Where Are We with Endovascular Management of Aortic Arch Aneurysms?

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Winnipeg Vascular and Endovascular Symposium

Disclosures

- Kenton Rommens
  - GORE Medical – Consultant
  - Terumo Aortic – Scientific Advisory Board

Outline

- Open Total Arch Replacement
- Different Techniques
- Current Devices
- Review of Outcomes
- Case Workup and Potential Complications
- Future Directions and Multidisciplinary Care

Open Total Arch Replacement

Outcomes of Total Aortic Arch Replacement in a Canadian Nationwide Registry

Julia F. Chen, MD, MPH • Maral Ouzounian, MD, PhD • Mark Peterson, MD, PhD • Mark Tatangelo, PhD, MBA • Francois Dagenais, MD • Ali Hage, MD, MPH • Thomas F. Lindsay, MD • Michael W.A. Chu, MD • Jennifer Chung, MD, MSc • Show less

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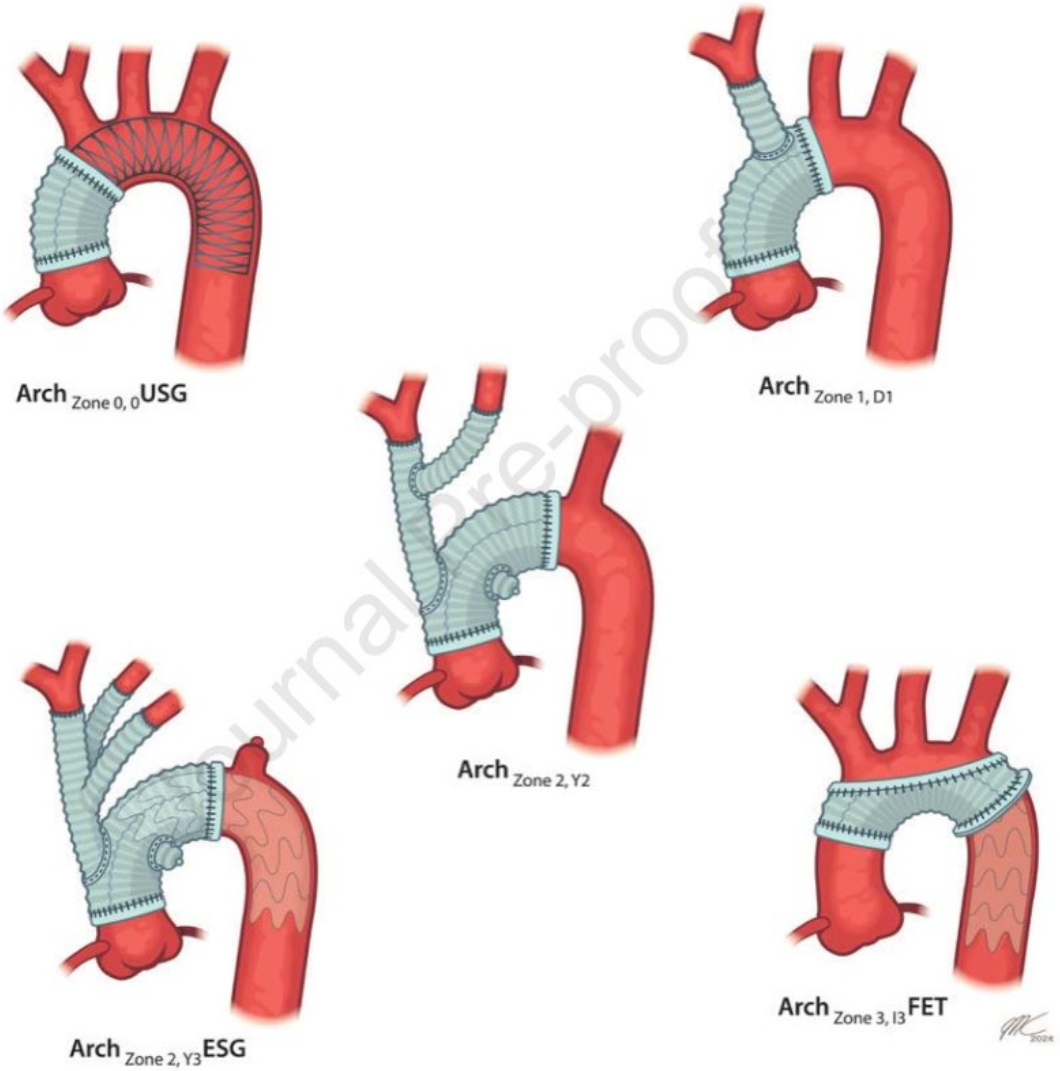
- 250 elective TAR 2010 to 2021
- Mortality 5.2%
- Stroke 10%
- More delirium (22%), prolonged intubation (18%), longer ICU stay (6 days) in and transfusions in TAR compared to hemiarch group

Open Total Arch Repair – Difficult to compare?

- Many configurations

- Blurs the line between:
  - “hybrid” arch repairs
  - classical Zone 3 TAR



Different Techniques

- Parallel Grafts
  - Antegrade (Chimney) or Retrograde (Periscope)
- In Situ Fenestration
  - Mechanical or Laser fenestration
- Physician Modified Endografts
- **Branched and Fenestrated Arch Grafts**

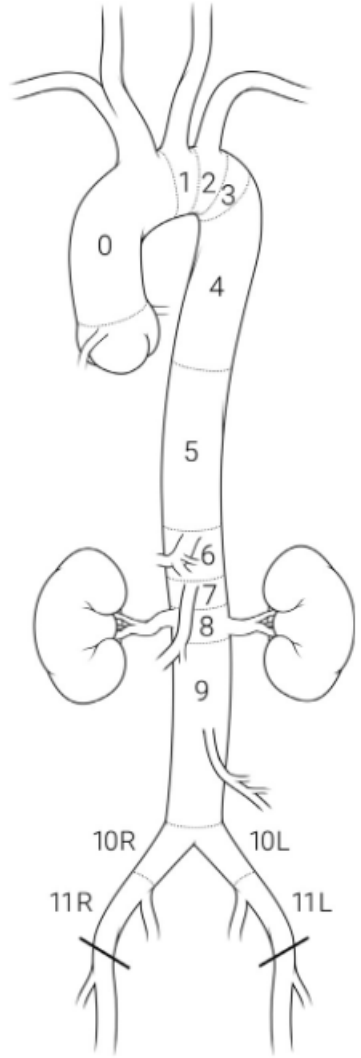
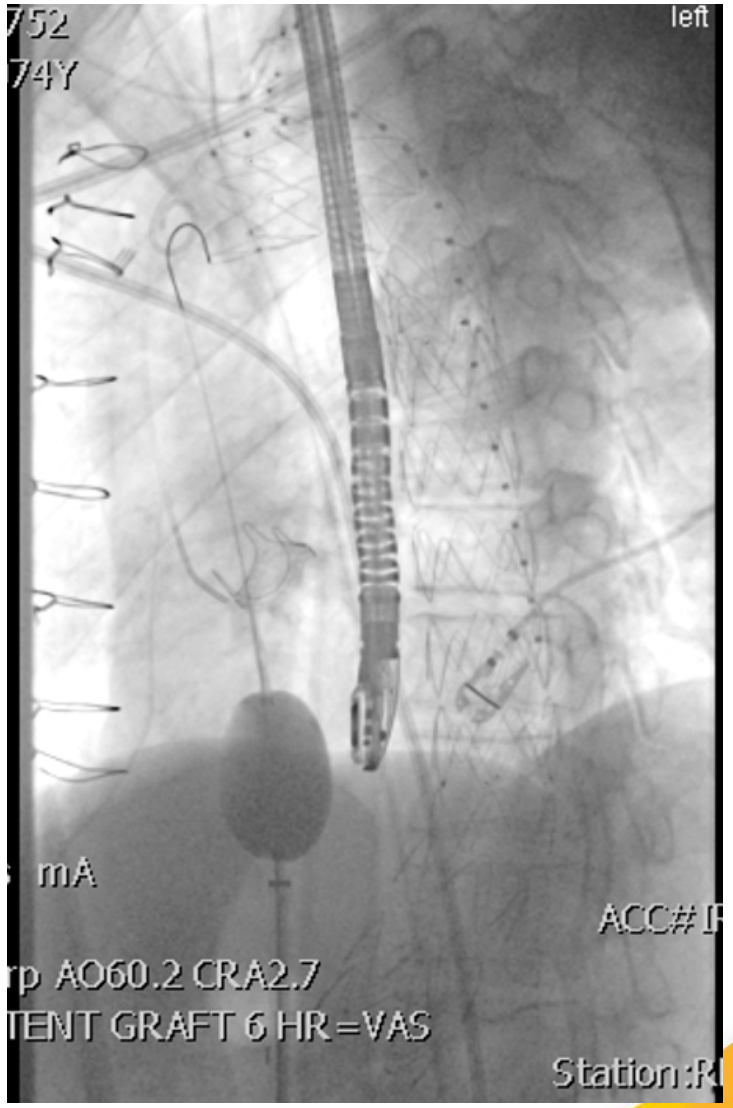


Figure 1. The aortic zones of attachment. Adapted from Fillinger et al.[8]

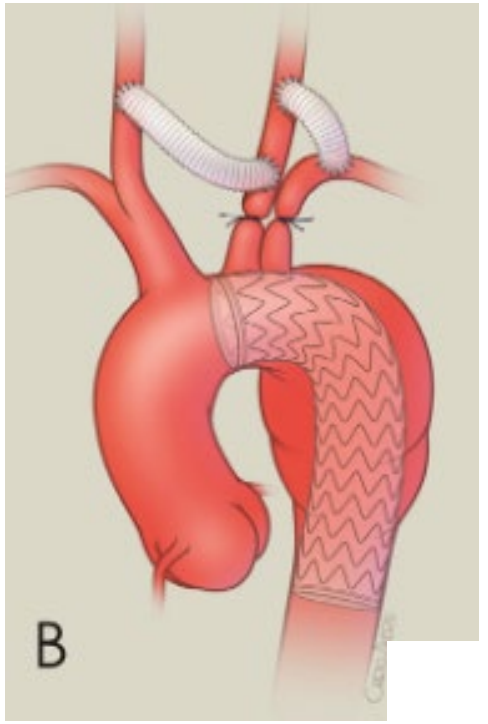
Intraoperative Adjuncts

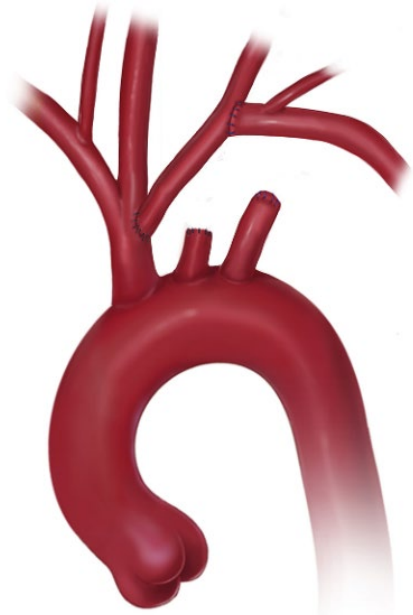
- TEE +/- IVUS
- Aortic impulse control
  - Partial right atrial inflow occlusion
  - Rapid ventricular pacing
  - Adenosine induced asystole
- Spinal drainage
  - For those with planned extension past T8
  - Previous perivisceral or aortic surgery
- Supra-aortic debranching and access



Supra-aortic Debranching

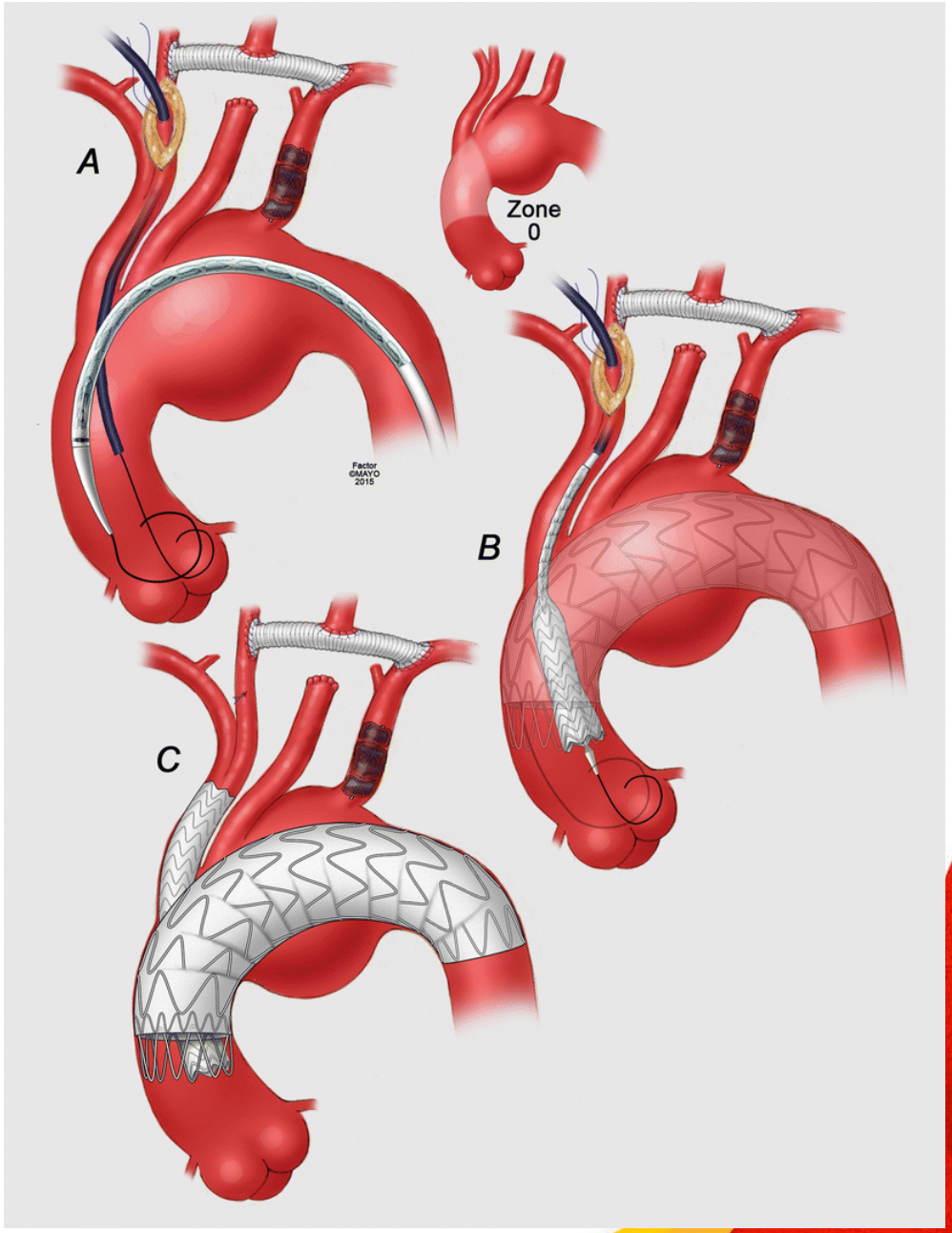
- Most commonly a carotid-carotid-subclavian bypass
- or carotid-carotid transposition with a L subclavian bypass.
- High patency (92% at 10 years)
  - occlusions usually carotid subclavian component and are asymptomatic
- 1% risk of stroke with isolated left C-S bypass, 2-3% with two vessel bypass
- Dysphagia can persist in 20%





Parallel Grafts

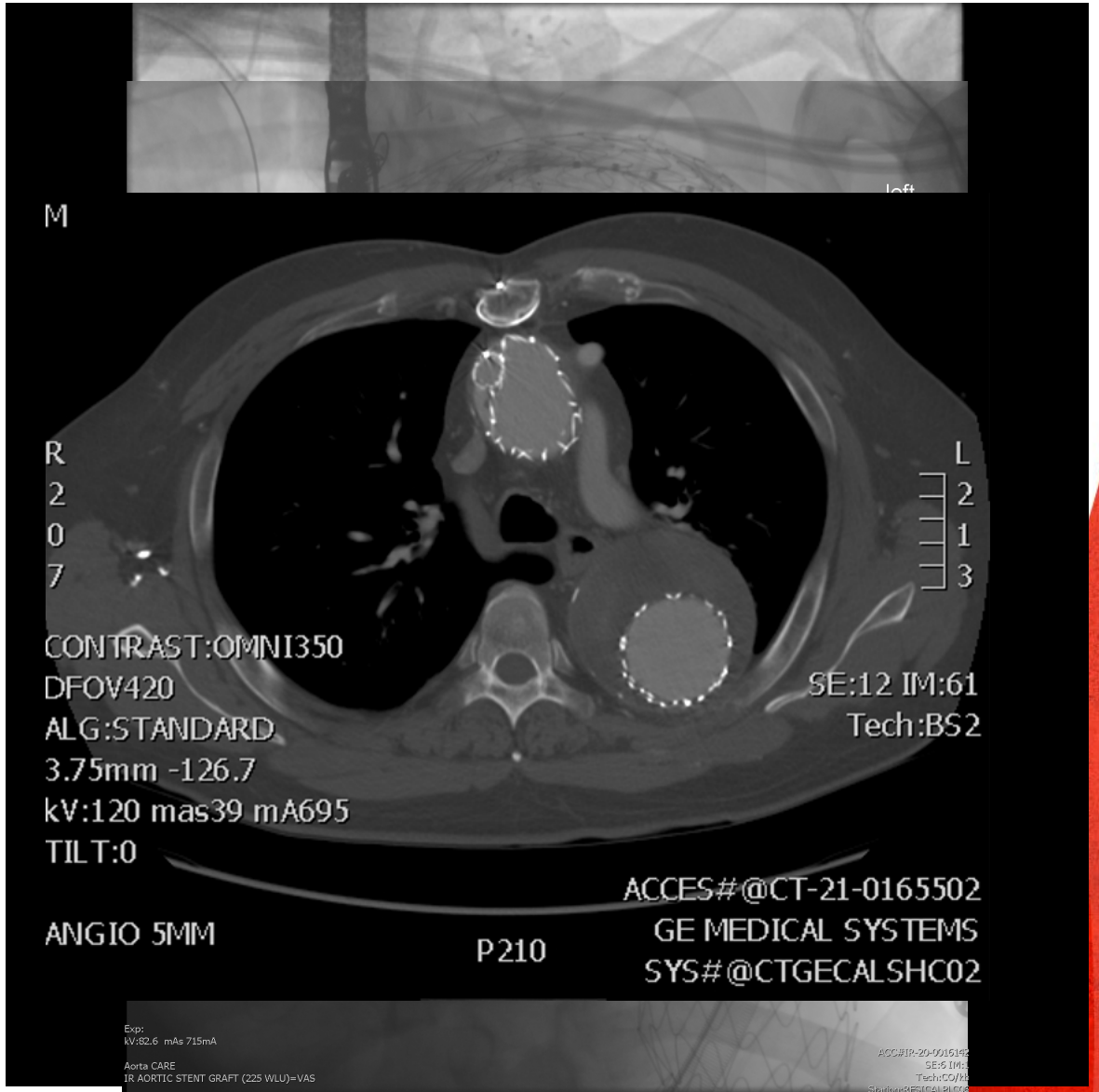
- Use of **off the shelf** covered stents to reconstruct branches in parallel with aortic component.
- A TEVAR is placed alongside this stent(s) with the goal of excluding flow from the aneurysm sac and preserving flow into the supra-aortic vessel(s)
- One major limitation is persistent Type 1A endoleaks (5-44%)
  - some resolve spontaneously but can persist in 10-15%



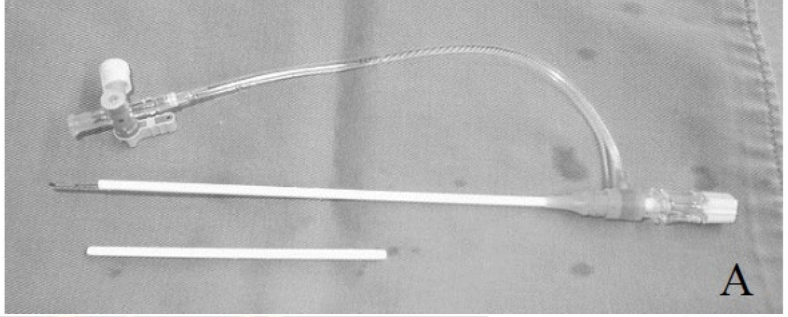
Endovascular Aortic Repair *(2017) 1st ed, G Oderich*

Zone 0 TEVAR with BCT Parallel Graft

- 65Y male with previous Bentall for Type A dissection
- Previous Zone 1 TEVAR with C-C-S debranching
- Proximal DTA chronic dissection aneurysm growing with concern for Type 1A endoleak.
- Unfit for redo ascending repair and decision made to extend into ascending (Zone 0) with BCT stent



In Situ Fenestration

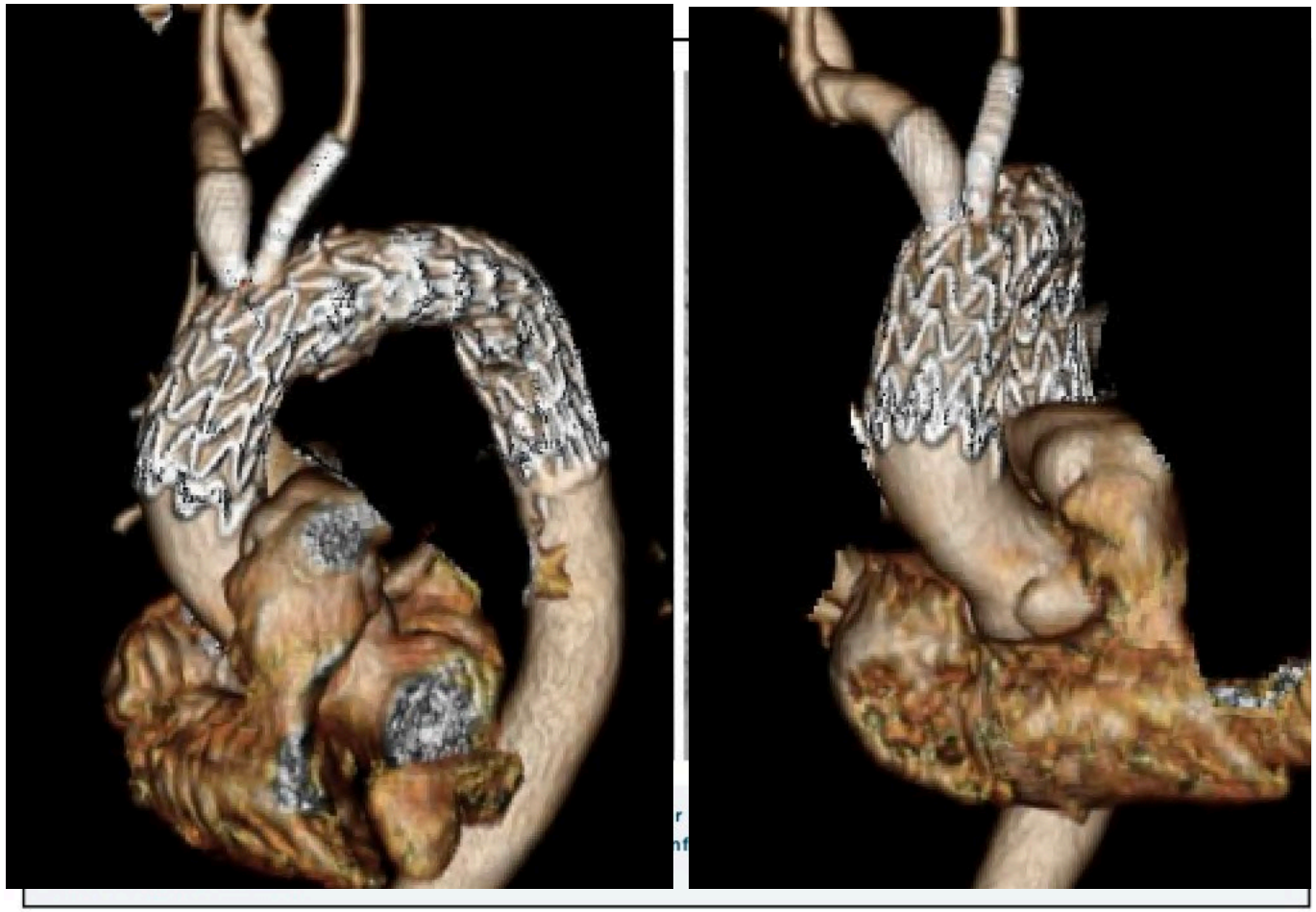


- Require some sort or cerebral perfusion while graft being deployed and fenestrated
  - Gutter balloon or extracorporeal circulation
- Fenestrations are not reinforced and can tear or fracture.
  - This is because they can be non-circumferential
  - Leads to difficult to manage Type III endoleaks (10-20%)
- Advantage is use of off the shelf non-custom devices

Images from Ohki *et al. JVS* 2021

In Situ Fenestration – Aorto-Bronchial Fistula

- 85 Y male, hemoptysis
- Recent *S. aureus* bacteremia
- Independent living at home
- Found to have Zone 1 mycotic aortic arch aneurysm
- Turned down for open repair
- Offered repair with insitu fenestration
- Post op stoke with recovery to mRS 2, back at home, walks with walker, 1 year out with aneurysm regressing
  - Died in February, urosepsis



Physician Modified Endografts

- Back table modifications of current off the shelf TEVAR devices.
  - Modifications done based on clinician's interpretation of CT scan and extrapolation to device.
- They are then re-constrained to delivery system and deployed with proper orientation.
- Require experience with technique and precise deployment.

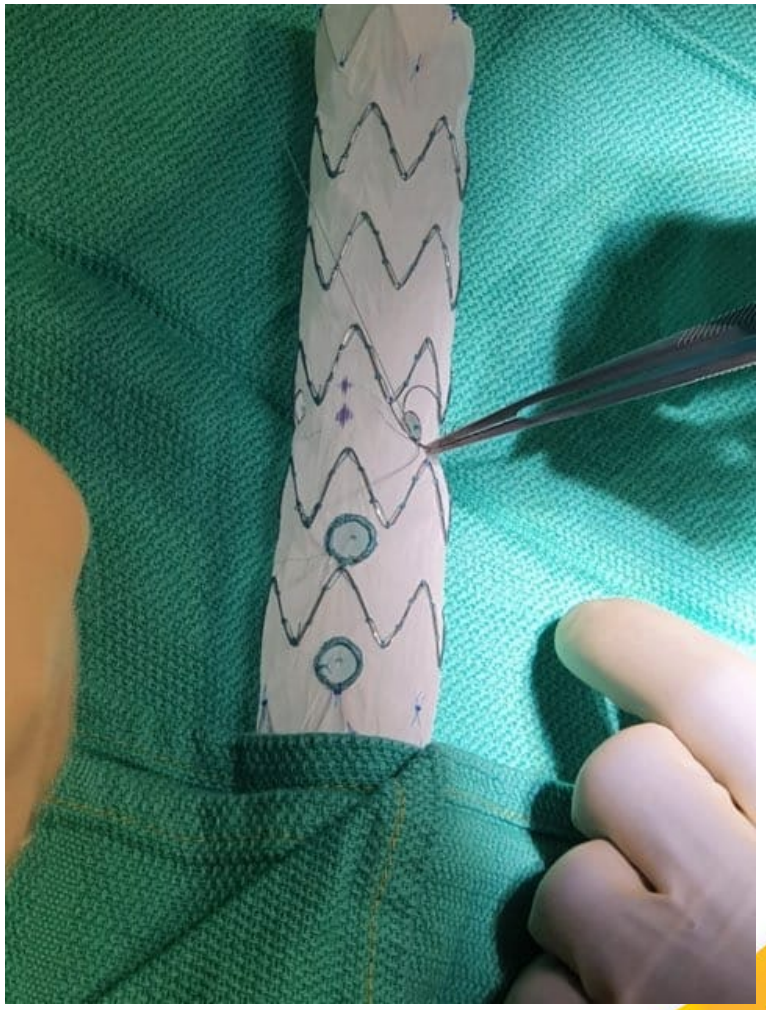
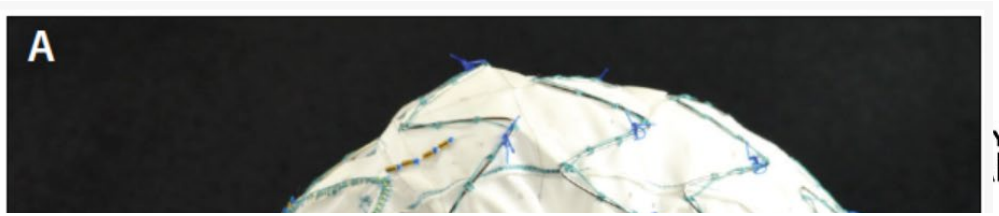
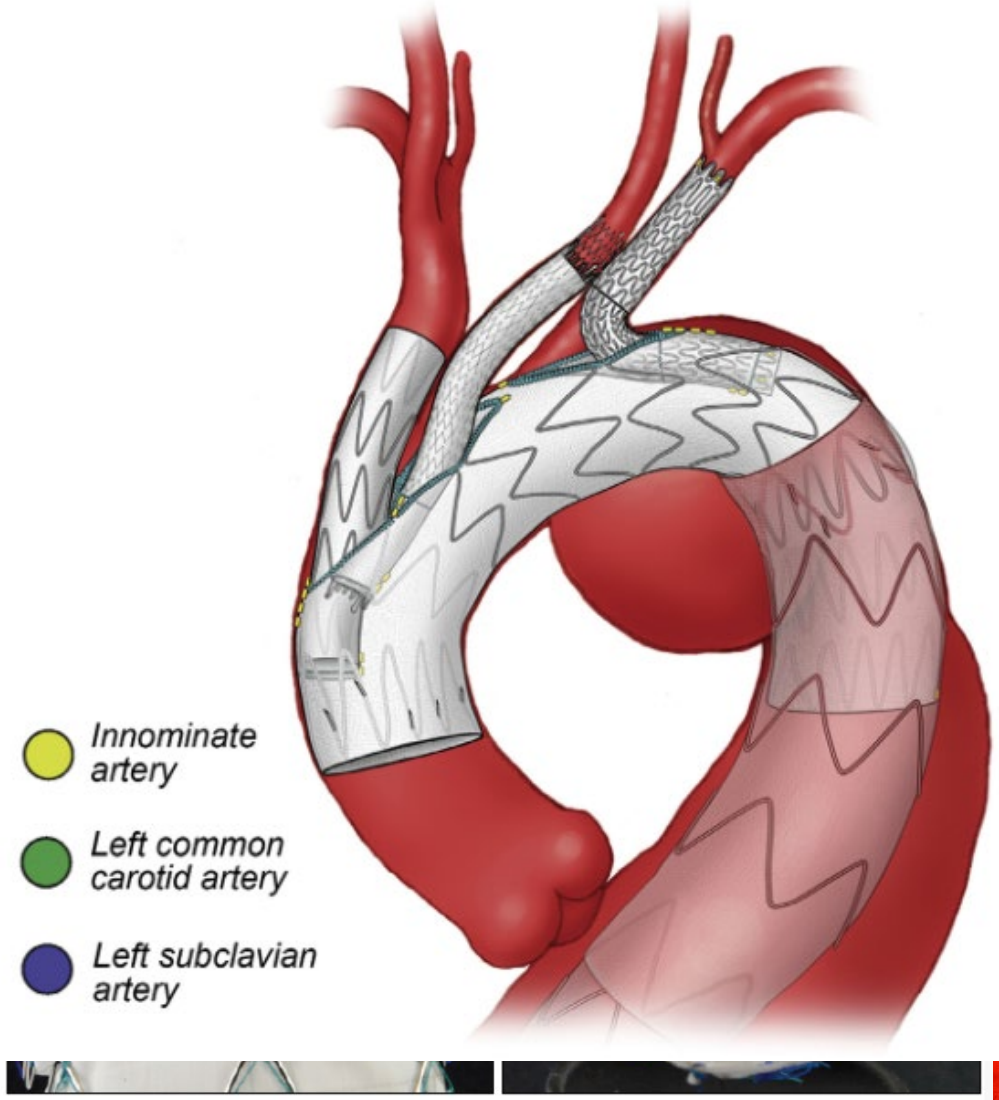


Photo courtesy of Tommaso Cambiaghi and Gustavo Oderich, ***University of Texas Health Science Center at Houston***

Cook Zenith Branched Arch Endo



- Most used to date, hundreds of implants worldwide
- Custom made device
  - Requires time to order and build
  - Antegrade or retrograde branches (IA and LCC) with option for retrograde 3rd branch (LSA)
- Health Canada Special Access
- Requires 22-26 Fr access, aortic diameter <38 mm for proximal landing zone

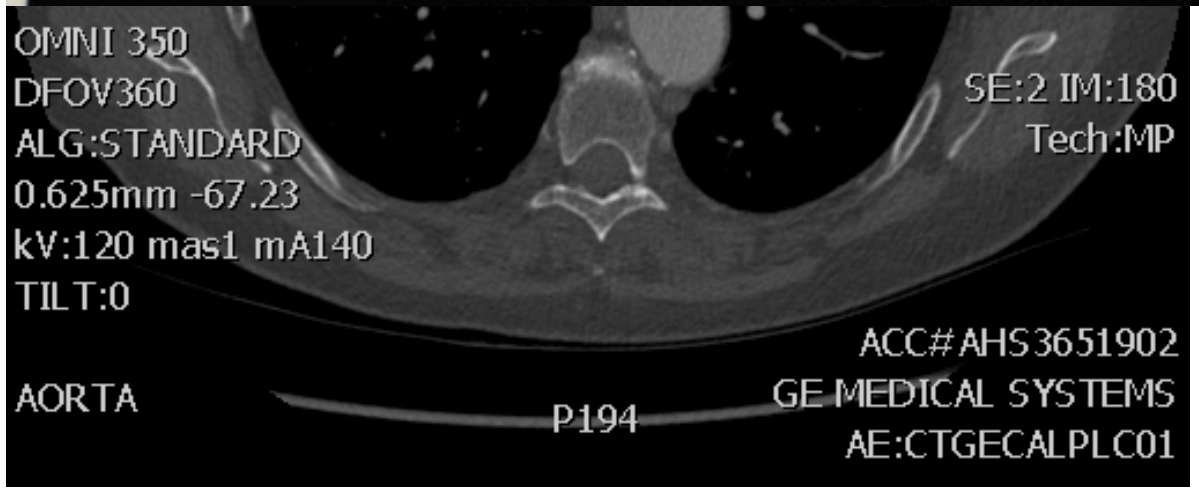


https://evtoday.com/articles/2018-nov/current-status-of-arch-branch-technology

GORE Thoracic Branch Endoprosthesis (TBE)

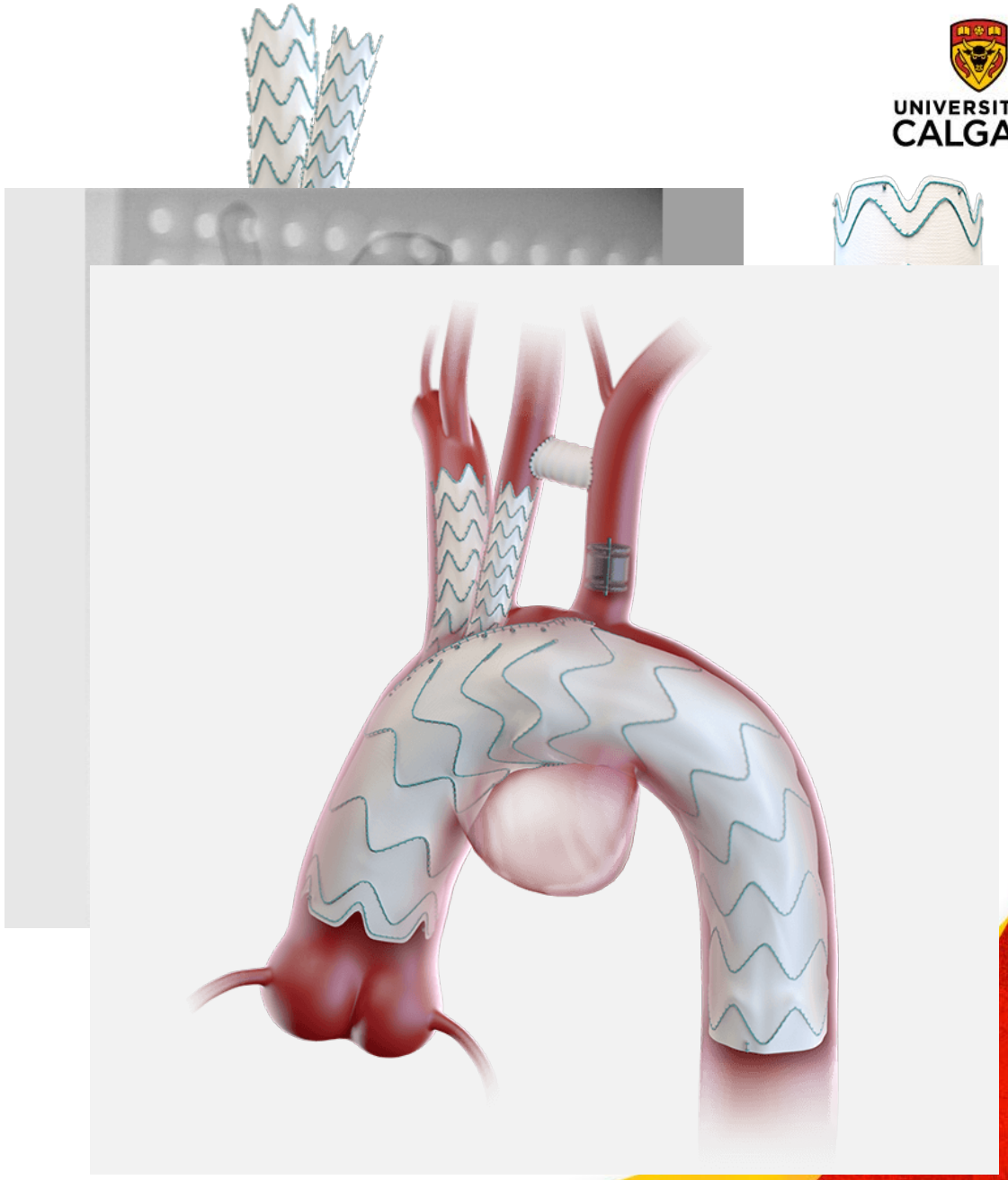
- Single branch device
- Available in Zone 2 (8mm portal) and Zone 0 (12mm portal) configurations
- Thoracic and side branched component delivered from femoral access
- Requires 22-26 Fr access, can treat 16 to 42mm diameter aorta, 6 to 18mm branches
- Health Canada **approved**

GORE Thoracic Branch Endoprosthesis (TBE)



Terumo Aortic Relay Branch

- Custom device with usually 2 antegrade branches – avoids C-C bypass
  - Can be custom configured for 1 or 3 branches (1 or 2 ante and 1 or 2 retrograde)
- Large branch portal facilitates cerebral perfusion and easy cannulation
- Dual sheath technology for easier aortic arch trackability
- Requires 22-26Fr access
- Health Canada special access



Zone 0 Relay Double Branch

- 74Y male previous Type A with Bio-Bentall and ascending replacement, LVEF now 30%
- Chronic dissection aneurysm with Zone 2 TEVAR and C-S bypass
- Type 1A endoleak with growing proximal DTA aneurysm

NEXUS Aortic Arch Stent Graft System

- Modular single branch arch stent graft
  - Different in that “branch” is the ascending aortic module
- Requires rapid ventricular pacing or caval inflow occlusion for deployment
- Would require supra-aortic (carotid-carotid-subclavian) debranching
- Currently Health Canada Special Access
- Also available in **Duo** and **Tre** configurations

https://www.jotec.com/en/products/thoracic-stent-grafts/nexus-by-endospan.html

Outcomes

- 39 pa
- ASA c
- Techr
- 30 da
- Majo
- Reint

Table IV. Early and late secondary interventions (n = 39)

		Secondary intervention		
Pt. No.	Aneurysm etiology	Timing, days	Reason	Description
Early secondary intervention, <30 days				
1[a]	Postdissection	6	Type II endoleak from RSA	Surgical ligation of RSA proximal to vertebral artery
2	Postdissection	2	Bilateral cervical hematoma	Surgical evacuation
3	Postdissection	1; 12	Left cervical hematoma; type Ic endoleak from the IA	Surgical evacuation; redo stenting with extension to RCCA
4	Postdissection	7	Flow limiting dissection of RCCA	Graft interposition of RCCA
5	Postdissection	7	Left cervical hematoma	Surgical evacuation
6[b]	Degenerative	11	Pseudoaneurysm	Patch angioplasty
7	Degenerative	12	Iliac thrombosis	Open thrombectomy
Late secondary intervention, >30 days				
8	Postdissection	119	Type Ic endoleak from IA and false lumen perfused	Redo stenting of IA and embolization of aortic false lumen using coils and Amplatzer plugs
9[a]	Postdissection	308; 661	False lumen perfused; type Ia and Ib endoleaks	Embolization of aortic false lumen; TEVAR plus false lumen occlusion with candy plug and endoanchors at proximal sealing zone
10	Postdissection	84	False lumen perfused at level of dissected IA/RCCA	Banding at level of RCCA and IA
11	Postdissection	179	False lumen perfused at level of dissected IA	False lumen embolization
12	Postdissection	503	Stent kink of left carotid branch	Reinforcement with new stent
13[b]	Degenerative	34	Type IIIc endoleak from LSA	Redo with VBX stent-graft
14	Postdissection	223	Aortic ulcer	TEVAR

IA, Innominate artery; *LSA*, left subclavian artery; *Pt. No.*, patient number; *RCCA*, right common carotid artery; *RSA*, right subclavian artery; *TEVAR*, thoracic endovascular aortic repair.
[a]Same patient.
[b]Same patient.

Outcomes

Canadian Journal of Cardiology 39 (2023) 49–56

Systematic Review/Meta-analysis

A Systematic Review of Total Endovascular Aortic Arch Repair: A Promising Technology

Ameen M. Basha, MD,[a] Randy D. Moore, MD, FRCSC,[b] Kenton L. Rommens, MD, FRCSC,[b] Eric J. Herget, MD, FRCPC,[c] and R. Scott McClure, MD, SM, FRCSC[a]

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Table 4. Comparison of the pooled analysis from Table 3 and results from the outcome meta-analysis

Outcome	Meta-analysis (95% CI)	Pooled crude data
Mortality	15.6% (8.7%-26.3%)	11.1%
CVA	14.0% (7.6%-24.3%)	9.5%
MI	3.7% (1.9%-7.1%)	3.5%
PVE	7.3% (1.2%-33.3%)	7.5%
Endoleaks	13.3% (6.6%-25.2%)	13.2%
Dissection	3.0% (0.3%-21.5%)	2.9%
Procedure success	92.5% (85.8%-96.3%)	93.6%

9% Type 1 or 3

Case Workup and Unique Complications

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Workup

- Previous cardiac surgery
  - CABG? Proximal graft anastomosis
  - Prosthetic aortic valve- ?mechanical
- Valvular pathology
  - Anticipated futu
- Corona
- aortic disease
  - root dimensions?
  - Previous graft? Kinking? Landing zone angles?

Complications

- Coronary partial coverag
  - Stent? ECMO?
- Valv
- ation
  - Sternotomy? Many patients have had previous cardiac surgery
  - Not easy for ascending crossclamp
  - Aortic cannulation?
- Pericardial tamponade
  - Sternotomy?
- Arrythmias
  - Pacing?

Have a Plan!... Make it with friends...

Future Directions – Multidisciplinary Care

Canadian Journal of Cardiology 39 (2023) 1484–1498

General Clinical Practice Update

The Aortic Team Model and Collaborative Decision Pathways for the Management of Complex Aortic Disease: Clinical Practice Update From the Canadian Cardiovascular Society/Canadian Society of Cardiac Surgeons/Canadian Society for Vascular Surgery/Canadian Association for Interventional Radiology

R. Scott McClure, MD, SM, (Co-Chair),[a] Thomas F. Lindsay, MDCM, MSc, (Co-Chair),[b] Michelle Keir, MD, (Co-Chair),[a] Jason P. Bayne, MD,[c] Robert F. Berry, MD,[d] Michael W.A. Chu, MD, MEd,[e] Jennifer C.-Y. Chung, MD, MSc,[b] Francois Dagenais, MD,[f] Robin A. Ducas, MD,[g] Audra Duncan, MD,[e] Gabrielle Horne, MBBS, MRCP(UK), PhD,[d] Darren Klass, MBChB, MD, MRCS,[h] François-Pierre Mongeon, MD, SM,[i] Julie Richer, MD,[j] and Kenton L. Rommens, MD[a]

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Future Directions – Ascending Stent Grafts

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Figure 2. Completion angiogram demonstrates successful exclusion of the ascending aortic pseudoaneurysm and continued patency of the coronary arteries.

Figure 3. Follow-up computed tomographic angiogram demonstrates a decrease in the size of the ascending aortic pseudoaneurysm without evidence of endoleak.

Future Directions – Ascending Stent Grafts

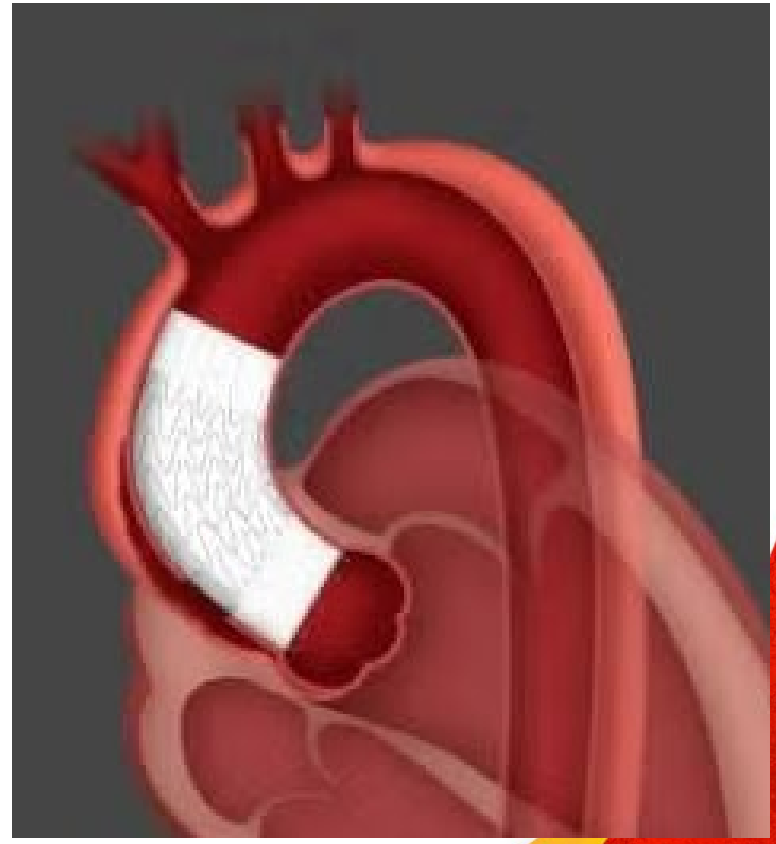
Evaluation of the GORE® Ascending Stent Graft (ARISEII)

ClinicalTrials.gov ID NCT05800743

Sponsor W.L.Gore & Associates

Information provided by W.L.Gore & Associates (Responsible Party)

Last Update Posted 2025-03-10

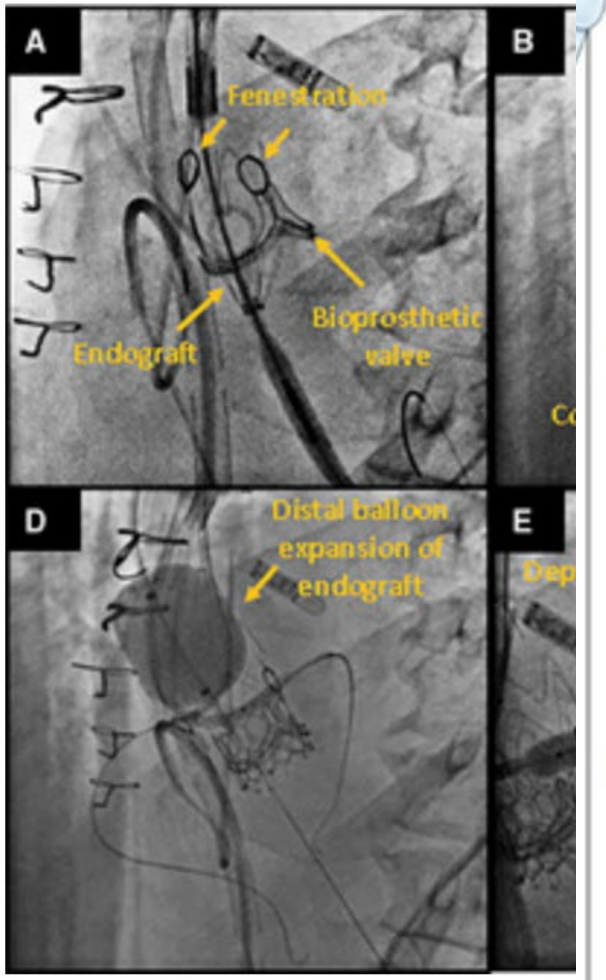


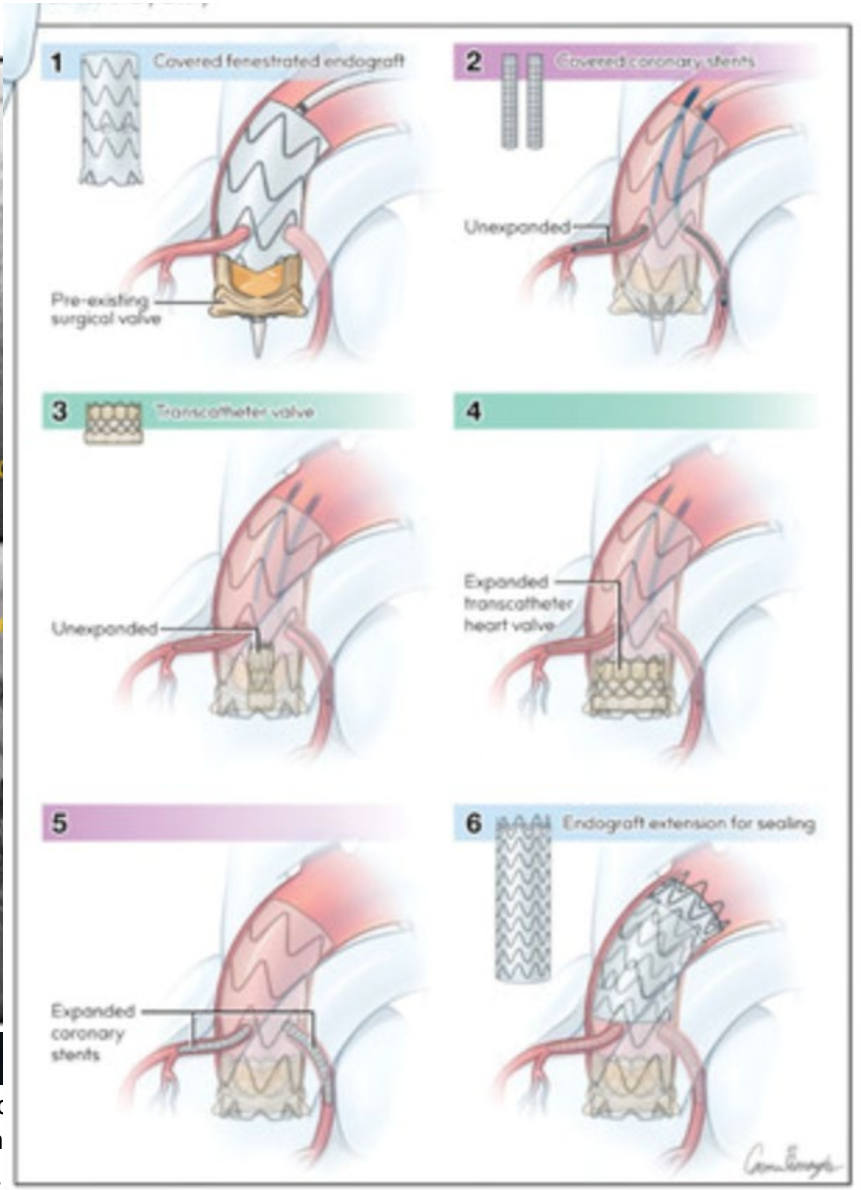
- **ARISE I**
- 15.8% 30-day mortality, 5.3% stroke
- Only 15-20% of patients assessed are on IFU
  - Usually due to lack of proximal landing zone

Roselli *et al.*, Journal of Endovascular Therapy 2023, Vol. 30(4) 550 –560

Future Directions – From Valve to Bifurcation

- Aortic valve – TAVR with coronary branches or fenestrations?
- Ascending Aortic Stent Grafts
- Total Endovascular Arch Repair
- DTA - TEVAR
- Perivisceral Aorta - FEVAR or BEVAR
- Infrarenal Aorta and bifurcation – EVAR
- Iliac Bifurcation – IBE grafts





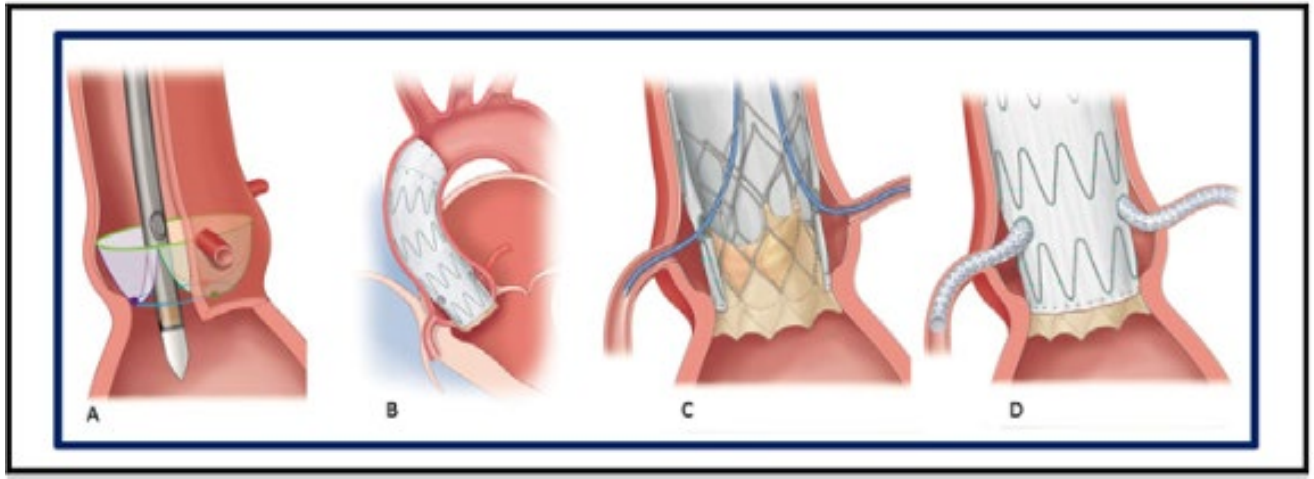
Leshnower BG, Duwayri YM, Nicholson WJ, Ueyama H, Gleasc
Using Off-the-Shelf Catheter Devices to Repair an Aorto-Atria
10.1161/CIRCINTERVENTIONS.122.012848. Epub 2023 Apr 3.

Future Directions – Endo-Bentall

Endo-Bentall repair: Early results and feasibility of a physician-constructed Endo-Bentall device

Mehrdad Ghoreishi, MD,[a] Aakash Shah, MD,[b] Diljon Chahal, MD,[c] Jeanwan Kang, MD,[d] Anuj Gupta, MD,[c] Bradly S. Taylor, MD,[b] and Shahab Toursavadkohi, MD[d]

- 8 patients
- 0% 30-day mortality, 0% stroke
- 1 permanent pacemaker
- 0% Type 1A endoleak
- 20% Type 1B endoleak



Endo-Bentall repair using a self-expanding trans-catheter valve-carrying conduit.

Ghoreishi *et al.,* J Thorac Cardiovasc Surg. 2025 Jan 15:S0022-5223(25)00028-5

Conclusions

- Total endovascular aortic arch repair (TEAAR) is an increasingly feasible technique for arch repair.
- Stroke risk mitigation is paramount.
- Much like F/B-EVAR there is a learning curve for both surgeon and institution.
- Multidisciplinary case planning and execution is key.
- Endoleaks can be difficult to treat.
- Important to have a full understanding of patient's structural heart disease prior to TEAAR.

Eur J Vasc Endovasc Surg (2019) 57, 165–198

Editor's Choice — Current Options and Recommendations for the Treatment of Thoracic Aortic Pathologies Involving the Aortic Arch: An Expert Consensus Document of the European Association for Cardio-Thoracic Surgery (EACTS) & the European Society for Vascular Surgery (ESVS)

Martin Czerny [a,*], Jürg Schmidli [a], Sabine Adler [a], Jos C. van den Berg [a], Luca Bertoglio [a], Thierry Carrel [a], Roberto Chiesa [a], Rachel E. Clough [a], Balthasar Eberle [a], Christian Etz [a], Martin Grabenwöger [a], Stephan Haulon [a], Heinz Jakob [a], Fabian A. Kari [a], Carlos A. Mestres [a], Davide Pacini [a], Timothy Resch [a], Bartosz Rylski [a], Florian Schoenhoff [a], Malakh Shrestha [a], Hendrik von Tengg-Kobligk [a], Konstantinos Tsagakis [a], Thomas R. Wyss [a]

Recommendation 30		
Endovascular aortic arch repair in zone 0 should be considered in patients unfit for open surgery and with a suitable anatomy		
Class	**Level**	**References**
IIa	B	[199,203]

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