Understanding Stroke in Presence of Aortic Dissection

Stroke Rounds
Dept. of Neuro Sciences, University of Calgary
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Today:

Conversation relationship between aorta and stroke
Focus on Aortic Dissection

Discuss Classification of Neuro symptoms and Dissection

Background info Type A Aortic Dissection
  classification/presentation
  surgery – brain protection
  Results of surgery today/Neuro outcome

Future areas of insight/paradigm change
Who we are?

Aortic Program
clinical
teaching
research
innovation

CALGARY THORACIC AORTIC PROGRAM

The Calgary Thoracic Aortic Program website is designed for patient education on a variety of aortic diseases and their treatment including aortic aneurysms and dissections. The Thoracic Aortic Program was established and is led by Dr. J. Arnaoropoulos and co-director, Dr. K. Long. The Program is built on an interdisciplinary platform for diagnosis, screening, and therapeutic management of thoracic aortic disease. Through an integrative approach involving clinical excellence, teaching, and research, we aim to provide state of the art therapy for our patients and contribute to the lifelong learning process to help improve patient outcomes.

WHAT IS THE AORTA?
WHAT IS THORACIC AORTIC DISEASE?
HOW IS IT TREATED?

www.aorta.ca
Case examples of neuro involvement with Aortic Dissection

Hemiplegic CVA before or after surgery for Aortic Dissection is most obvious example, so chose 2 different examples
Recent Example Type A Dissection and Neuro finding Aug 2015

48 y.o  2 day history of atypical chest pain and SOB
CT PE RGH – Possible Type A dissection
Transfer to FMC - Syncope x 2 enroute, one episode in FMC ER & in CT scanner

Repeat CTA:
Recent Example Type A Dissection and Neuro finding Aug 2015

Due to recurrent syncopal episodes Dry CT Head done with repeat CTA chest

CT Head: “nil acute”
Recent Example Type A Dissection and Neuro finding Aug 2015

**Syncope in acute Type A:**

- Dissection of carotids/vertebrals
- Cardiac tamponade/hypotension
- ? Vasovagal
Post op Course

Agitation and Hypertension – amphetamines found on UA

Extubated after agitation resolved. Neuro intact. Rest of course uncomplicated
56yo male
Seen 12 hrs post presentation
Severe Malperfusion:
  Ischemic leg – cold, pulseless, immobile
  Ischemic gut
  Renal failure
Cook Zenith TX2 Proform device unsheathed distal to ostium of Left Carotid Artery aorta

Lower extremity, visceral & renal malperfusion resolved

Residual ischemic damage to femoral nerve – uses a cane to help with ambulation
Case 2:

Post op on cardiac surgery ward Recurrent Syncope:

emergency CT scans to R/O Type A Dissection...

no associated hemodynamic collapse (on tele)

Neuro consult – med student noted that patient was left handed and repetitively squeezing a ball with his left hand...

Dx of vertebro-basilar insufficiency secondary to subclavian steal

Rx’d with carotid-subclavian bypass
Two cases show diffuse neurological involvement possible with Aortic Dissection

- Vasovagal syncope
- Vertebro-basilar insufficiency
- Peripheral nerve damage
- Spinal cord ischemia
- Stroke
Among the most notable advances in medical diagnosis during the past decade one of the most striking has been the clinical recognition of spontaneous dissecting aneurysm of the aorta. Of the various clinical manifestations of the disease neurological disturbances stand high in order of importance, frequency and gravity.
“It is anticipated that a fuller knowledge of these neurological symptoms will be of value to both the neurologist by giving order to a variety of neurological symptoms and signs.”
11 case reports of aortic dissection and neuro presentation based on post mortem pathological examination.

Fig. 3.—The extent of the spinal cord damage is shown in black (Case 1).
Conclusions:

“Some of the most interesting complications of dissecting aortic aneurysm are those due to involvement of the nervous system. The clinical syndromes which are produced can be classified into 3 groups, depending on the portion of the nervous system involved”
Proposed Classification (1944):

**Ischaemic Necrosis of the Peripheral Nerves**
- Pulseless, cold extremity with weakness, anaesthesia and loss of tendon reflexes

**Ischaemic Necrosis of the Spinal Cord**
- Flaccid paralysis, urinary retention and anaesthesia below a level on the trunk

**Ischaemic Necrosis of the Brain**
- Confusion, stupor or coma with flaccid hemiplegia, hemianaesthesia and aphasia
Few publications

Variety of definitions for neuro deficit
especially in surgical literature
“permanent residual deficit”
“neuro finding on physical exam confirmed by imaging”

surgical literature focused on different techniques to reduce post op “stroke”, but little understanding of cause of stroke
<table>
<thead>
<tr>
<th>Study</th>
<th>N</th>
<th>Preop CVA</th>
<th>Post op CVA</th>
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<tbody>
<tr>
<td>Bossone Circ 2013</td>
<td>2202</td>
<td>6%</td>
<td>5.5%</td>
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<td>Sadi Scand Cardiovasc J 2012</td>
<td>99</td>
<td></td>
<td>22%</td>
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<tr>
<td>Haldenwanga Eur J CTSurg 2012</td>
<td>122</td>
<td></td>
<td>16%</td>
</tr>
<tr>
<td>Banerjee Thorac Cardiovasc Surg 2015</td>
<td>90</td>
<td>10%</td>
<td>28%</td>
</tr>
<tr>
<td>Gaul Stroke 2007</td>
<td>102</td>
<td>29%</td>
<td>48%</td>
</tr>
<tr>
<td>Lee Neurology 2013</td>
<td>59</td>
<td>14%</td>
<td>12.1%</td>
</tr>
<tr>
<td>Blanco Acta Neurol Scand 1999</td>
<td>24</td>
<td>25%</td>
<td>17%</td>
</tr>
<tr>
<td>Tsukbe Circ 2011</td>
<td>181</td>
<td>15% (coma-GCS&lt;11)</td>
<td></td>
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</table>
### Preop Symptoms – Type A Dissection

<table>
<thead>
<tr>
<th></th>
<th>Cerebral Ischemia</th>
<th>Hypoxic Encephalopathy</th>
<th>SCI</th>
<th>Ischemic Neuropathy</th>
<th>Vocal Cord Paralysis</th>
<th>Seizure</th>
<th>Syncope</th>
<th>Coma</th>
<th>Transient Global Amnesia</th>
<th>Somnolence</th>
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<tbody>
<tr>
<td>Gaul Stroke 2007</td>
<td>53%</td>
<td>7%</td>
<td>3%</td>
<td>37%</td>
<td></td>
<td>10%</td>
<td>20%</td>
<td>7%</td>
<td>7%</td>
<td>13%</td>
</tr>
<tr>
<td>Lee Neurology 2013</td>
<td>35%</td>
<td>30%</td>
<td>4%</td>
<td>17%</td>
<td>4%</td>
<td>9%</td>
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</table>
2 papers with Neuro Classification
Post Op Neuro Symptoms – Type A Dissection

<table>
<thead>
<tr>
<th></th>
<th>Cerebral Ischemia</th>
<th>Hypoxic Encephalopathy</th>
<th>SCI</th>
<th>Ischemic Neuropathy</th>
<th>Nerve Compression</th>
<th>Intracerebral Hemorrhage</th>
<th>Septic Encephalopathy</th>
<th>Delerium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaul Stroke 2007</td>
<td>30%</td>
<td>17%</td>
<td>8.5%</td>
<td>6%</td>
<td>15%</td>
<td>2%</td>
<td>32%</td>
<td></td>
</tr>
<tr>
<td>Lee Neurology 2013</td>
<td>70%</td>
<td>10%</td>
<td>10%</td>
<td>5%</td>
<td>2%</td>
<td>5%</td>
<td></td>
<td>32%</td>
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</table>
Summary of literature on Stroke and Dissection:

Young patient population (≈60y.o) – maybe different from classic stroke population

≈10-20% present with neuro deficit
≈ 10-20% have a post op neuro deficit

Rates much higher if we look for it

Cerebral Ischemia most common manifestation
  ? Embolism
  ? Dissection of head vessel
  ? Temporary vs. permanent interruption of circulation
Thoracic Aortic Aneurysm Disease
Why is Aorta challenging?

**SILENT KILLER**

*Lethal*

Aneurysm disease top 20 causes of death of human beings
Actual number likely underestimated

*Asymptomatic*

95% are asymptomatic prior to catastrophic event
The Silent Killer: Guilt by association in detecting thoracic aortic aneurysm. Key associations include:

- Family History
- Intracranial Aneurysm
- Bovine Aortic Arch
- Abdominal Aneurysm
- Bicuspid Aortic Valve
- Renal Cysts
- Thumb-palm sign
- Temporal Arteritis
Silent Killer
Classification of Aortic Dissection

- **1427 patients**
  - 954 male
  - mean age 61.7 years – not a disease of the “old”

Type A Dissection 70%

Type B Dissection 30%

IRAD in Press
Aortic Dissection has variable urgency and variable presentation:

**Variable Urgency:**
Generally 1%/hr mortality quoted

48y.o recent case – 2 days of feeling unwell before presenting
57y.o male – this week – early presentation – didn’t survive transfer to FMC

**Variable Presenting Symptoms**
Most common is pain
Presenting symptoms of Aortic Dissection

How to attempt to distinguish from ACS:

PAIN:

Abrupt onset of CP
Maximal intensity at time of onset
CP more often “sharp” than “tearing”
CP radiating to back or abdomen

Can be painless!
Aortic Dissection known as the **Great Masquerader**

Signs and symptoms of Aortic Dissection other than chest pain:

- Cerebral Ischaemia
- Arm Ischaemia
- Spinal Cord Ischaemia
- Tamponade (intrapericardial rupture)
- Myocardial Infarction
- Free Rupture
- Intestinal Ischaemia
- Renal Ischaemia
- Leg Ischaemia

- **RCA** more commonly involved
- SBP difference >20mmHg
## Misdiagnosis of Aortic Dissection in ER

<table>
<thead>
<tr>
<th>Country</th>
<th># of pts</th>
<th>Misdiagnosed</th>
<th>Misdiagnosed as ACS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>66</td>
<td>39%</td>
<td>80%</td>
</tr>
<tr>
<td>Japan</td>
<td>109</td>
<td>16%</td>
<td>59%</td>
</tr>
<tr>
<td>Singapore</td>
<td>68</td>
<td>38%</td>
<td></td>
</tr>
<tr>
<td>China</td>
<td>361</td>
<td>14%</td>
<td>47%</td>
</tr>
</tbody>
</table>

### Predictors of misdiagnosis:
- Walk in Mode of presentation
- Absence of pulse deficit
- Absence of widened mediastinum

Hansen et al. American J of Cardiology 2007
Kurabayashi et al. J of Cardiology 2011
Management of stroke and aortic dissection:

thrombolytics should not be given due to risk of aortic rupture

“In patients who are admitted to the Emergency Department with the loss of consciousness and stroke, carotid artery involvement of aortic dissection should be kept in mind.”


Aortic arch dissection causing cerebral ischemia: an uncommon contraindication for thrombolytics. Circulation 2011

Excluding aortic dissection before thrombolysis in patients with ischemic stroke has been insufficiently advised. J of Stroke and Cerebrovascular Diseases 2011

Guidelines for the early management of adults with ischemic stroke. Stroke 2007
Results of Surgery for Type A Dissection
Current “standard of care” for acute Type A Dissection

Mortality with medical treatment is 60-70%....“1%/hr”

Recommendation for surgery
Brain protection in acute Type A Dissection

Need a bloodless field to resect dissected aorta
Aorta not clampable to provide bloodless field
Deep Hypothermia and Circulatory Arrest:

Cool to EEG silence

- 95% of patients achieve EEG silence after 50 mins of cooling
- ≈15-18 degrees Celsius core temperature

Likely “safe” for ≈ 30mins

Deleterious effects of deep hypothermia
Brain protection in acute Type A Dissection

**Retrograde Cerebral Perfusion**

Cold blood given in a retrograde fashion via SVC to “perfuse” the brain

Shown not to have any nutrient benefit to the brain

May be helpful in topic cooling, flushing out of emboli/air
Brain protection in acute Type A Dissection

Selective (Unilateral) Antegrade Cerebral Perfusion:

Right axillary artery cannulation
Clamp placed at ostium of innominate artery
Flow arrested to body and continues up Right carotid artery

Decreases stroke rate if longer than 30mins needed
Decreased amount of hypothermia required
May decrease TND

Neuro Monitoring
Cerebral Oximetry
EEG
Contemporary results of surgery in acute type A aortic dissection: The International Registry of Acute Aortic Dissection experience

Background: Surgical mortality for acute type A aortic dissection reported in different experiences from single centers or surgeons 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 200 clinical variables and their relationship to surgical outcomes in 526 of 1032 patients enrolled in the International Registry of Acute Aortic Dissection from 1996 through 2001. Extracted cases, categorized according to risk profile, were defined as unstable (group I) in the presence of cardiac tamponade; shock; congestive heart failure; cerebrovascular accident; stroke; coma; myocardial ischemia, infarction, or both, electrocardiograms 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 in-hospital mortality was 25.1%. Mortality in group I was 31.4% compared with 16.7% in group II (P < .001). Independent preoperative predictors of operative mortality were history of aortic valve replacement (odds ratio = 2.12), migrating chest pain (odds ratio = 2.77), hypotension as sign of acute type A aortic dissection (odds ratio = 2.33), shock or tamponade (odds ratio = 2.59), preoperative cardiac tamponade (odds ratio = 3.22), 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

Mortality 17% (10-35% based on age quartile)

Post op Neurodeficits 17% (includes 7% with preop deficit)
Conclusions from IRAD & GERAADA

Contemporary era of Aortic Dissection Surgery

Operative Mortality 17-25%

* Single centre experiences of < 10% operative mortality
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
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)

JJ Appoo
RS McClure
M Boodhwani
A Gupta
I El-Hamamsy
MW Chu
Z Pozeg
F Dagenais
M Ouzounian

9 Canadian sites
Inclusion Criteria:

surgery for type A dissection
Jan 1, 2007 to Dec 31, 2013
suffered a perioperative death

Local REB approval at each site
Data Sharing Agreements

Measured Baseline preop characteristics
Intraoperative variables
Post operative variables
Etiology of Mortality

adjudicated by single attending surgeon at each site after chart review classified to 1 of 7 predetermined categories:

1. Stroke
2. Hemorrhage
3. Cardiac
4. Other organ ischemia
5. Multisystem organ failure
6. Sepsis
7. Other
Results

123 charts reviewed

692 type A dissections that had surgery

Mortality rate across 9 Canadian sites  17.8%
Demographics

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<table>
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<tbody>
<tr>
<td>Mean age</td>
<td>65y.o</td>
</tr>
<tr>
<td>M/F</td>
<td>1:1</td>
</tr>
<tr>
<td>Previous cardiac surgery</td>
<td>7%</td>
</tr>
<tr>
<td>Known CAD</td>
<td>20%</td>
</tr>
</tbody>
</table>
Presenting Clinical Status

Tamponade 27%
Focal neurologic deficit 26%
Limb ischemia 13%
Visceral Ischemia 7%
### Post operative complications

<table>
<thead>
<tr>
<th>Complication</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke</td>
<td>31%</td>
</tr>
<tr>
<td>Paraplegia</td>
<td>7%</td>
</tr>
<tr>
<td>Re-exploration for bleeding</td>
<td>20%</td>
</tr>
<tr>
<td>Dialysis</td>
<td>26%</td>
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</tbody>
</table>
Primary Etiology of Mortality:

**Stroke** 22%
Hemorrhage 22%
Cardiac 25%

Other organ ischemia 11%
Multisystem organ failure 12%
Sepsis 4%
Other 5%
Patients who presented with stroke were more likely to have stroke as primary etiology of mortality (P<.05)

17% of deaths were attributed to new strokes not detected preoperatively

? Surgical conduct of neurocirculatory management
? Extension of dissection
? embolism
Limitations

Deaths may have been adjudicated in a different fashion

Quality of data collection; Independent data audit not performed

Only reviewed mortalities, not all comers
Conclusions

Periop mortality of 18% following surgery for Type A dissection in Canada is very much in keeping with contemporary worldwide data.
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70% of the reason for death following surgery for acute Type A dissection are due to:

- Stroke
- Cardiac Failure
- Hemorrhage
Conclusions

Periop mortality of 18% following surgery for Type A dissection in Canada is very much in keeping with contemporary worldwide data.

70% of the reason for death following surgery for acute Type A dissection are due to:

- Stroke
- Cardiac Failure
- Hemorrhage

If we can’t choose risk profile of whom gets an operation....future surgical strategies will need to address these 3 factors to substantially improve nationwide operative mortality following Type A dissection.
Brainstorm Question:

How do we change surgical strategies to avoid stroke post Dissection repair on a national level??
Brainstorm Question:

How do we change surgical strategies to avoid stroke post Dissection repair across the country? 

modify neuroprotective strategy? 
resect dissection flap into carotids? 
go colder? Warmer? 
Change cerebral protection?
Brainstorm Question:

How do we change surgical strategies to avoid bleeding, stroke and cardiac failure post Dissection repair across the country??

Will newer hybrid techniques improve results?
Brainstorm Question:

How do we change surgical strategies to avoid stroke post Dissection repair across the country??

Difficult to make changes to practice if we as surgeons don’t understand cause of ischemic brain injury:
Embolism?
Hypoperfusion/hyperperfusion?
Intracranial dissection
Areas of brain affected...
Conclusions:

Aorta and Brain have an intimate connection
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Aorta and Brain have an intimate connection

Surgeon intricately involved with state of neuro circulation
during operation
post op effects of residual dissection flaps/re-routing of head vessels
Conclusions:

Aorta and Brain have an intimate connection

Surgeon intricately involved with state of neuro circulation
during operation
post op effects of residual dissection flaps/re-routing of head vessels

Cerebral ischemic injury is most common neuro manifestation pre and post op in patients with Type A Aortic Dissection
Conclusions:

Aorta and Brain have an intimate connection

Surgeon intricately involved with state of neuro circulation during operation post op effects of residual dissection flaps/re-routing of head vessels

Cerebral ischemic injury is most common neuro manifestation pre and post op in patients with Type A Aortic Dissection

Neuro manifestations in patients with aortic dissection poorly understood/classified
Conclusions:

Aorta and Brain have an intimate connection

Surgeon intricately involved with state of neuro circulation during operation post op effects of residual dissection flaps/re-routing of head vessels

Cerebral ischemic injury is most common neuro manifestation pre and post op in patients with Type A Aortic Dissection

Neuro manifestations in patients with aortic dissection poorly understood/classified

Stroke is common in patients with dissection surgically may be able to decrease incidence if we understood pathophysiology/mechanism of why they occur
Future:

More nuanced understanding of pathophysiology of aortic flow patterns and neuro injury

Is there a role for systematic review on the topic?

Should dry CT Head be part of Dissection Protocol CT at FMC?
   All patients have f/u CT post surgery – should we do a CT Head at 1 week post op?