graft with Distal Arch Replacement</td>
</tr>
</tbody>
</table>
Uchida 2013 (Personal Communication)

Zone 2 Arch

118 pts

6% op mortality
Indications for frozen elephant trunk in type A aortic dissection

- Younger Patients (Age < 70 Years)
  - N = 40
- Age ≥ 70 yrs
- Primary Entry: Located on the distal arch
  - N = 36
- True Lumen: Occluded or severely collapsed
  - N = 27
- Arch Dilatation > 40 mm
  - N = 15

To Consider

Frozen elephant trunk Technique as a Distal Repair
398 patients with acute Type A

Mortality 7.8%
Stroke 2.5%
SCI 2.5%

False lumen thrombosis: 95%

Ma et al. Ann Cardiothorac Surg 2013
E-Vita
E-vita open registry

416 patients
10 high aortic volume European centres

142 acute dissection cases

Op. Mortality 16%
CVA 7%
SCI 4%

Global evolving technical approaches to extended distal repair

IA  Frozen Stent Graft with Distal Arch Replacement
IB  Frozen Stent Graft with Proximal Arch Replacement
IIA Warm Stent Graft with Proximal Arch Replacement
IIB Warm Stent Graft with Distal Arch Replacement
Antegrade Thoracic Stent Grafting During Repair of Acute DeBakey I Dissection Prevents Development of Thoracoabdominal Aortic Aneurysms

Alberto Pochettino, MD, William T. Brinkman, MD, Patrick Moeller, BS, Wilson Y. Szeto, MD, William Moser, CRNP, Katherine Cornelius, BSN, Frank W. Bowen, MD, Y. Joseph Woo, MD, and Joseph E. Bavaria, MD

Division of Cardiovascular Surgery, Department of Surgery, University of Pennsylvania School of Medicine, Philadelphia, Pennsylvania

Technique currently used by some surgeons at N. American Centres: Penn, Mayo & Texas

Early Outcomes of FET – Open Stent Graft with Hemi arch 2005-2012

<table>
<thead>
<tr>
<th></th>
<th>Stented (N)</th>
<th>Standard Repair (N)</th>
<th>Mortality: Stented vs. Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penn</td>
<td>62</td>
<td>180</td>
<td>10% vs. 14% (p= NS)</td>
</tr>
<tr>
<td>Texas</td>
<td>25</td>
<td>87</td>
<td>12% vs. 14% (p=NS)</td>
</tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Penn</td>
<td>62</td>
<td>180</td>
<td>5% vs. 8% (p= NS)</td>
<td>6% vs. 2% (p=NS)</td>
</tr>
<tr>
<td>Texas</td>
<td>25</td>
<td>87</td>
<td>12% vs. 10% (p=NS)</td>
<td>8% vs. 2% (p=NS)</td>
</tr>
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Early Outcomes of FET 2005-2012

<table>
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<tr>
<th></th>
<th>Stented (N)</th>
<th>Standard Repair (N)</th>
<th>Malperfusion Resolved Stented vs. Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penn</td>
<td>62</td>
<td>180</td>
<td>NA</td>
</tr>
<tr>
<td>Texas</td>
<td>25</td>
<td>87</td>
<td>84% vs. 54% (p &lt; 0.05)</td>
</tr>
</tbody>
</table>

Vallabhajosyula Preventza  
J Thorac Cardiovasc Surg 2014  
J Thorac Cardiovasc Surg 2014
Imaging Research

Does standard surgical repair of Debakey Type 1 Dissection alter true lumen geometry downstream?

2006-2013
128 Type A Dissections

Conventional hemiarch

True lumen/total aortic ratio distally unchanged

Increased 44%
Decreased 56%

Harmse, Appoo, Herget, Merchant, Wong & Ferris. CCC 2014
Our 46y.o patient

Is standard “hemiarch” surgery the right operation?

Will visceral, renal, & peripheral perfusion be restored?

Will he have use of his legs?

Will he survive?

50/50 chance that complicated malperfusion resolves with standard repair
Simplified frozen elephant trunk repair for acute DeBakey type I dissection

<table>
<thead>
<tr>
<th>Single anastomosis frozen elephant trunk repair</th>
<th>n = 17 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acute outcomes</strong></td>
<td></td>
</tr>
<tr>
<td>Hospital mortality</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Stroke</td>
<td>2 (12)</td>
</tr>
<tr>
<td>Paraplegia</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Temporary paraparesis</td>
<td>2 (12)</td>
</tr>
<tr>
<td>Tracheostomy</td>
<td>2 (12)</td>
</tr>
<tr>
<td>New hemodialysis</td>
<td>3/16 (19)</td>
</tr>
<tr>
<td>Mean length of stay (mean ± SD)</td>
<td>20 ± 12</td>
</tr>
<tr>
<td>ICU</td>
<td>10 ± 9</td>
</tr>
<tr>
<td><strong>Intermediate outcomes</strong></td>
<td></td>
</tr>
<tr>
<td>Late deaths</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Reintervention</td>
<td>1 (6)</td>
</tr>
<tr>
<td>False lumen thrombosis</td>
<td>14/16 (88)</td>
</tr>
</tbody>
</table>
Total arch repair with open triple-branched stent graft placement for acute type A aortic dissection: Experience with 122 patients

Liang-Wan Chen, MD, Lin Lu, MD, Xiao-Fu Dai, MD, Xi-Jie Wu, MD, Gui-Can Zhang, MD, Guo-Feng Yang, MD, and Yi Dong, MD

J Thorac Cardiovasc Surg 2014;148:521-8
Global evolving technical approaches to extended distal repair

IA  Frozen Stent Graft with Distal Arch Replacement
IB  Frozen Stent Graft with Proximal Arch Replacement
IIA Warm Stent Graft with Proximal Arch Replacement
IIB Warm Stent Graft with Distal Arch Replacement
Arch Debranching and Zone 0 TEVAR for acute Type A Dissection
Transforming “difficult distal” operation to a more “proximal” operation

Siena technique
Staged approach
An Alternative Approach to Diffuse Thoracic Aortomegaly: On-Pump Hybrid Total Arch Repair Without Circulatory Arrest

William D. T. Kent, MD, MS, Jason K. Wong, MD, Eric J. Herget, MD, Joseph E. Bavaria, MD, and Jehangir J. Appoo, MDCM

Diffuse thoracic aortomegaly has conventionally been managed with a two-stage elephant trunk procedure, requiring prolonged circulatory arrest, with an inherent risk of major morbidity and mortality. Recently, to improve outcomes, several hybrid arch procedures have been proposed using off-pump techniques. We have adopted an alternative, single-stage hybrid strategy using cardiopulmonary bypass without circulatory arrest to replace the ascending aorta and perform arch debranching and anastomosis undiagnostic stent graft deployment. Unlike off-pump procedures, pathology of the aortic valve, root, and ascending aorta is addressed while avoiding the complications of stent graft placement in the native ascending aorta.

Arch Debranching and Zone 0 TEVAR for acute Type A Dissection

  Siena technique
  Staged approach

  Single stage total arch repair
  Without circ arrest
Arch Debranching and Zone 0 TEVAR for acute Type A Dissection

Siena technique
Staged approach

Ann Cardiothorac Surg 2013
Single stage total arch repair without circ arrest

Chang et al. JTCVS 2013
Single stage total arch repair without circ arrest
21 patients with Type A
Hybrid Type II Debranching Arch for Acute Debakey Type 1 Dissection - The Calgary Approach and Evolution

Jehangir J. Appoo
Labin Cardiovascular Institute, University of Calgary

STS/EACTS Session: Management of Aortic Arch in Aortic Dissection
STS 51st Annual Meeting
San Diego, California
January 27th, 2015
Global evolving technical approaches to extended distal repair

IA Frozen Stent Graft with Distal Arch Replacement

IB Frozen Stent Graft with Proximal Arch Replacement

IIA Warm Stent Graft with Proximal Arch Replacement

IIB Warm Stent Graft with Distal Arch Replacement
Our ongoing evolution

Orthotopic Zone 0 endovascular stent landing is feasible but proximal landing zone is an issue and needs ongoing observation

While we wait for technology to improve, we have transitioned towards a “Zone 2” Approach
Our ongoing evolution

Transect the arch between the left carotid and left subclavian
Classic Type II Hybrid Arch

Zone 2 Arch – next generation of Hybrid Arch

Zone 2 Arch
HCA 12 to 15 mins
SACP 22 to 25 mins
Hybrid Zone 2 Arch Replacement
Depending on whether you are at CCF, Mayo, Calgary, Penn, Germany, Japan or China & which surgeon is on call, variety of novel operations being carried on for Type A dissection. Not standardized….yet
Validation!
2016 Joint CCS/CSCS/CSVS Position Statement Thoracic Aortic Disease Interventions
Recommendations Extended Distal Repair for Type A Dissections:

1. A “hemiarch” or Zone 0 replacement utilizing an open distal anastomosis is the current standard therapy for repair of Type A dissections.

2. An extended distal repair technique should be considered in centres of adequate expertise for patients who present with Type A dissection and one of the following:
   1. Distal malperfusion
   2. Primary intimal entry tear in the arch or descending aorta
   3. Significant aneurysmal disease of the arch

3. In centres of adequate expertise, it is reasonable to consider an extended distal repair technique for patients who present with Type A dissection and one of the following:
   1. Concomitant descending thoracic aortic aneurysm
   2. Young patients
   3. Patients with known connective tissue disorders
Share local experience with some of these techniques

Share our thought process
Example of IB Frozen Stent Graft with Hemiarch Replacement
52 y.o with acute Type A & high risk features on preop CT:

Primary Intimal Tear in distal arch

No flow in FL – lack of re-entry tears

Large false lumen

Intima Intussuception /windsock
52 y.o with acute Type A & high risk features on preop CT:

- Frozen Stented Elephant Trunk
- Ascending/Hemi Arch Anastomosis
- Aorto-Subclavian bypass
Our 46y.o male flown in from OSH – May 2014
Type A dissection with shock, visceral, renal & LE malperfusion
Post CPB on table Angio after IB Open stent graft, HemiArch, Asc Ao Replacement & Ao valve repair

Thoracic Ao TL expansion seen on angio & TEE

Good perfusion of celiac, SMA & nephrograms visible
IB – Open Stent Graft with Hemiarch repair and distal stents
Example of IIA Warm Stent Graft with Ascending Aortic Replacement
69y.o male with Type A dissection and Distal Arch Tear
69y.o male with Type A dissection and Distal Arch Tear

Type II Hybrid Arch Repair

Total arch reconstruction without circ arrest
59 y.o. Male

acute Type A Dissection

pre-existing 5.5cm descending thoracic aortic aneurysm
59 y.o. Male  
acute Type A Dissection 2014  
pre-existing 5.5cm descending thoracic aortic aneurysm

Type II Hybrid Arch Repair
Example of Siena Technique

Debranch then re-assess
39y.o acute Type A
BMI 60!

Pulseless/Ischemic leg

Debranch then re-assess – may or may not need stent graft

Debranched but no stent graft

Stable at 2 year follow up
Example of IIB – Warm Stent Graft with Zone 2 Arch
May 2015

48 y. o female

Acute Type A Dissection

Distal entry tear with retrograde extension
Immediate Surgery

Intraop: massive amt of hematoma in ascending aorta, innominate artery and left carotid artery – thrombosed FL causing compression of true lumen
IIB – Warm Stent Graft with Zone 2 arch and distal BMS extension
Future

Results of:
- Hemi-arch vs. Extended arch
- Open vs. Closed Stent Graft
- Single stage vs. delayed endovascular intervention
- Extent of coverage

Which operation for which patient?

Focus on decreasing both periop mortality and long term mortality

Investigation into Stroke and Ao Dissection Surgery

Imaging characterization of risk factors

Dissection Team – Surgeons and Interventional Radiologists
Going Forward

Big Data

International Aortic Arch Surgery Study Group (IAASSG)

33 centres
11 countries
>11,000 arch patients

Five-point Research Plan

1. Systematically evaluating current literature
2. Achieving clinical consensus
3. ARCH Project (I) - Multi-institutional retrospective database
4. ARCH Project (II) - Multi-institutional randomized controlled trial
5. ARCH Project (III) - Multi-institutional prospective registry
Indication for surgery (entire database)

- Elective: 7505 (54%)
- Emergent: 3969 (29%)
- Urgent: 1585 (12%)
- Salvage: 27 (0%)
- Other: 682 (5%)

Dissection
- 847 (13%)
- 359 (5%)

Aneurysm
- 5591 (74%)
- 666 (12%)

Dissection and aneurysm
- 305 (4%)

Other etiology
- 110 (7%)
- 219 (14%)
- 303 (4%)
- 306 (8%)
- 115 (3%)
- Other (356, 9%)
Method of arterial cannulation

Central

Peripheral, antegrade

4126
49
3669

151
3
9

1944

Peripheral, retrograde
Going Forward

Establishment of Canadian Thoracic Aortic Network

Cross country group of cardiac surgeons interested in aortic surgery

Share data

Work on thoracic aortic research projects
Going Forward
Summary

Contemporary results of Conventional Surgery of Acute Type A Dissection

IRAD
GERAADA
US Registry Data
CTAC

Operative Mortality ≈ 20%
Substantial long term morbidity and mortality
Summary

Open Stent Graft vs. Closed Stent Graft

World wide “tour de force” of novel techniques used by select cardiac surgeons – not institution wide yet

Early results 2012-2015

Currently on a steep learning curve

Guidelines supportive
Summary

Our current indications for considering extended aortic replacement:

1. Primary intimal tear in distal arch/descending aorta
2. Malperfusion
3. Collapsed True Lumen in descending aorta
4. Dilated arch/descending aorta
5. Young Patient
Thank you
Thank You
Surgical colleagues
IR colleagues
OR Team
Th Ao Research Team
Di
Biomed Engineering
Pathology
CV Anaesthesia
Coordinators

Thank You

Foothills Medical Centre, University of Calgary

jehangir.appoo@albertahealthservices.ca
In the future:

What % of pts would be eligible for isolated endovascular repair of acute type A dissection?

Which patients benefit from conventional surgery vs. hybrid surgery vs. endovascular?

Strategies

Surgical asc ao replacement followed by branch grafts?
### Early Outcomes of FET

Pochettino/PENN (Vallabhajosyula JTCVS 2014)  
Coselli/Texas (Preventza JTCVS 2014)

Study Period: 2005-2012

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<tbody>
<tr>
<td>N (Penn)</td>
<td>62</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>(Texas)</td>
<td>25</td>
<td>87</td>
<td></td>
</tr>
<tr>
<td>Mortality</td>
<td>10%</td>
<td>14%</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>12%</td>
<td>13.8%</td>
<td>NS</td>
</tr>
<tr>
<td>CVA</td>
<td>5%</td>
<td>8%</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>12%</td>
<td>10.3%</td>
<td>NS</td>
</tr>
<tr>
<td>Transient SCI</td>
<td>6%</td>
<td>2%</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>8%</td>
<td>2.4%</td>
<td>NS</td>
</tr>
<tr>
<td>Circ arrest times</td>
<td>55±18 mins</td>
<td>37±18 mins</td>
<td>P =.001</td>
</tr>
<tr>
<td></td>
<td>35mins</td>
<td>34mins</td>
<td>NS</td>
</tr>
<tr>
<td>False Lumen Obliteration</td>
<td>82%</td>
<td>39%</td>
<td>P&lt;.001</td>
</tr>
<tr>
<td></td>
<td>~50%</td>
<td>~50%</td>
<td>NS</td>
</tr>
<tr>
<td>Malperfusion Resolved</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>84.2%</td>
<td>54.2%</td>
<td>P&lt;.037</td>
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### Pochettino/UPENN Early outcomes

2005 – 2012

<table>
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<tr>
<th></th>
<th>Stented</th>
<th>Standard Repair</th>
<th>P value</th>
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<tbody>
<tr>
<td>N</td>
<td>62</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>Mortality</td>
<td>10%</td>
<td>14%</td>
<td>NS</td>
</tr>
<tr>
<td>CVA</td>
<td>5%</td>
<td>8%</td>
<td>NS</td>
</tr>
<tr>
<td>Paraplegia</td>
<td>0%</td>
<td>1%</td>
<td>NS</td>
</tr>
<tr>
<td>Circ arrest times</td>
<td>55±18 mins</td>
<td>37±18 mins</td>
<td>P =.001</td>
</tr>
<tr>
<td>False Lumen Obliteration</td>
<td>82%</td>
<td>39%</td>
<td>P&lt;.001</td>
</tr>
</tbody>
</table>

Mean f/u 2.7 yrs
Extended aortic repairs

- Improved false lumen obliteration
  - Reduced potential malperfusion
  - Reduced late dilatation
- Reduced late re-interventions
- Reduced late mortality
- Improve our late outcomes with minimal morbidity

= No brainer
Significance of malperfusion syndromes prior to contemporary surgical repair for acute type A dissection: outcomes and need for additional revascularizations☆

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Received 5 February 2007; received in revised form 29 March 2007; accepted 3 April 2007; Available online 17 May 2007

Operative Mortality
Malperfusion: 30%
No malperfusion: 6%
Is Emergency Total Arch Replacement With a Modified Elephant Trunk Technique Justified for Acute Type A Aortic Dissection?

Hirotaka Watanuki, MD, Hitoshi Ogino, MD, Kenji Minatoya, MD, Hitoshi Matsuda, MD, Hiroaki Sasaki, MD, Motomi Ando, MD, and Soichiro Kitamura, MD

Department of Cardiovascular Surgery, National Cardiovascular Center, and Department of Thoracic Surgery, Fujita Health University, Osaka, Japan

Operative Strategy for Acute Type A Aortic Dissection: Ascending Aortic or Hemiaortic Versus Total Arch Replacement With Frozen Elephant Trunk

Naomichi Uchida, MD, Hidenori Shibamura, MD, Akira Katayama, MD, Norimitsu Shimada, MD, Miwa Sutoh, MD, and Hiroshi Ishihara, MD

Division of Cardiovascular Surgery, Hiroshima City Asa General Hospital, and Kajikawa Private Hospital, Hiroshima, Japan

Background. In surgery unresected dissection an causes of the progression c grafted the ascending aort grafting possible through all patients with type A descending aorta, wherever arch.

Methods. A total of 27 cases of type A dissection underwent grafting between August 1988 and 1999, with 21 of these undergoing emergency total arch replacement. The distal anastomotic “Elephant Trunk” technique was used to perform the operation.

Results. The hospital and 1-year survival rates for ascending aortic and hemiaortic replacements were 82.6% and 74.1%, respectively. The survival rates for total arch replacement were 64.3%, 54.9%, and 45.7% at 1, 2, and 3 years, respectively.

Background. We assess the outcomes of emergency total arch replacement with a modified elephant trunk technique for acute type A aortic dissection. Our aggressive approach is justified.

Methods. Between 2000 and 2006, 15 patients underwent emergency total arch replacement for acute type A aortic dissection. The technique involved using open distal anastomosis and cerebral perfusion under arch replacement with individual aortic arch further distal to the transverse arch or the proximal descending aorta, massive arch dissection, Marfan syndrome, and aneurysm. A modified elephant trunk technique was used for secure anastomosis and early thrombosis of the false channel in the descending aorta.

Methods. This report compares long-term results with total arch replacement with frozen elephant trunk (FET) to ascending aortic or hemiaortic replacement (AHR) for acute type A aortic dissection.

Results. Three patients in the FET group and 2 patients in the AHR group died. In long-term follow-up (mean, 67 months), the survival rate after 5 years was 95.3% for the FET group and 69.0% for the AHR group (p = 0.03). The event rate for the thoracic aorta after 5 years showed a significant difference between the FET and AHR groups (95.7% versus 73.0%, p = 0.01). A false lumen at the proximal descending aorta was patent in 16 patients (29%) in the AHR group, but it was thrombosed in all in the FET group.

Conclusions. In patients with acute type A aortic dissection, it is possible to perform extensive primary repair using the FET technique with relative safety. FET may reduce the necessity for further operations to manage a residual false lumen.

• Very good results but not likely reproducible worldwide led to introduction of
  – “Frozen Elephant Trunk”
E-Vita Results

106 patients ~ half acute/half chronic
SACP 74mins + 8mins HCA
12% operative mortality
False lumen thrombosis 92% (acute) & 66% (chronic)
An Alternative Approach to Diffuse Thoracic Aortomegaly: On-Pump Hybrid Total Arch Repair Without Circulatory Arrest

William D. T. Kent, MD, MSc, Jason K. Wong, MD, Eric J. Herget, Joseph E. Bavaria, MD, and Jehangir J. Appoo, MDCM

Diffuse thoracic aortomegaly has conventionally been managed with a two-stage elephant trunk procedure, requiring prolonged circulatory arrest, with an inherent risk of major morbidity and mortality. Recently, to improve outcomes, several hybrid arch procedures have been proposed using off-pump techniques. We have adopted an alternative, single-stage hybrid strategy using cardiopulmonary bypass without circulatory arrest to replace the ascending aorta and perform arch debranching and antegrade endovascular stent graft deployment. Unlike off-pump procedures, pathology of the aortic valve, root, and ascending aorta is addressed while avoiding the complications of stent graft placement in the native ascending aorta.

(Ann Thorac Surg 2011;xx:xxxx) © 2011 by The Society of Thoracic Surgeons
Completed Arch Debranching
Acute Type A Case
Completed Hybrid Procedure
Potential Advantages of our Hybrid Total Arch for Acute Type A

Early

• Avoidance of circulatory arrest
  – Hypothermia
  – Stroke?
• Decreased bleeding
  – From distal anastomosis
  – Mild Hypothermia
• Avoid/Treat Malperfusion

Late

• No residual flap in aortic arch
• Obliteration of false lumen
• Good potential landing zone if needed
• Disease specific approach
Surgical Correction of Ascending Type A Thoracic Aortic Dissection: Simultaneous Endoluminal Exclusion of the Arch and Distal Aorta

Edward B. Diethrich, MD; Marwan Ghazoul, MD; Grayson H. Wheatley III, MD; Jeffrey Alpern, DO; Julio Rodriguez-Lopez, MD; Venkatesh Ramaiah, MD; and James Williams, BA
Hybrid Aortic Arch Debranching With Staged Endovascular Completion in DeBakey Type I Aortic Dissection

Antonino G.M. Marullo, MD, PhD, Samuele Bichi, MD, Rocco A. Pennetta, MD, Gerardo Di Matteo, MD, Antonio M. Cricco, MD, Luigi Specchia, MD, Fausto Castriota, MD, and Giampiero Esposito, MD

Department of Cardiovascular Disease, Città di Lecce Hospital, GVM Research and Care, Strada Provinciale per Arnesano, Lecce, Department of Surgery and Bioengineering, Unit of Cardiac Surgery, University of Siena, Siena, Italy

Background. We assess midterm results of a hybrid approach to DeBakey type I aortic dissection using a new multibranched Dacron graft to create, by relocation of the inflow openings to the arch vessels toward the aortic root, a new aortic arch for an easier and safer second-staged endovascular stent grafting of the distal thoracic aorta.

Methods. From March 2006 to July 2008 24 patients with DeBakey type I aortic dissection underwent ascending aorta and aortic arch replacement with debranching of epiaortic vessels using a new prosthesis to create an optimal landing zone for possible subsequent endovascular stent grafting of the distal thoracic aorta. Fifteen patients, who postoperatively presented a residual patent distal false lumen, underwent a successful second-stage endovascular stent-graft implantation.

Results. One patient died after the surgical stage while there was no death after the endovascular stage with hospital mortality of 4.2%. Follow-up confirmed complete thrombosis of the residual distal false lumen in 95.6% and partial thrombosis in 4.4% of patients with no evidence of endoleaks in the cases that required the endovascular procedure. Overall actuarial survival at 28 months is 92.1% ± 7.9% with 100% freedom from reoperation.

Conclusions. Hybrid treatment of DeBakey type I aortic dissection with aortic arch debranching, using a new multibranched prosthesis (Lupiae Graft; Vascutek Terumo Inc, Scotland, United Kingdom) is confirmed to facilitate the subsequent endovascular completion. Midterm results in terms of survival and distal false lumen thrombosis are satisfactory. Further study of this operation is warranted to confirm the effectiveness and the durability of this approach.

Siena Technique
Staged Operation

Fig. 1. The Lupiae prosthesis (Vascutek Terumo Inc, Scotland, UK).

Circulatory Arrest Used for Distal Aortic Anastomosis
Hybrid Total Arch for Acute Dissection

• Evolving experience
• No right answer/dogma
• Multiple options
• Pros & Cons
Hybrid Total Arch for Acute Dissection

• Who should we be doing this “disease specific” operation for?

  • Intimal tear in aortic arch
  • Retrograde dissections

  • Arch re-entry tears
  • CT disorder?
  • Arch aneurysm
  • Younger age
Results of “Type II” Hybrid Arch Repair with Zone 0 Stent Graft Deployment

Jehangir Appoo, William Kent, Eric Herget, Jason Wong, Alberto Pochettino and Joseph Bavaria

Division of Cardiac Surgery, Libin Cardiovascular Institute of Alberta & Division of Diagnostic Imaging, University of Calgary
&
Hospital of the Univ. of Pennsylvania, Dept. of Cardiac Surgery, University of Pennsylvania
Evolution of Management Options for Diffuse Pathology of the Ascending, Arch and Descending Thoracic Aorta

I. Conventional open two-stage procedure
   I. Treatment mortality including first stage, second stage and interval mortality as high as 36% in contemporary series
      Etz, Griepp et al. EJCTS 2008;34;605-615

II. Frozen stented elephant trunk concept (E-vita Registry)
   I. 15% operative mortality and 8% SCI
III. Type I Hybrid – Arch Debranching Procedure

I. 122 of 195 cases were Zone 0 TEVAR:
   – 10.5% incidence of proximal Type I endoleak, retrograde Type A dissection and graft migration

       Antoniou et al., Eur J Vasc Endovasc Surg 2010;39:683-690

IV. Type II Hybrid Arch Procedure

I. Novel approach which may have advantages for managing both acute and chronic diffuse thoracic aortic pathology
Milewski, Bavaria et al., JTCVS 2010;140:590-7
The “Type II” Hybrid Option

Advantages:

1. Single stage

2. “Bavaria graft” replaces diseased ascending aorta, provides robust fixation for stent graft and minimizes risk of endoleak and retrograde dissection
The “Type II” Hybrid Option

Advantages:

3. Avoidance of prolonged circulatory arrest

4. CPB is advantageous:
   - Cerebral protection
   - Perfusion during arch debranching
   - Resection of ascending aorta
28 mm
Tube Graft

Left Common Carotid and Left Subclavian Branches

Brachiocephalic Trunk Branch

Endovascular System Delivery Branch
Branches to Left Carotid and Left Subclavian Arteries

Proximal Stent Graft Landing Zone in Replaced Ascending Aorta

Branch to Innominate Artery Under Innominate Vein

Native Ao Arch
## Procedure

- Replacement of Ascending +/- aortic valve and root repair
- Arch debranching
- Antegrade endovascular stent graft deployment

### Operative Details

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Intraoperative Temperature</td>
<td>25 - 30°C</td>
</tr>
<tr>
<td>Mean CPB time</td>
<td>259 min</td>
</tr>
<tr>
<td>Mean Cross-Clamp Time</td>
<td>100 min</td>
</tr>
<tr>
<td>*Circulatory Arrest (Simple open distal)</td>
<td>9/18 patients</td>
</tr>
<tr>
<td>Stent’s Deployed Antegrade (mean #)</td>
<td>1.9</td>
</tr>
<tr>
<td>Aortic valve repair +/- root work</td>
<td>4/18 patients</td>
</tr>
</tbody>
</table>
## Results: Perioperative

<table>
<thead>
<tr>
<th>Variable</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Successful technical deployment</td>
<td>18 (100)</td>
</tr>
<tr>
<td>In-hospital mortality</td>
<td>1 (5.5)</td>
</tr>
<tr>
<td>Transient paraplegia</td>
<td>3 (16.7)</td>
</tr>
<tr>
<td>Renal Failure (Dialysis)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Reoperation for bleeding</td>
<td>4 (22.2)</td>
</tr>
<tr>
<td>Stroke</td>
<td>1 (5.5)</td>
</tr>
</tbody>
</table>
Results: Late
Mean Follow-up: 24 months

<table>
<thead>
<tr>
<th>Condition</th>
<th>Pt. (%)</th>
</tr>
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<tbody>
<tr>
<td>Late mortality</td>
<td>2 (11.1)</td>
</tr>
<tr>
<td>Stent fracture</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Stent migration</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Retrograde Type A Dissection</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Aneurysm growth</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Endoleak</td>
<td>2 (11.1)</td>
</tr>
</tbody>
</table>
Type II Hybrid Procedure:

Two year follow-up:

- Technically achievable repair
- Less invasive and potentially improved perioperative outcomes
- No incidence of rupture, aneurysm progression, or retrograde type A dissection at 2 year follow up. No delayed type 1 endoleak
- Attractive option for patients with diffuse thoracic aortic pathology
- Long-term results yet to be determined
<table>
<thead>
<tr>
<th>Surgeon</th>
<th>Year</th>
<th>ET1 Mortality</th>
<th>ET2 Mortality</th>
<th>Interval Mortality</th>
<th>Rx Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Svensson</td>
<td>2004</td>
<td>2%</td>
<td>8.5%</td>
<td>14%</td>
<td>18%</td>
</tr>
<tr>
<td>Safi</td>
<td>2007</td>
<td>6.3%</td>
<td>9.6%</td>
<td>10%</td>
<td>13.3%</td>
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<tr>
<td>Lemaire/Coselli</td>
<td>2006</td>
<td>12%</td>
<td>4%</td>
<td>25%</td>
<td>36%</td>
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<tr>
<td>Kouchoukos</td>
<td>2007</td>
<td>7.2%</td>
<td>--</td>
<td>--</td>
<td>7.2%</td>
</tr>
<tr>
<td>Grieppe</td>
<td>2008</td>
<td>6%</td>
<td>7%</td>
<td>12%</td>
<td>24.5%</td>
</tr>
</tbody>
</table>

ET1 Mortality – 6-7% in high volume leading centres.
Interval mortality may be decreased with endo stage II but is still real.
Thus, best case scenario for open total arch in real world is likely a treatment mortality of at least 15%, possibly higher.

Significant mortality in an asymptomatic lesion in an elderly patient.

Morbidity of bleeding, stroke, prolonged ICU.

Role for decreasing “dimensions” of this operation.
Large data bases show us that mortality for all cardiac surgery increases with age

AVR: 60 y.o → 80 y.o 3x increase in op risk

Total arch/Elephant Trunk 60 y.o → 80 y.o ?
Defn of Hybrid Arch:
  Combination of sternotomy & endovascular surgery

Idea behind Hybrid Arch:
  Decrease the scope of invasive surgery to improve upon morbidity and mortality
Many techniques
  On pump – off pump
  Circ arrest, no circ arrest
  Single stage vs. two stage
  Location of stent placement
  Antegrade vs. retrograde stent placement
  Cardiac surgery vs. vascular surgery vs. IR
Bavaria classification for Hybrid Arch

General Principles of our Type II Hybrid Arch Strategy

Sternotomy

On CPB with Mild-Mod Hypothermia

Replacement of Ascending aorta

Short Circ arrest or avoid circ arrest

Arch Debranching

Antegrade Deployment

Single Stage Repair

Diffuse Aortomegaly → Acute Type A Dissection
Advantages of Hybrid Strategy for diffuse aortic disease

- Avoidance of prolonged circ arrest
- Avoid effects of deep hypothermia
- Avoid dissection around recurrently laryngeal
- Challenging distal operation converted to proximal repair
- Single stage repair
Total arch replacement: A 2% to 6% risk of death and a 2% to 7% risk of stroke have been reported for these extensive and high-risk procedures. Emergency operation mortality and stroke rates are higher (15% and 14%, respectively) (778). Careful brain and myocardial protection, correction of coagulopathies, and improved operative techniques, including the use of elephant trunk procedure, have led to improved outcomes (680,779).