MHIF Research Highlights: SEPT 2018

Thanks to all who contribute to sharing MHIF research at important conferences:

**TCT:** 25 presentations; 15 sessions as moderators/discussants; 5 training session leaders; 1 live case panelist; and 12 posters!

**ELSO:** 21 presentations; 3 posters; 1 oral abstract presented by an MHIF intern!

MHIF Heartbeat Gala – Oct. 13, 2018
Join us for an evening of inspiration to benefit MHIF research and education!

**FEATURED MHIF STUDIES**
Open for Enrollment and Referrals!

- AEGIS* for acute coronary syndrome
- TRANSCEND for peripheral artery disease
- ASAP-SVG for coronary artery disease

**CONGRATULATIONS FOR FIRST PATIENT ENROLLMENTS!**

*Dr. Knickelbine and Stephanie Ebnet for the AEGIS trial

Dr. Gössl and Sara Olson for Prelude (mitral valve replacement study)

Dr. Gössl and Karen Meyer for TVINCITIES study (racial and ethnic disparities in valve disease)

**PUBLISHED**

Structural Heart Cases: A Color Atlas of Pearls and Pitfalls

by Dr. Paul Sorajja

Manual of Coronary CTO Interventions

by Dr. Emmanouil Brilakis

**REGISTER TODAY:** Mplsheart.org/gala
Endovascular Management of the ascending Aorta –
The latest in Dissection Treatment?

Professor Christoph A. Nienaber
The Royal Brompton and Harefield NHS Trust
Cardiology and Aortic Centre
C.Nienaber@rbht.nhs.uk

CN: No relevant financial relationships to disclose.
Figure 1: Annual Survey of Cardio-aortic Surgery [1984–2013] by Japanese Association for Thoracic Surgery. Modified from reference (2). TAA, thoracic aorta; CAD, coronary artery disease; VHD, valvular heart disease; CHD, congenital heart surgery.


Feasible: My 1st TEVAR: In Type B Dissection

Feasible
Safe
Quick recovery
Open surgery abandoned

Dake MD, et al. NEJM 1999;340:1546-1552
All Type B Dissection

- Complicated
- Chronic
- Uncomplicated

ESC 2014

Concavity Location
higher Complication Rate

Typical case of Type B Dissection managed by endovascular intervention (including a PETTICOAT)
PETTICOAT for improved realignment?

SOP in distal dissection

LSA bypass/single branch
LSA occluder
Proximal Stentgraft
Open extension (PETTICOAT)
Distal management
Pragmatic Classification of Acute Aortic Syndrome

- Complicated AAS (acute aortic syndrome)
  - Any proximal dissection/IMH
  - Evidence of Malperfusion
  - Imminent rupture (extraaortic blood collection)

- AAS with high risk features
  - Uncontrolled blood pressure
  - Recurrent episodes of pain
  - Early false lumen expansion (>4.5 cm)
  - Any FL expansion >4.5 cm
  - Malperfusion
  - True lumen collapse
  - Ongoing aortic inflammation on PET/CT

- AAS without high risk features
  - Apply Morphologic risk predictor score

Type B dissection with malperfusion
Survival after TEVAR in complicated Type B aortic dissection (TAD). Remodelling is key to success, long-term surveillance still recommended!

Type B aortic dissection: Survival and predictors. Estimated Survival by Predictors:
- Hypotension/Shock
- Malperfusion

Lower risk Type B
High risk Type B

Complicated AAS (acute aortic syndrome)
Any proximal dissection/IMH
Evidence of Malperfusion
Imminent rupture (extraprosthetic blood collection)

AAS with high risk features
- Uncontrolled blood pressure
- Recurrent episodes of pain
- Early false lumen expansion (>4.5 cm)
- Any FL expansion >4.5 cm
- Partial FL thrombosis
- Single entry tear; > 10 mm
- True lumen collapse
- Ongoing aortic inflammation on PET/CT

AAS without high risk features
- Apply morphologic risk predictor score

Pragmatic Classification of Acute Aortic Syndrome

New high risk group: Pain & persisting hypertension

Cardiovascular Surgery

Importance of Refractory Pain and Hypertension in Acute Type B Aortic Dissection

Trimarchi S et al. Circulation 2009
Two patients with a small initial false lumen diameter at the upper descending thoracic aorta showed a complete resorption of the false lumen (left) or did not show an aneurysm for approximately 3 years (middle), while another patient with a large initial false lumen diameter developed an aorta aneurysm after approximately 2.5 years (right).

New high risk group: Long-term outcome of aortic dissection.

Entry tear of aortic dissection visualized by 2-dimensional (left) and color-Doppler (right) TEE.

- Type B dissection with an entry tear located in the proximal part of the descending aorta (arrow) by tranverse view.
- Type A dissection with an entry tear in the proximal part of the residual dissection (arrow) in the upper ascending aorta by longitudinal view.

Evangelista et al. Circulation 2012

New high risk group: Aortic inflammation

Baseline After TEVAR Biology

CT PET-CT

Sakalihasan N, Nienaber CA et al, EHJ 2015
But not all cases show therapeutic remodelling.

Nienaber CA et al. Circulation CV Int 2013

(Definition: FLT thrombosis & shrinkage, no progression)

* p<0.0001

FLT 22% 91%
TLD 18mm 33mm*
Remod. 10% 79%

CV death (2nd EP)

...late advantage consistently supported by RCT and registries

<table>
<thead>
<tr>
<th>RCT</th>
<th>REGISTRY</th>
<th>RCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>INSTEAD-XL (n=140)</td>
<td>Chinese registry (n=193)</td>
<td>ADSORB (n=61)</td>
</tr>
</tbody>
</table>

The initial RCT showed a long-term advantage of an intervention (stent-grafting the TL), with two large registry-based analyses confirming the signal from the RCT; findings are supported by short-term F/U of an independent RCT. On aggregate, all data are consistent! Very strong signal!
...late advantage also supported by MGH Cohort study

![Graph showing survival over time for uncomplicated TBAD](image1)

**Figure 3. Kaplan-Meier curve for survival of 298 patients with uncomplicated, acute type B dissection, from the time of presentation, stratified by those undergoing intervention (green) and those remaining medically managed throughout the operative period (red).**

**Table: Predictors of long-term stability**

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B</th>
<th>SE</th>
<th>p-value</th>
<th>OR</th>
<th>95% CI for Hazard Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>.030</td>
<td>.020</td>
<td>.134</td>
<td>1.031</td>
<td>.991-1.072</td>
</tr>
<tr>
<td>Female</td>
<td>-1.097</td>
<td>.649</td>
<td>.091</td>
<td>.334</td>
<td>.094-1.193</td>
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<tr>
<td>STJ diameter</td>
<td>-1.880</td>
<td>.637</td>
<td>.003</td>
<td>.153</td>
<td>.044-5.32</td>
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<tr>
<td>Complete FLT</td>
<td>1.678</td>
<td>.751</td>
<td>.025</td>
<td>5.354</td>
<td>1.229-23.329</td>
</tr>
</tbody>
</table>

**Figure 4. Kaplan-Meier analysis shows freedom from aortic events.**

- A: In the occluded false lumen group
- B: In the patent false lumen perfusion group

**IRAD data on file**

Suenaga H. et al. EJCTS 2016
Uncomplicated TBAD...

Really...

- Complicated AAS (acute aortic syndrome)
  - Any proximal dissection/IMH
  - Evidence of Malperfusion
  - Imminent rupture (extraaortic blood collection)
  - AAS with high risk features
    - Uncontrolled blood pressure
    - Recurrent episodes of pain
    - Evidence false aneurysm expansion (>4.5 cm)
    - Any false aneurysm >4.5 cm
    - Partial FL expansion
    - FL expansion > 4.5 cm
    - Partial FL thrombosis
    - True lumen collapse
    - Ongoing aortic inflammation on PET/CT
  - AAS without high risk features
    - Apply morphologic risk predictor score

Pragmatic Classification of Acute Aortic Syndrome

Definition of “misnomer” from the Cambridge Advanced Learner’s Dictionary & Thesaurus © Cambridge University Press
Estimation of risk in type B aortic dissection


On October 23, 1760 George II rose at 6 am, asked for his chocolate and repaired to his closet-stool. The valet heard a “noise louder than the royal wind and a groan.” The King was...

...pericardium extended with coagulated blood and a transverse fissure on the inner side of the ascending aorta 3.75 cm...

tissue on the inner side of the ascending aorta 3.75 cm long through which blood had passed to form an ecchymosis, which was interpreted as an incipient aneurysm
Hybrid theatre: new options of complex endovascular approaches

Hybrid: My 1st TEVAR in the arch
Endovascular SG placement during cardiac arrest

Successful SG placement in aortic arch under Rapid Pacing for cardiac arrest
Pioneering work led to custom-made Chuter endograft.

- Total-arch solutions
- Ascending aorta
- Dissection-specific devices
- Type A dissections
- More long-term data

Ready for broader applications? TEVAR and the near future

Expanding Indications

- Total-arch solutions
- Ascending aorta
- Dissection-specific devices
- Type A dissections
- More long-term data

Low profile branch technology

Technology on the horizon, but not successful and not approved
Selection

Previous sternotomy for type A
Not suitable for re-do surgery

Pharyngolaryngectomy
Neck dissection, radiotherapy...etc
Tracheostomy
The NEXUS device

(A) Final angiography showing no aortic regurgitation or endoleak with patency of the coronary arteries and bridging stents perfusing the supra-aortic trunks. Results were confirmed on the postoperative 3-dimensional reconstruction (B) and maintained on the 7-month follow-up scan (C).

Hertault et al. JEVF 2018
Recent trends in management in type A dissection:
- Fewer rejections for type A surgery
- Declining open surgery for type B dissection
- Increasing endovascular intervention

In Hospital Mortality:
Operated Type A Dissection

Frequency (%)

<table>
<thead>
<tr>
<th>Year</th>
<th>Frequency</th>
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</thead>
<tbody>
<tr>
<td>1996-2003</td>
<td>17.5%</td>
</tr>
<tr>
<td>2004-2009</td>
<td>15.8%</td>
</tr>
<tr>
<td>2010-2016</td>
<td>12.2%</td>
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</table>

Linear Trend: p=0.013

Increasing Use of Valve Sparing

Linear Trend $p<0.001$

Retrograde Linear Trend $p=0.005$
Antegrade Linear Trend $p=0.005$

Cerebral Perfusion Strategies

Retrograde Linear Trend $p=0.005$
Antegrade Linear Trend $p=0.005$

Parikh N et al. IRAD 2016.
The ultimate goal: Dr. DeBakey at age 95... had chest pain!

- Finally my 1st AMI...?
- No, a DeBakey Type II Dissection!
- Difficult decision to go for surgery!
- Intermittent loss of consciousness!

Anatomy and Classification of Aortic Dissection

DeBakey I II III
Stanford A B
Figure 4


Implantation under rapid RV pacing
Delivery of 36 mm x 6.4 cm TX2 Graft
The ultimate goal in treating any dissection is mending the layers and healing of the aorta which requires stent-graft induced FL tear thrombosis and remodelling.

**TEVAR in type A dissection**

Pre-TEVAR at discharge  12 months  24 months  36 months  48 months  60 months

Sakalihasan N, Nienaber CA et al. in preparation

**Ascending Aorta + TEVAR**

**Endovascular Repair of Ascending Aortic Dissection**

A Novel Treatment Option for Patients Judged Unfit for Direct Surgical Repair

Qiaoqiang Lu, MD, Faizan Feng, MD, Jun Zhou, MD, Zaiqing Zhao, MD, Junxia Bao, MD, Rui Feng, MD, Liangyi Yuan, MD, Xiong Feng, MD, Leling Qu, MD, Yifei Pei, MD, Zhijun Mei, MD, Zaiqing Jiao, MD, PhD
Shanghai, China

**Objectives**

This paper reports the outcomes of patients who were considered unfit for urgent surgical repair of ascending aortic dissections (AADs) who were treated using a novel endovascular repair strategy.

**Background**

AADs are treated by direct surgical repair. Patients who are unable to undergo this form of treatment have poor outcomes. Preliminary, clinical case reports suggest that endovascular repair of AADs may be an option for patients who are considered poor candidates for direct surgical repair.

**Methods**

Between May 2010 and January 2011, 43 consecutive patients with AADs were treated in our institution. Fifteen patients were considered poor candidates for direct surgical repair and subsequently underwent the endovascular repair.

**Results**

The details of this clinical experience are not always consistent with the above endovascular repair device: Ascending aortic dissections cannot be treated. Aortic dissections change in the future. Patients with AADs were treated with endovascular devices: Ascending aortic dissections change in the future. The follow-up period was 12 months. The overall survival rate at 12 months was 100%. The 6-month survival rate was 100%. The 1-year survival rate was 100%. The 2-year survival rate was 100%. The 3-year survival rate was 100%. The 4-year survival rate was 100%. The 5-year survival rate was 100%. The 6-year survival rate was 100%.

**Conclusions**

Endovascular repair of AADs was successful in patients who were considered poor candidates for direct surgical repair after the clinical outcomes were used in our institution. A large series of cases with long-term follow-up is needed to substantiate these results.
Emerging Therapy for the ascending Aorta


Series of 12 patients unfit for open surgery

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age &amp; Sex</th>
<th>Diagnosis</th>
<th>EuroScore II</th>
<th>Procedure duration (min)</th>
<th>Follow-up (months)</th>
<th>Complications</th>
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<tbody>
<tr>
<td>1</td>
<td>75M</td>
<td>xTAAD</td>
<td>0.9</td>
<td>Cook</td>
<td>99</td>
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<td>2</td>
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<td>0.1</td>
<td>Robotic NS</td>
<td>140</td>
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<td>3</td>
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<td>xTAAD</td>
<td>1.3</td>
<td>Robotic NS</td>
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<td>4</td>
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<td>5</td>
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<td>6</td>
<td>60M</td>
<td>xTAAD</td>
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<td>Cook</td>
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<tr>
<td>7</td>
<td>75M</td>
<td>xTAAD</td>
<td>4.9</td>
<td>Robotic NS</td>
<td>78</td>
<td>None</td>
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<td>8</td>
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<td>xTAAD</td>
<td>9.6</td>
<td>Cook</td>
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<tr>
<td>9</td>
<td>87F</td>
<td>xTAAD plus FVR</td>
<td>7</td>
<td>Optimal</td>
<td>120</td>
<td>None</td>
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<tr>
<td>10</td>
<td>88M</td>
<td>xTAAD</td>
<td>6.9</td>
<td>Cook</td>
<td>09</td>
<td>None</td>
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<tr>
<td>11</td>
<td>75F</td>
<td>xTAAD</td>
<td>0.9</td>
<td>Cook</td>
<td>68</td>
<td>None</td>
</tr>
<tr>
<td>12</td>
<td>75F</td>
<td>xTAAD</td>
<td>0.9</td>
<td>Cook</td>
<td>68</td>
<td>None</td>
</tr>
</tbody>
</table>

Characteristics

9 M, 3F, aged 81±7 years

Proximal tear in ascending aorta

EuroScore II 9.1±4.5

Procedural success 91.7%

30 day mortality 8.3%
The opposite of FLIRT: True Lumen Intervention...nice initial Results!

True Lumen Intervention...lasting 15 months.
2- and 3-dimensional images of proximal aortic dissection before (A) and after stent-graft (B) with successful remodelling, but later total erosion of distal stent-edge at 16 months (C).

Yuan X et al. Cath Cardiovasc Int 2018

Gore Announces Successful Patient Implant of Endovascular Stent Graft for the Ascending Aorta

Aug 27, 2018, 0:30am EDT

GORE® Ascending Stent Graft, an investigational device, is an off-the-shelf endovascular solution designed to treat life-threatening Type A dissections of the ascending aorta.

FLAGSTAFF, Ariz. -- (BUSINESS WIRE)

W. L. Gore & Associates, Inc. (Gore) today announced the first implant in conjunction with the Gore-ARISE Study of the GORE® Ascending Stent Graft, an investigational device and the only endovascular stent graft specifically designed to treat Type A dissections of the ascending aorta. The successful procedure took place on August 14, 2018 at Memorial Hermann Medical Center in Houston, Texas by Anthony Estrella, M.D. and Bruce Takeda, M.D. as part of the Gore ARISE Study.
This time another strategy... why not a FLIRT this time?

CASE M.P
Inoperable
Euroscore II 21%

• Exclusively percutaneous minimalistic technique (based on the use of occluders, coils and ONYX)
• Promotes false lumen thrombosis to initiate remodelling
• Amenable to communications in any kind of dissection (A/B)
• Avoids the risk of (add’l) BEVAR/FEVAR or open surgery

Is it worth a FLIRT?

Yuan X et al Cath Cardiovasc Interv 2014
Interventional Repair of Type a Aorta Dissection

CT and echo images pre-procedure (A), at discharge (B) and 6-month follow-up (C) showing entry closure false lumen thrombus and shrinkage with true lumen expansion (remodelling) (patient no.2). Star shows the ASD occluder.

Pre-procedure

[FLIRT]

At discharge

6 months F/U

Yuan X et al. CCI 2018
64 y/o male patient
- Sudden onset of chest/back pain
- History of chronic HTN
- Triple rule out CT diagnosis:
  - Acute type B dissection
  - Lusoria anatomy
  - Distal malperfusion
    - Right arm claudication/ischemia
    - Lower extremity hypotension

Another FLIRT: Subacute/Chronic dissection to induce remodelling?

Sequential follow-up CT scans after the 1st procedure
Tear in fabric of SG and partial thrombosis of FL at day 5 post TEVAR
At day 55 the FL thrombosis has improved, but is still incomplete and fed from the fabric tear
Strategy:
Secondary induction of complete FL thrombosis
3D CT-guided reintervention with FLIRT concept in type B dissection

1st attempt
- Coils, occluder
- and iliac Stentgraft to isolate FL

2nd attempt

...or false lumen coils & occluder to facilitate thrombosis and aortic remodeling

Pre-TEVAR 55 d post-TEVAR 3 d post-repair

Complex, but uncomplicated case with secondary reperfusion of false lumen from proximal inflow caused by rupture of graft fabric. Retrograde coiling and an occluder turn procedural failure into a great success with additional procedures!
75 y/o female

- Admitted from a routine surveillance CT of thoracic aortic aneurysm showed a new dissection in aortic root

- Hypertension
- Apronectomy in Feb 1999
- Coronary angiogram: LAD 70% stenosis in 2001
- Infra-renal AAA repair in 2006
- Permanent pacemaker implantation in Mar 2007
- Osteoarthritis with total knee replacements
- Lower gastrointestinal haemorrhage with bowel resection in 2015, end-to-end anastomosis
- Aorto-femoral bypass

**FLIRT with the impossible... FL management in this type A dissection?**

Type A dissection confined to just above the aortic root to mid ascending aorta.
Measured 26 x 42 mm
Entry tear diameter 5mm

**Individual approach – false lumen management in type A dissection**
Angiogram confirms the false lumen and entry tear.

- 15 x 5 mm coils deployed via MP followed by a 10mm Amplatzer PFO closure device placed across the entry tear.
- Final angiogram shows tear sealed and coronary ostium unblocked.

Individual approach – false lumen management in type A dissection

CT scan 3 days after procedure
No contrast communication to the false lumen

CT scan 6 months after procedure
Device sealing in site precisely with excellent remodelling

Yuan X et al. JEVT 2017
Demographic information, pathology and procedures

Procedural details (FLIRT concept) and success rate

ASD, atrial septal defect; MAACE, major adverse cardiovascular and cerebrovascular events; PFO, patent foramen ovale.
Impact of FLIRT on anatomic details, remodelling and false lumen thrombosis in proximal (type A) and distal (type B) aortic dissection

Proximal dissection cases treated with FLIRT (occluders and coils) demonstrated the increasing true lumen area and shrinking maximum diameter of the aorta over time.
Can this be replaced by an Endovascular Procedure?

**Bentall Procedure**
Open Heart Surgery

Final Challenge:
Is there a potential for an Endovascular Bentall Procedure?

Sketch from Engineering Lab in 2006

Covered stents (Jostent) for Coronaries
Anatomic Feasibility of an Endovascular Valve-Carrying Conduit for the Treatment of Type A Aortic Dissection

157 patients
3 landing zones
113 patients (68%)

With high quality CT scans were screened for anatomic feasibility

① distal sealing zone
② proximal sealing zone
③ transcatheter valve

Are potential candidates, but most would require tapered stent-grafts

Kreibich M et al., JTCVS 2018

The future is approaching... but not close yet!

Wishful thinking by Ted Diethrich † in 2006
Is an Endo-Bentall a Feasible Option soon?

Answer:
Almost Certainly, but not today & not tomorrow!