

# **Thoracic Aortic Aneurysm Repair: No Incisions Necessary**

**Joseph E. Bavaria, M.D.**

**Brooke Roberts-William M. Measey**

**Professor of Surgery**

**Vice-Chief, Division of Cardiovascular Surgery**

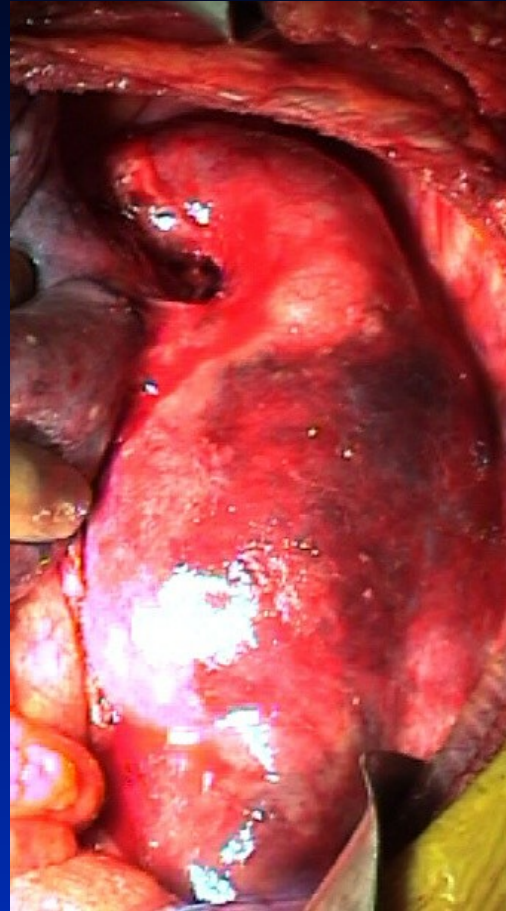
**Director, Thoracic Aortic Surgery Program**

**Hospital of the University of Pennsylvania**

Department of Surgery, University of Pennsylvania Health System



# Classic Surgical Open Procedure





MI:0.5  
6.2/5.0T2  
07 JAN 97  
13:20:48  
PROC 2/1/E  
UNIVERSITY OF  
PENNSYLVANIA  
DEPT OF ANESTH

015357452  
T655  
ATC/OLD  
0:27:33  
GAIN 56  
CAL 2 1 1

PAT T: 37.0C  
TEE T: 38.0C

Cephalad

(hp)

DESCENDING Ao  
Long Axis View  
with Intraluminal  
Elephant Trunk  
Graft (arrows)

0 0 180

Caudad



CONFORMANCE BY DESIGN

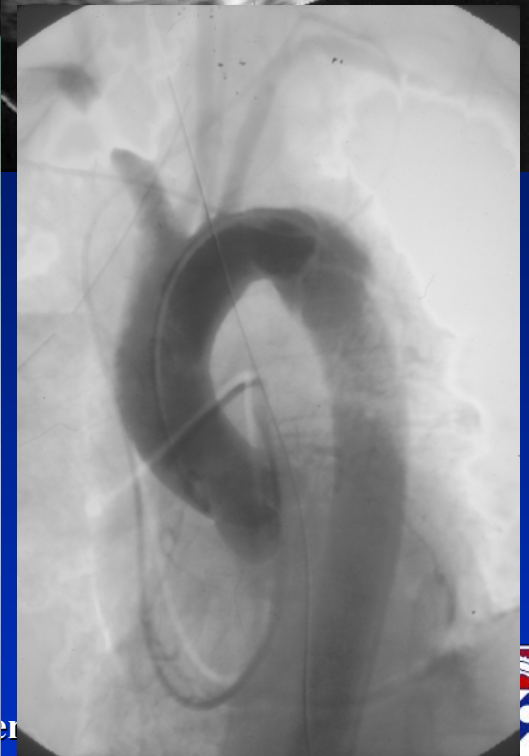
TALENT™

WORLD MEDICAL

Thoracic  
Stent-Graft System

Illustration of an  
excluded descending  
thoracic aortic aneurysm  
with the TALENT™  
Endoluminal  
Stent-Graft System

WORLD MEDICAL



# Stent Graft Revolution





# Descending Thoracic Aneurysms (DTA)

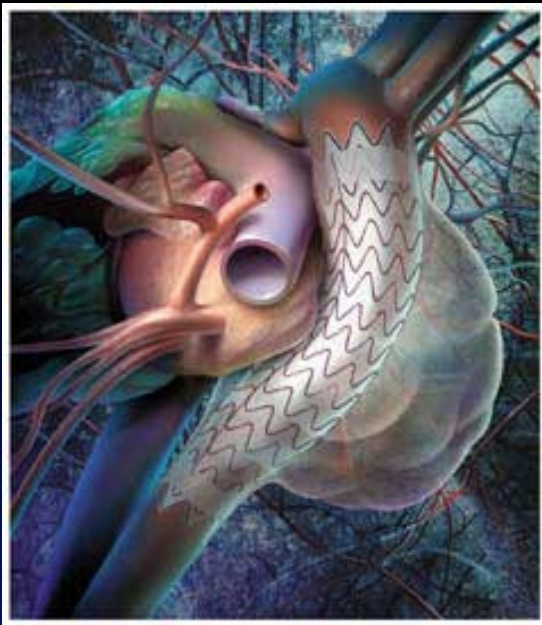


- ~ **15,000** new cases diagnosed each year
- Ruptured DTA aneurysms cause **2500** deaths per year in US
- **>5000** procedures per year for DTA repair
- Type B Dissection is **DOUBLE** these numbers

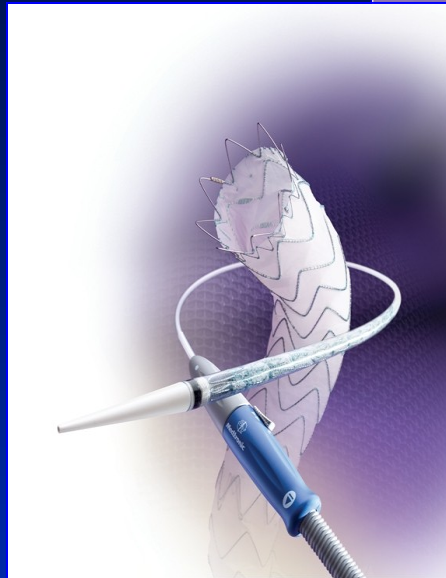
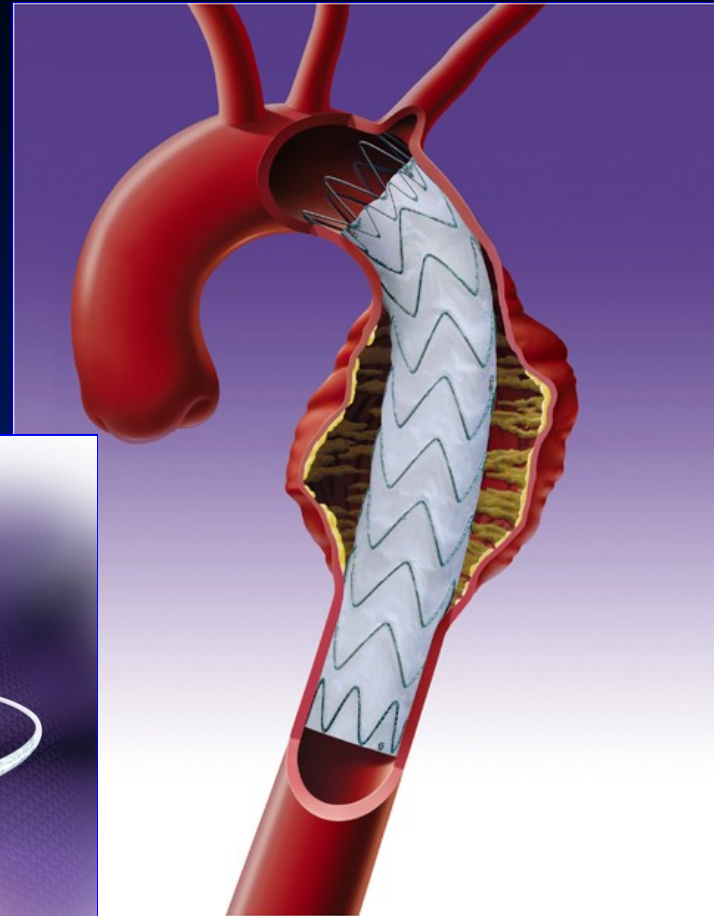




Gore  
TAG



Medtronic: Valiant



Cook  
Zenith  
TX2

New trials and Grafts on the horizon

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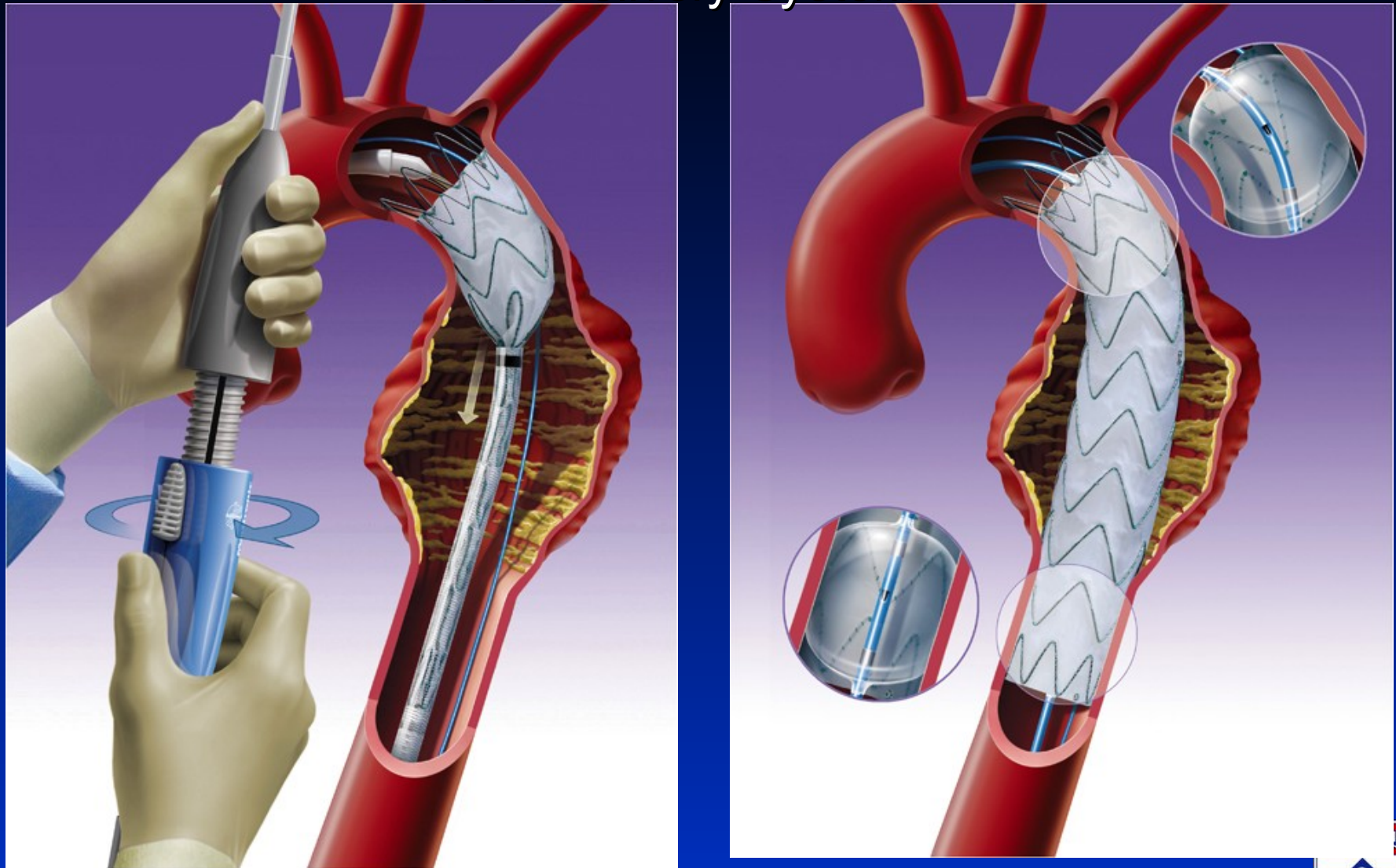
# Insertion and Positioning





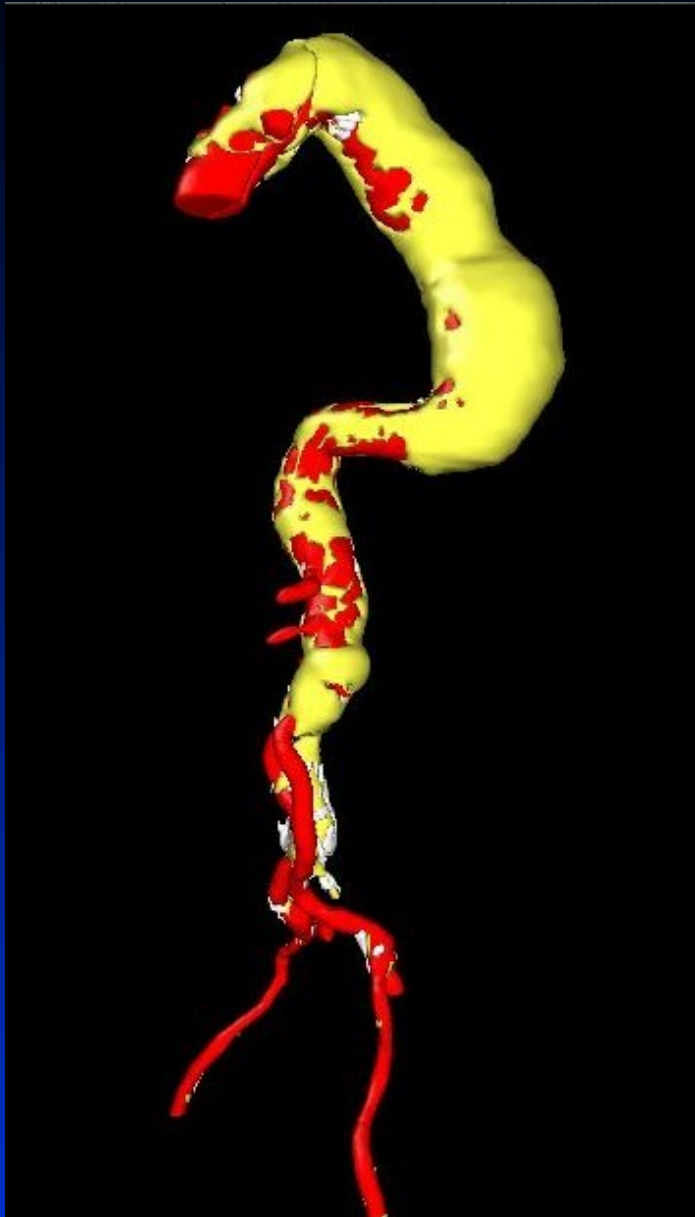
# Proximal Deployment and Completion

## New Delivery System





# Before and After Repair



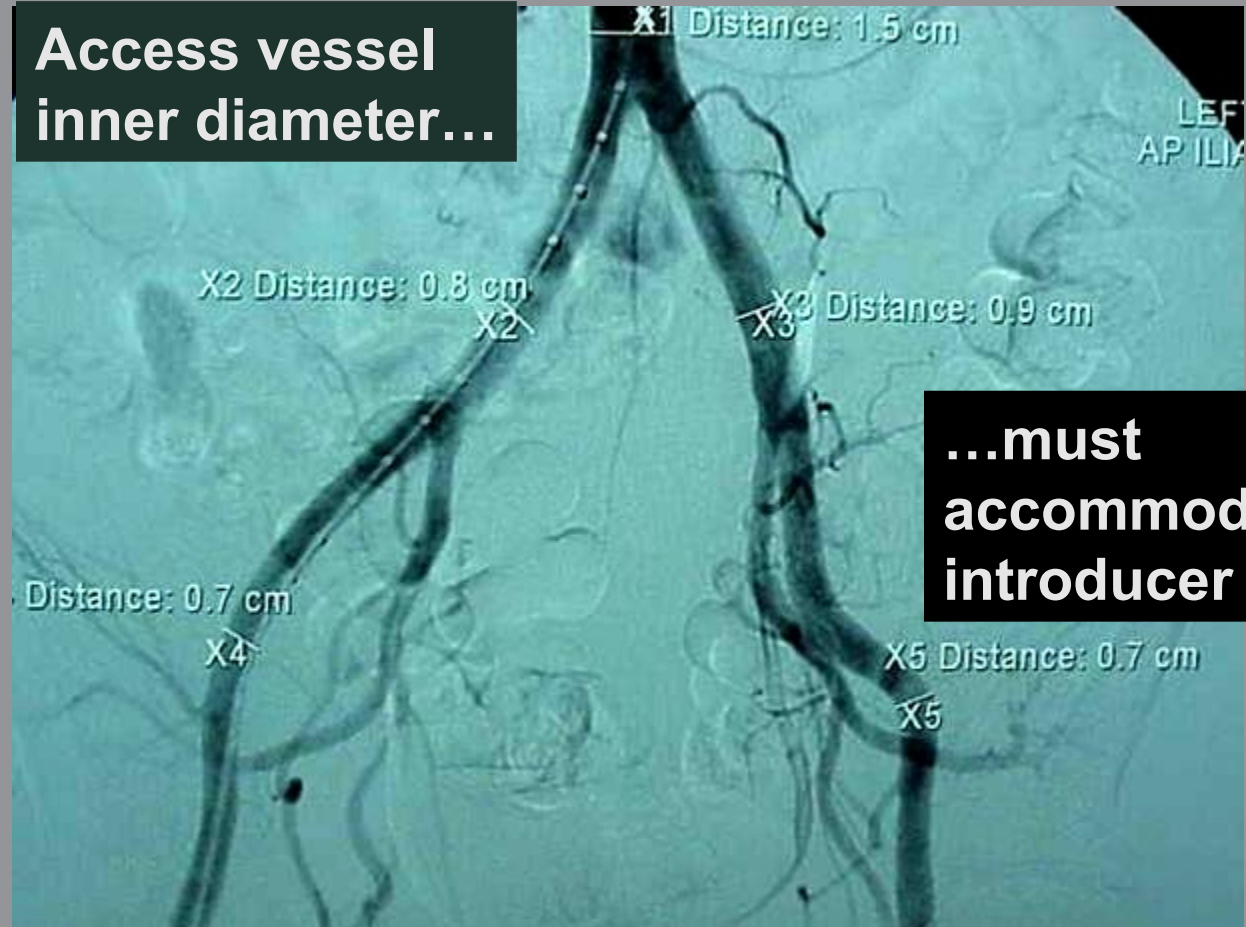
ent of Sur





# Adequate Access

Access vessel  
inner diameter...



...must  
accommodate  
introducer OD.

20F=6.9 mm

22F=7.5 mm

Investigational device, limited by federal (U.S.A.) law to investigational use.

TX2™  
Clinical  
Trial

COOK®

# Vascular Access Complications: Completely Avulsed External Iliac (Iliac on-a-stick)



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**Key Aortic Arch Anatomic Issues  
which are Important for  
Successful DTA Endograft  
Outcomes: Pitfalls and Nuances**

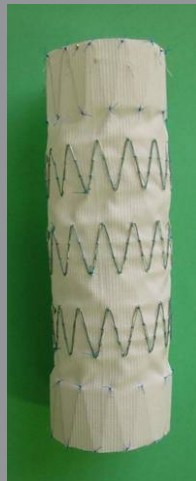
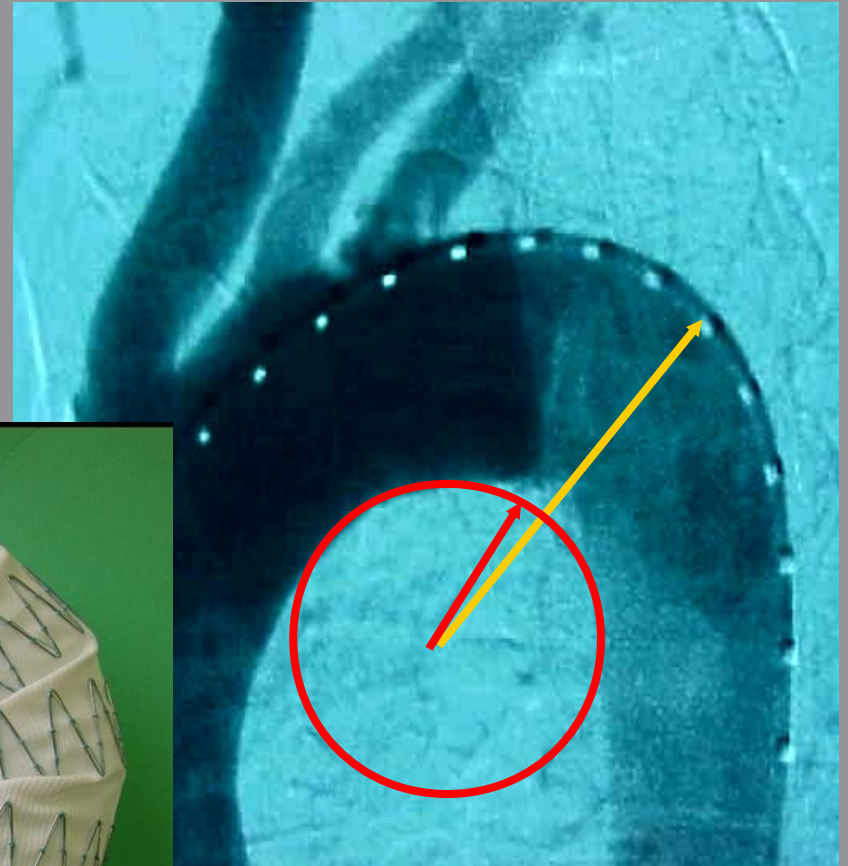




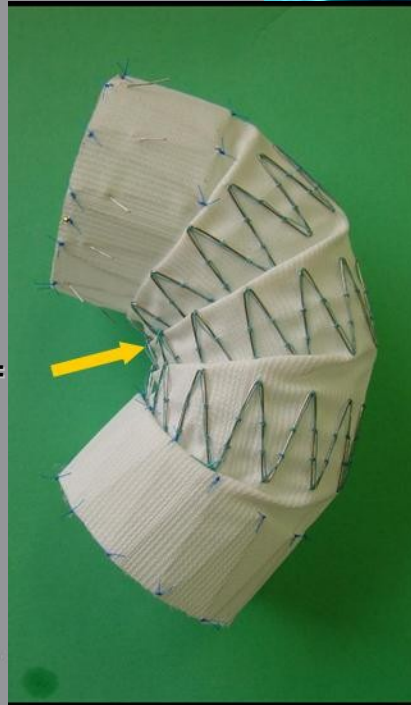
**Aortic Arch  
Inner Radius  
must be  
> 35 mm**

**Outer Radius  
Should be  
70 mm or  
Greater**

# Aortic Arch Radius



Radius=  
35 mm



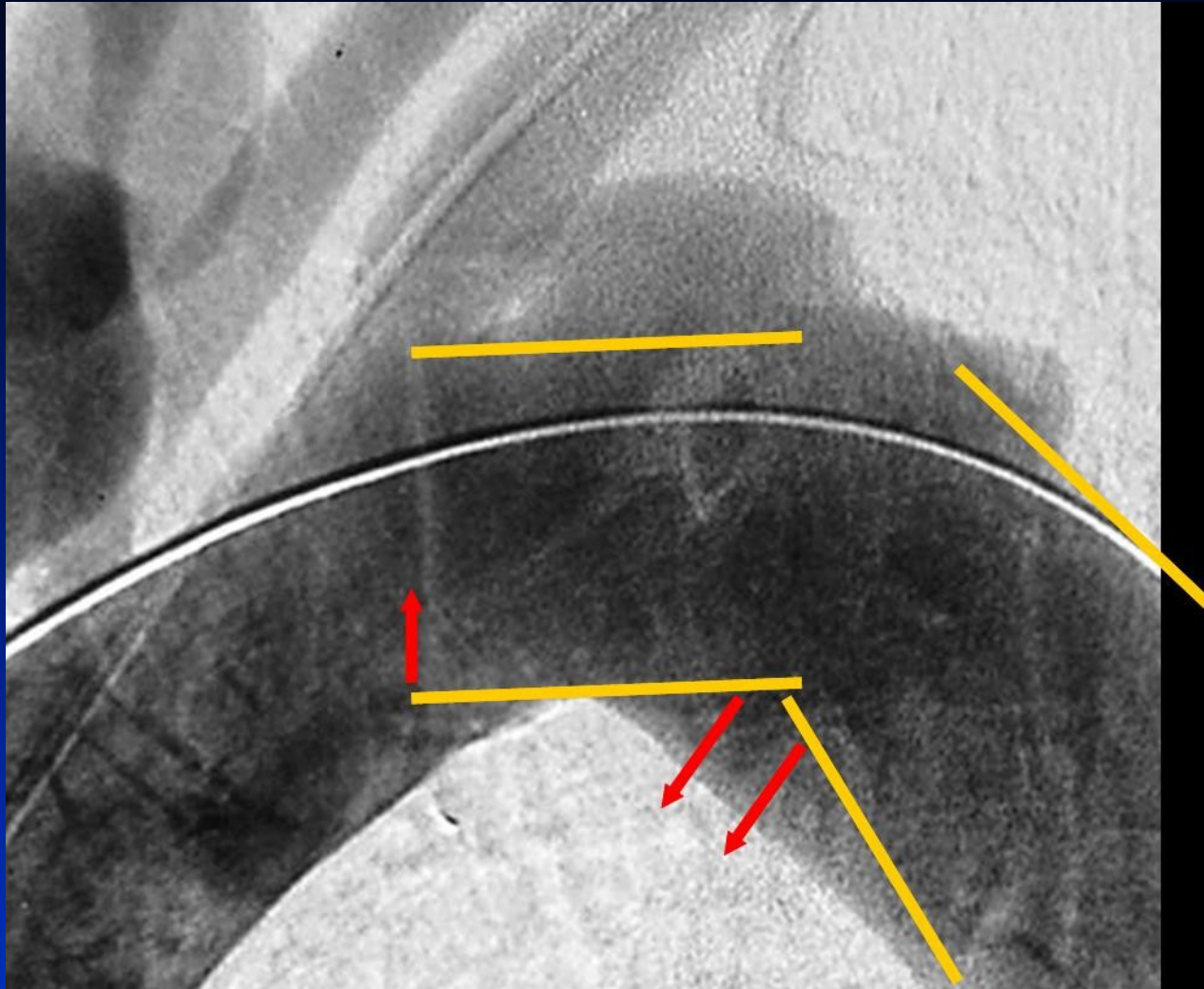
Investigational device,

o investigational use.

**TX2™  
Clinical  
Trial**

**COOK®**

# Arch LZ: Not Optimal

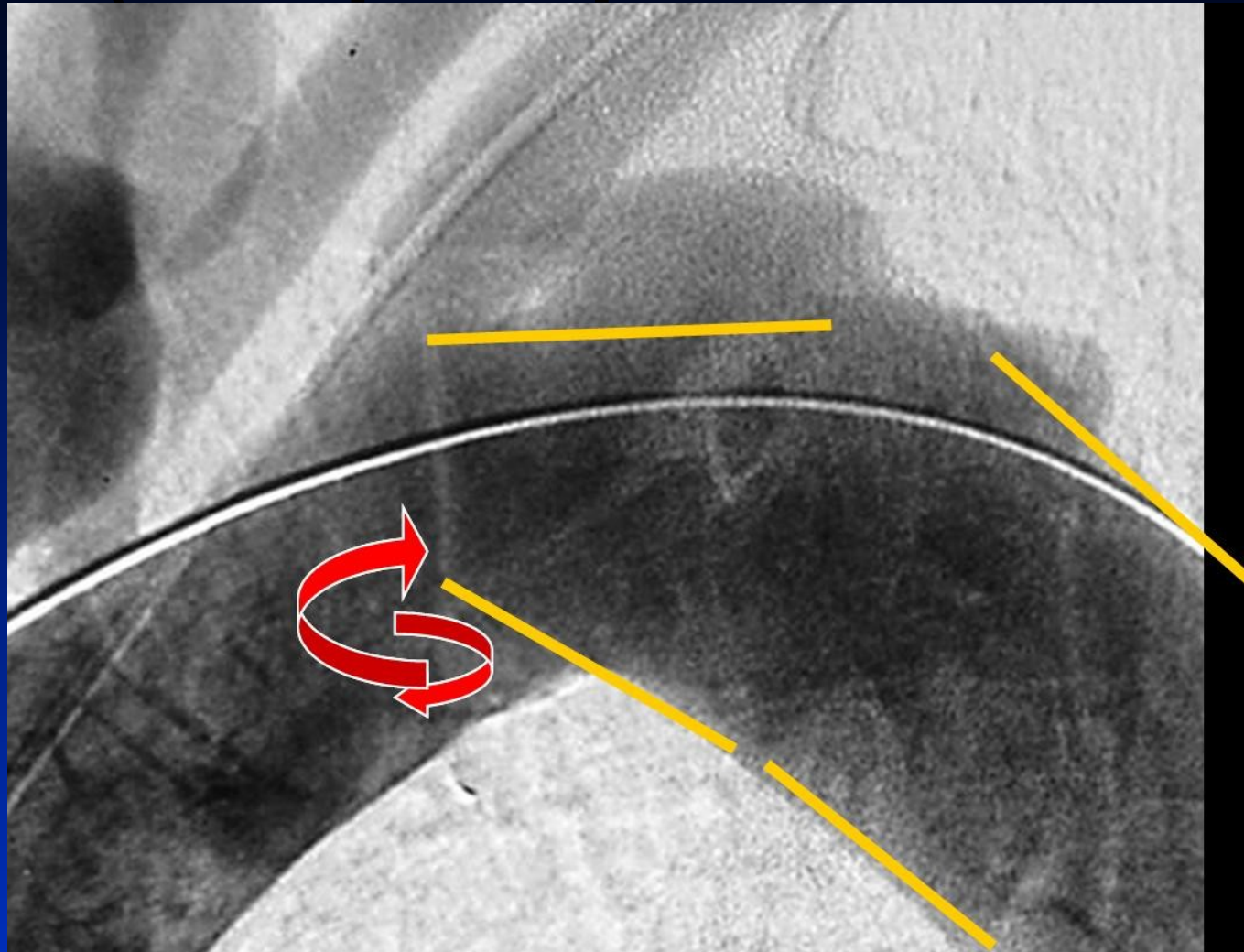


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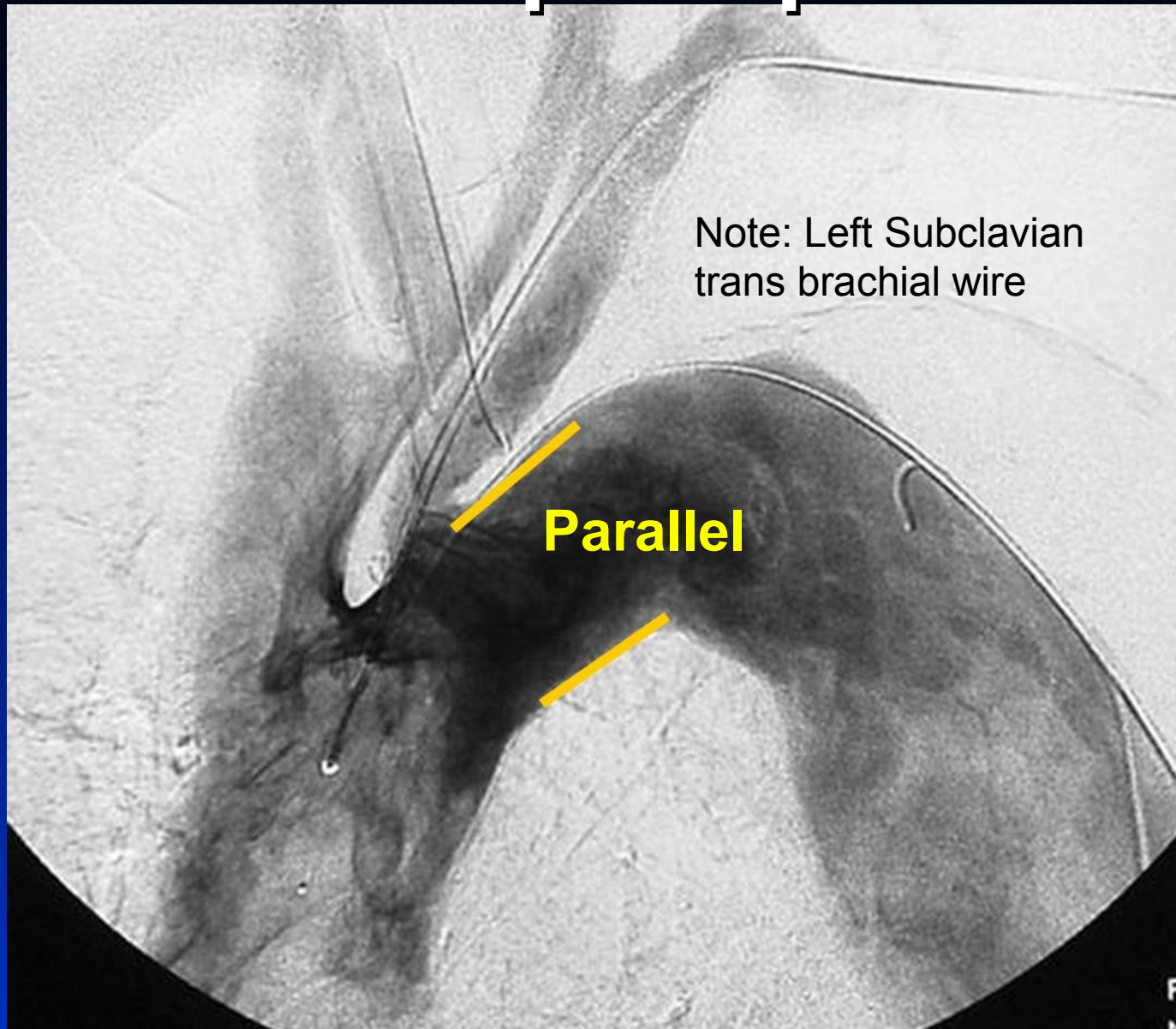
# Arch Neck Shape: Not Optimal (except Supra-Subclavian)



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# Neck Shape: Optimal



# **The Arch Branches:**

## **The Left Subclavian**

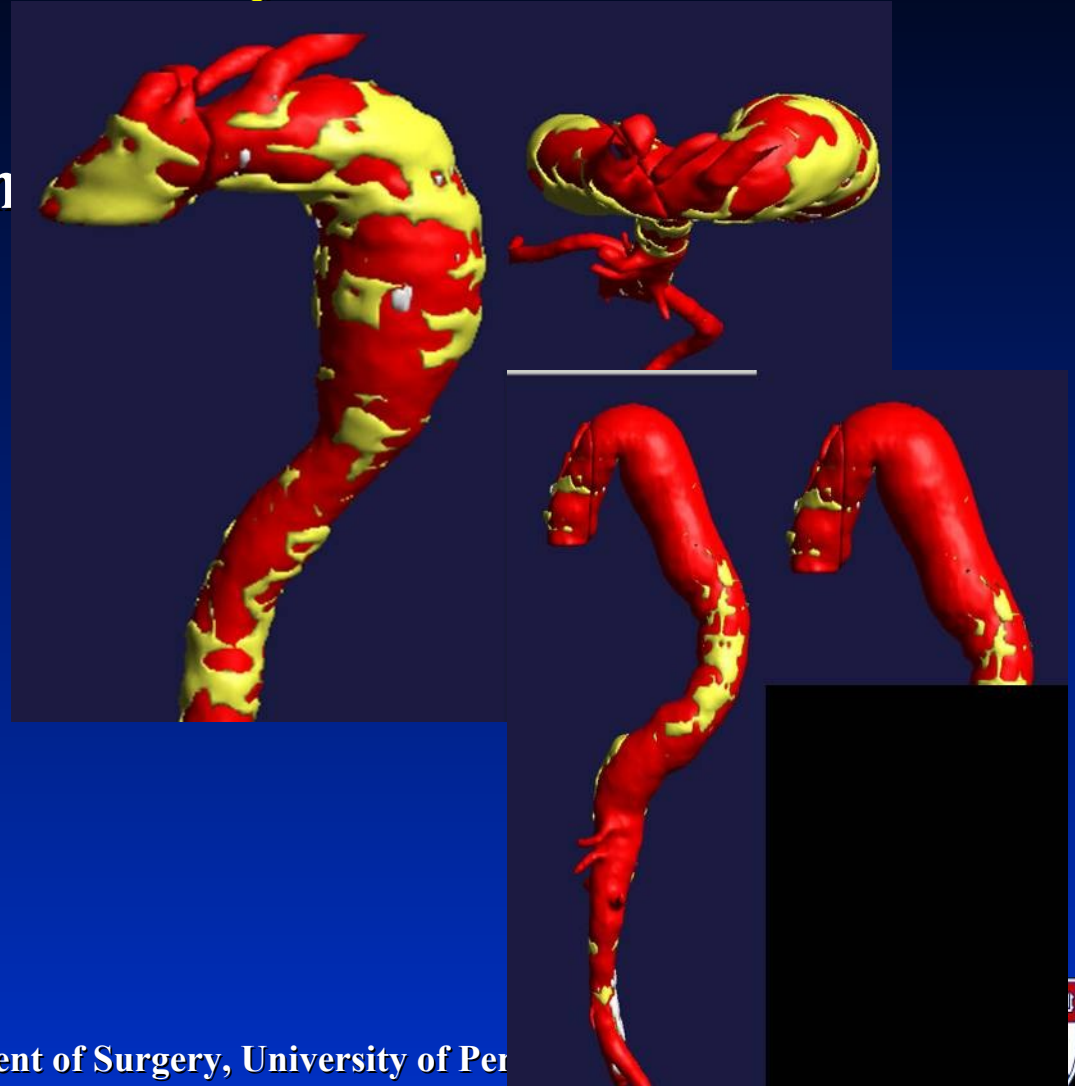
## **The Left Carotid**





# Coverage of the Left Subclavian Artery

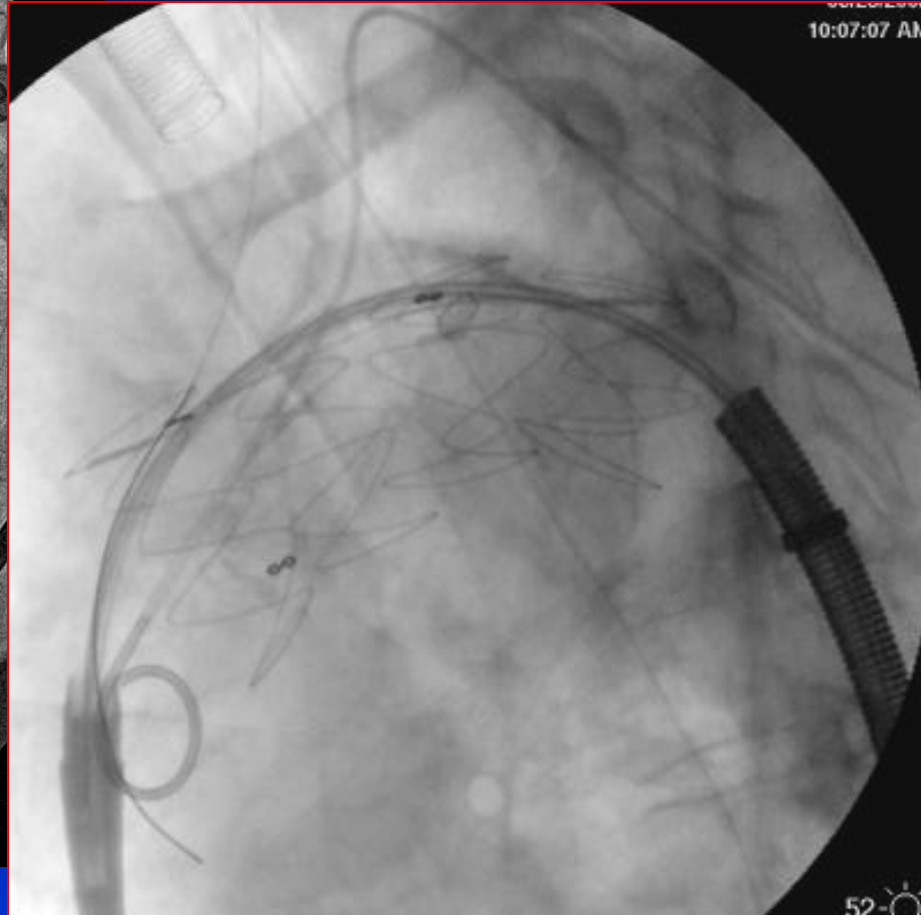
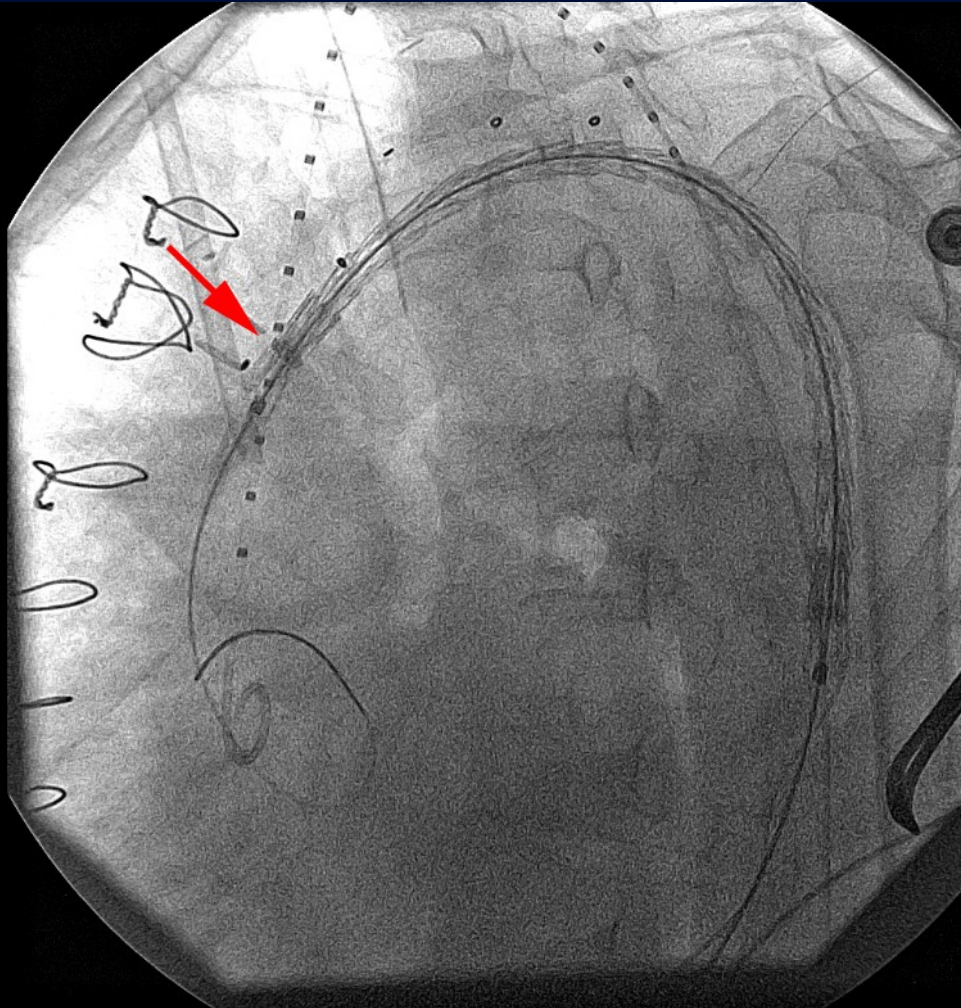
- **Extension of the proximal landing zone**
  - Proximal aneurysm extent
  - Angulated arch
  - Traumatic aortic injuries
  - Type B dissection



# Transposition/Angulated Arch: High Arch Position for Proximal Landing Zone (LZ), Zone 2

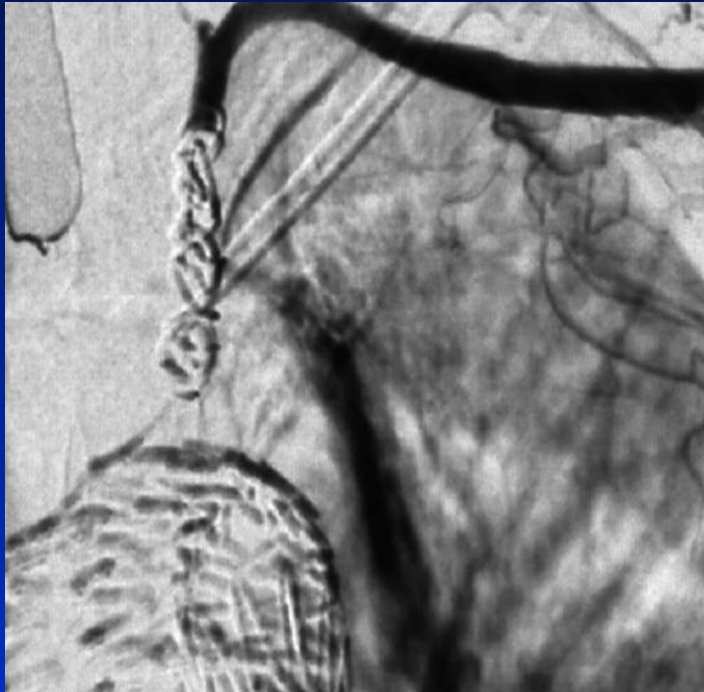
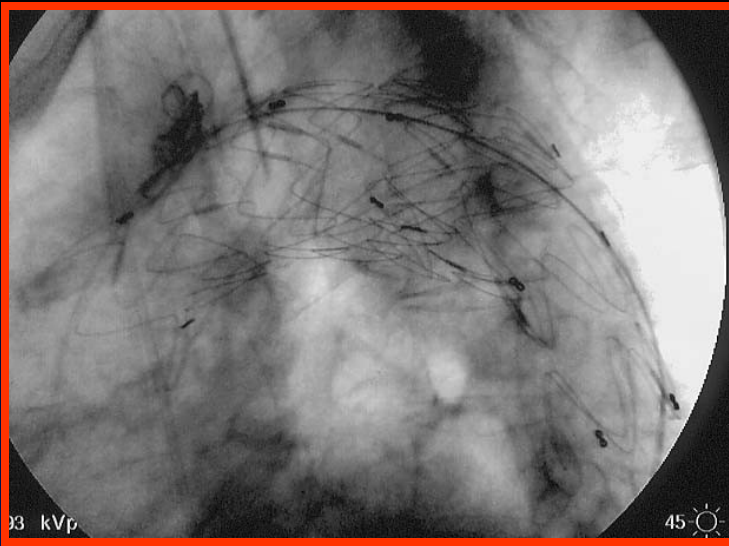


# How Easy Access to Left Subclavian and Left Carotid helps in the “Conduct of Operation”





# Coil Embolization of Intrathoracic Subclavian artery via left Brachial after bypass 1 week earlier



ent

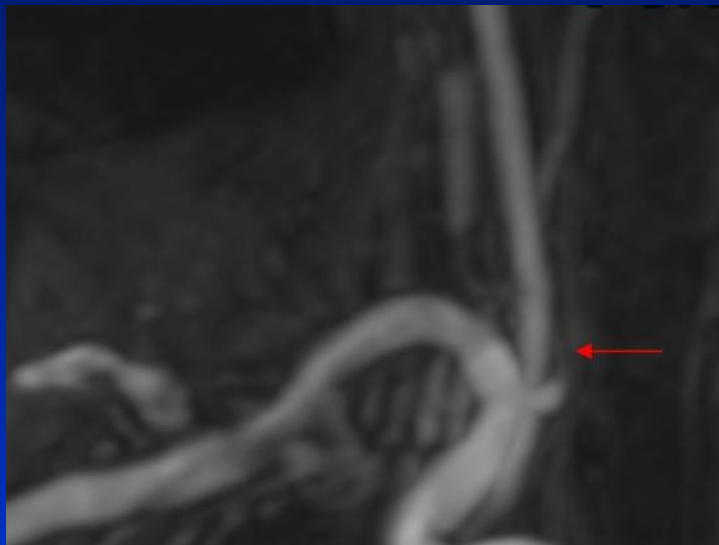
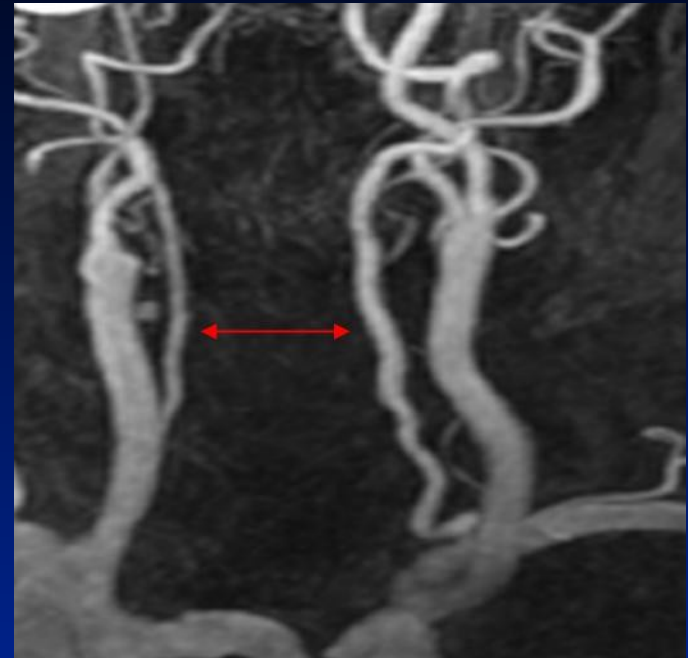


# Necessity for Revascularization

To Do or Not to do!

- **Vertebrobasilar ischemia**

- Dominant LVA
- Hypoplastic or atretic RVA
- Incomplete Circle of Willis
- Lesions of the RVA



Key: Will have a stroke if one doesn't  
Think of the anatomy



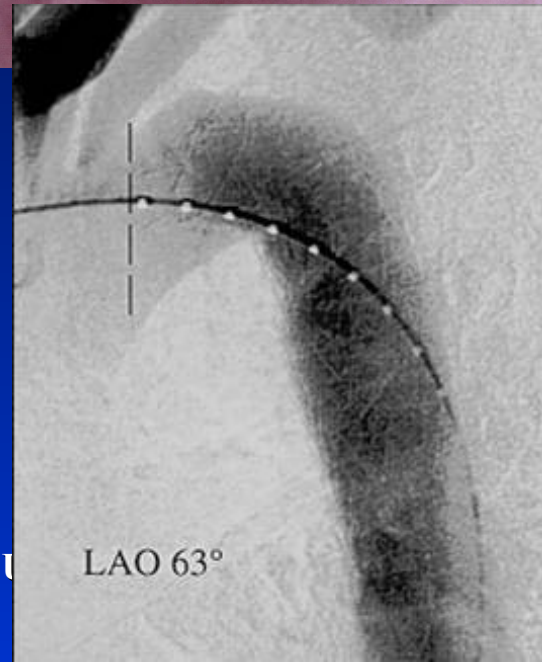
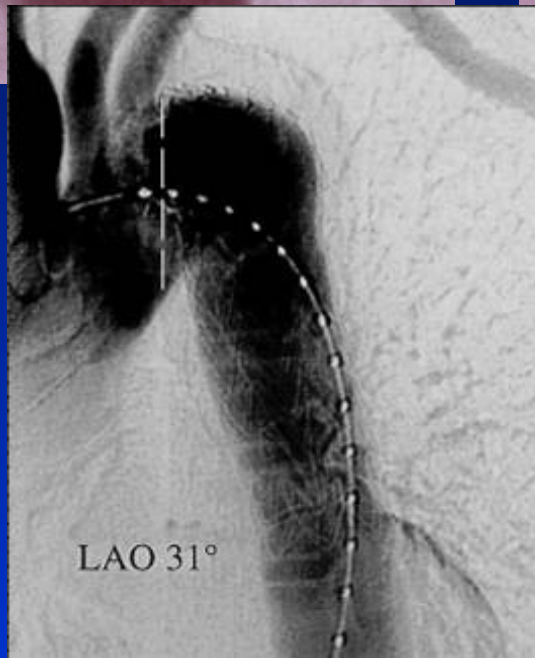
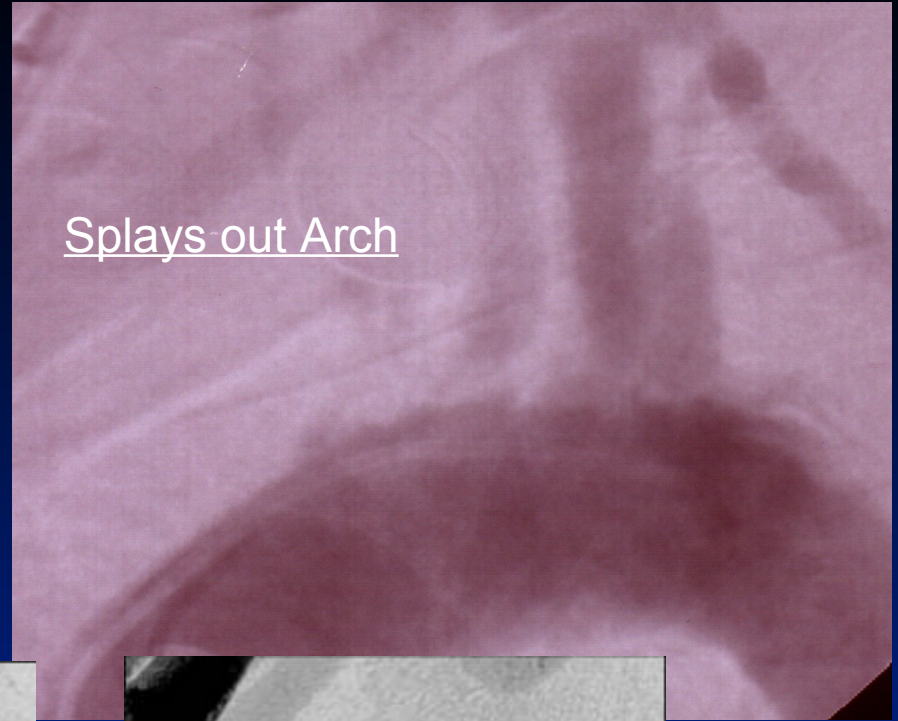
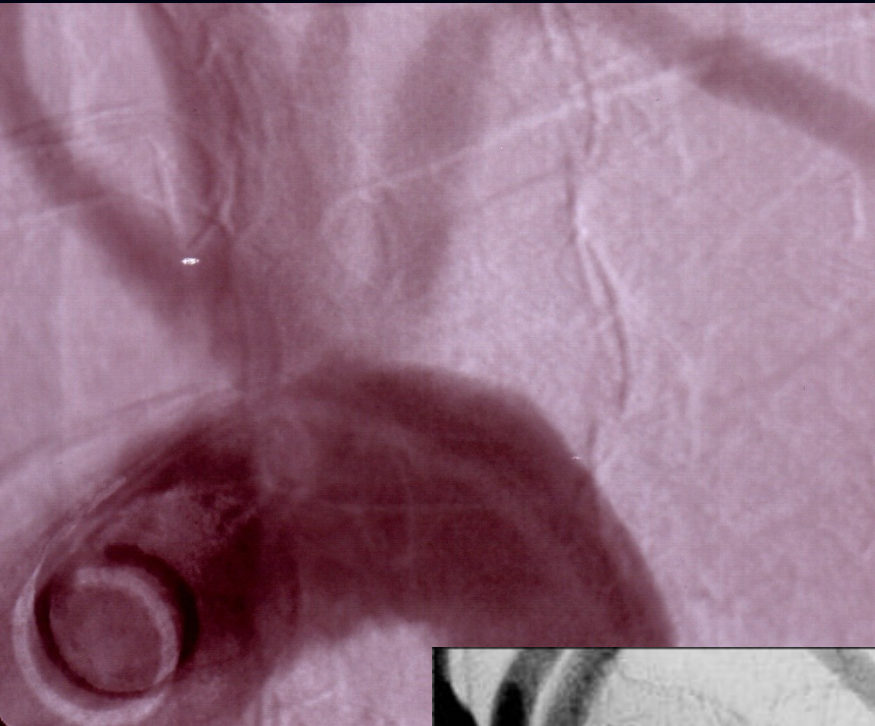
# **Intra-Operative Imaging: New Lingo, New Tools, New Concepts**

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# Oblique Views/Complex Arch Angiography

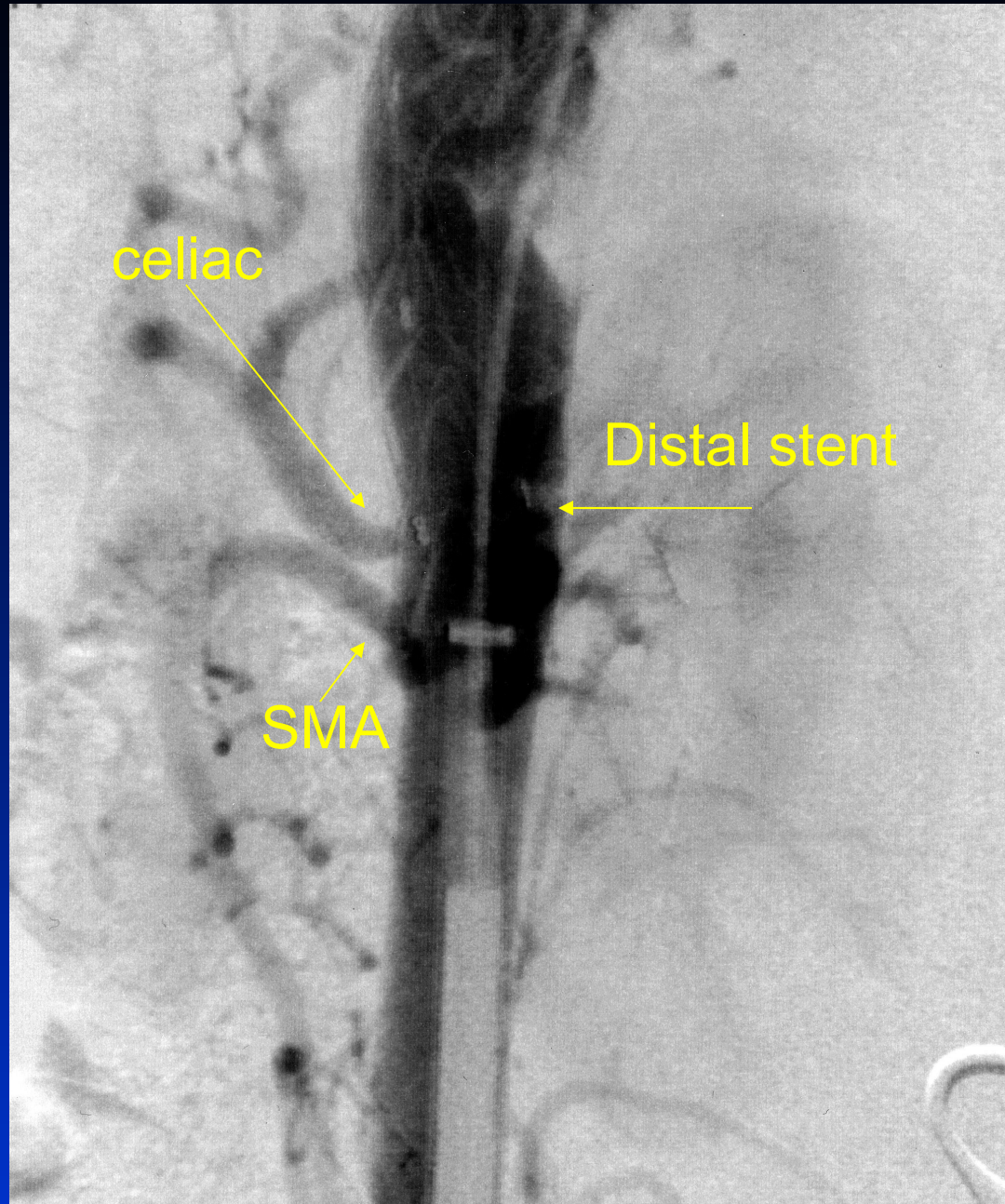


gery, U

System



# Lateral: For Distal LZ





**Bailout!:** Carotid Stent: After partial coverage of the Carotid by the TEVAR stent graft





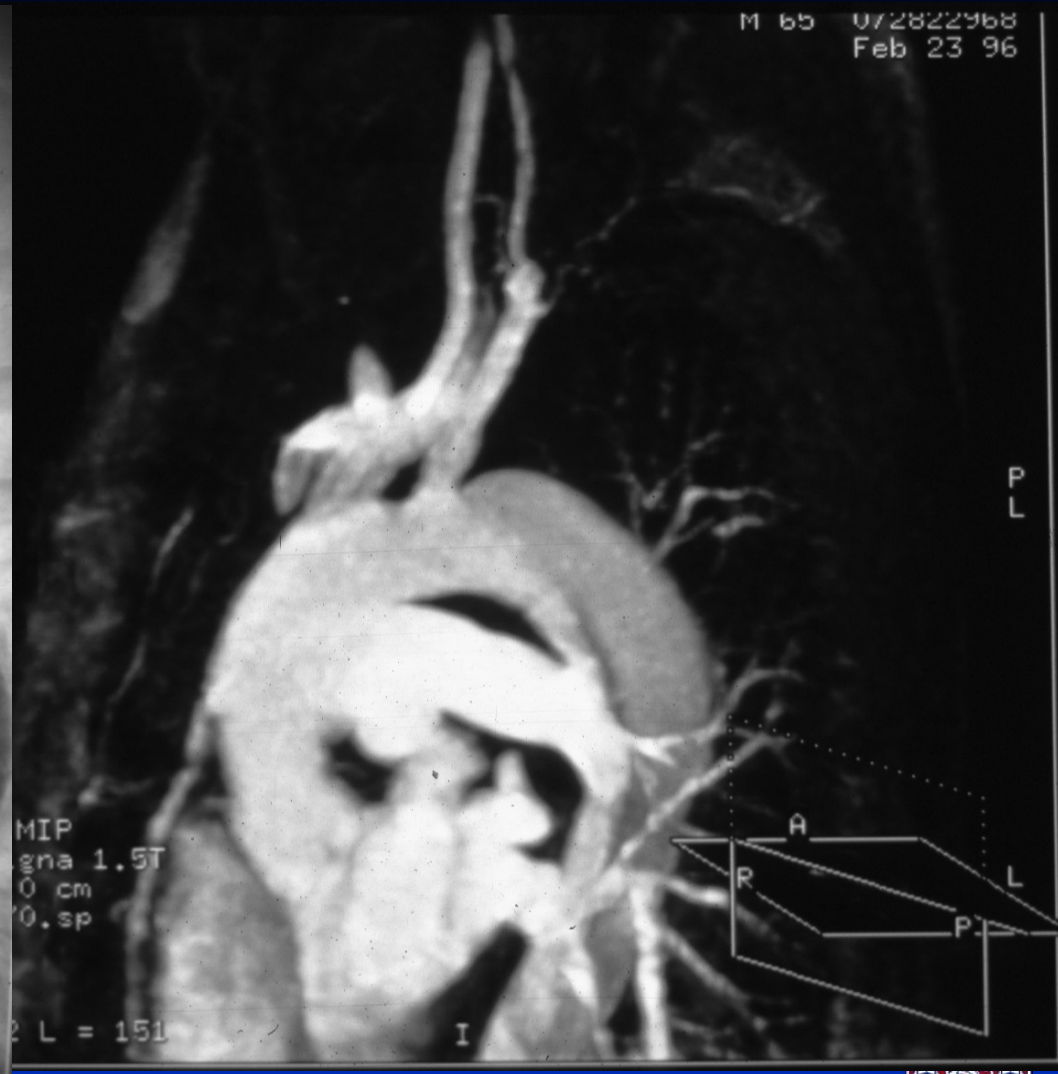
# The Hybrid OR Suite



of Sur



# What About Aortic Dissection ?



# Aortic Dissection and Stent Grafting

- Acute Type A
- Chronic Type A (Residual)
- Chronic Type B
- Acute Type B
  - Uncomplicated
  - Complicated (Malperfusion, Rupture)





# **Key Requirements for Successful Type B Dissection Stent Grafting before You Even Start!**

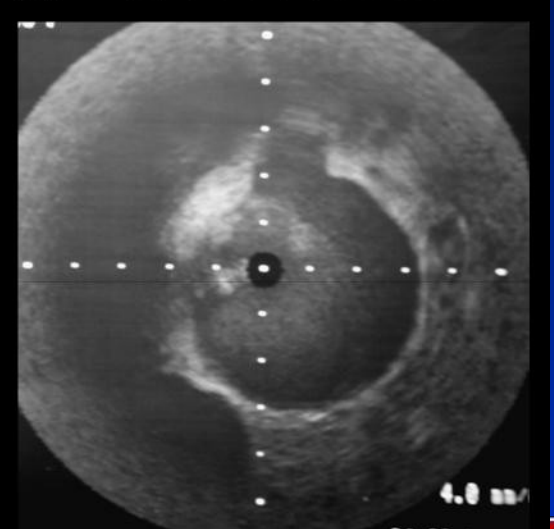
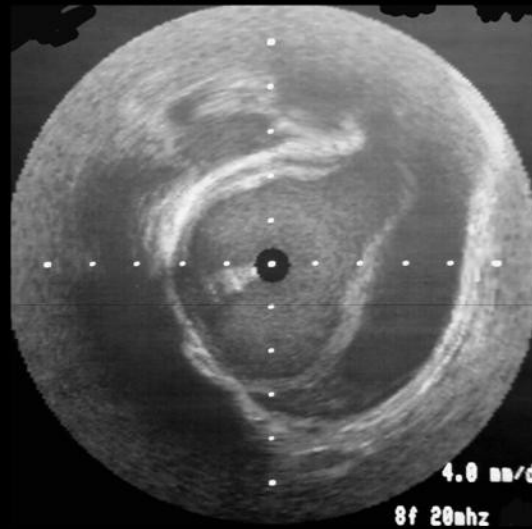
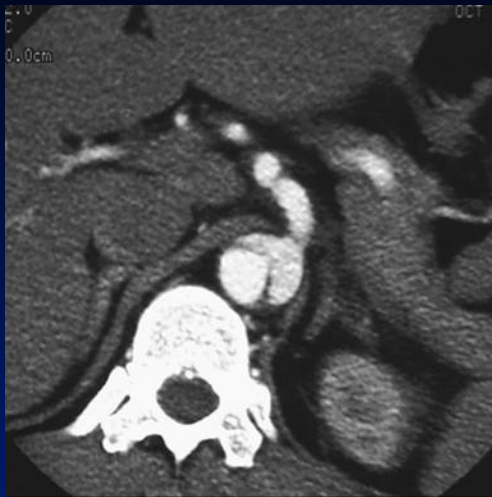
## **Flouro/TEE/IVUS:**

## **The Image**

## **Complex Access**



# Dissection CTA vs. IVUS



**Celiac**

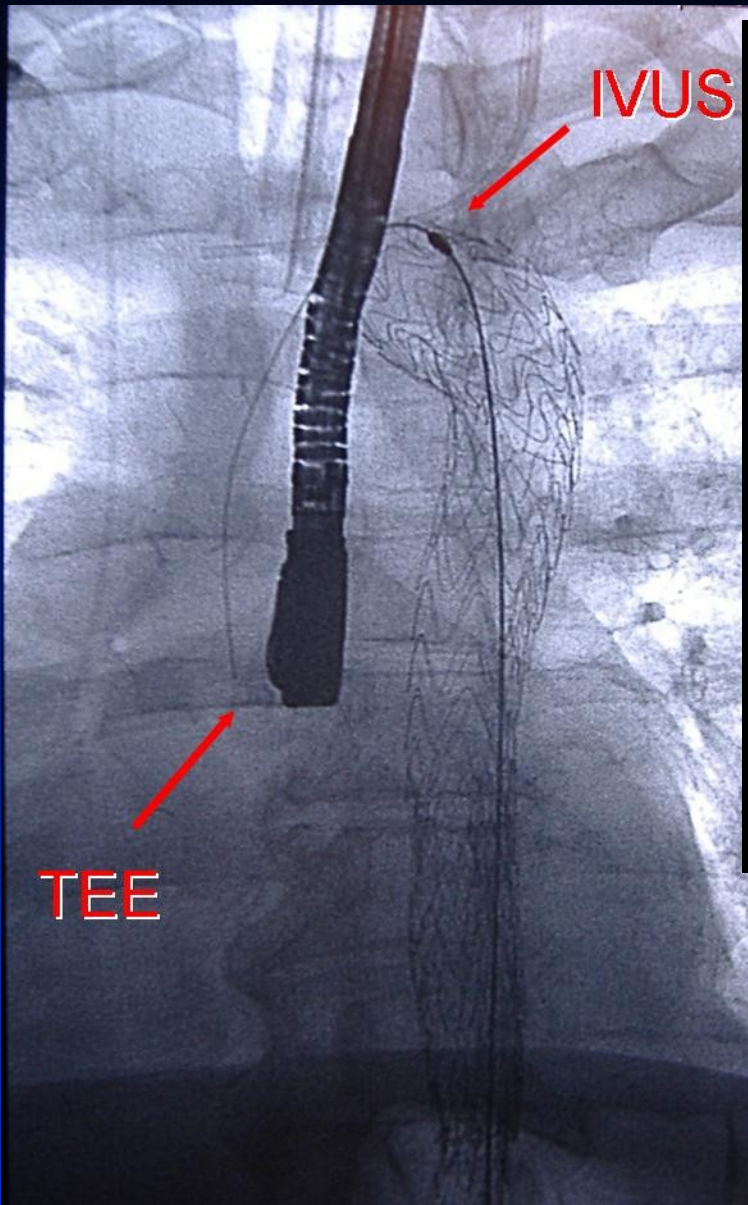
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**SMA**

**IMA**



# TEVAR of Type B Aortic Dissection with IVUS only



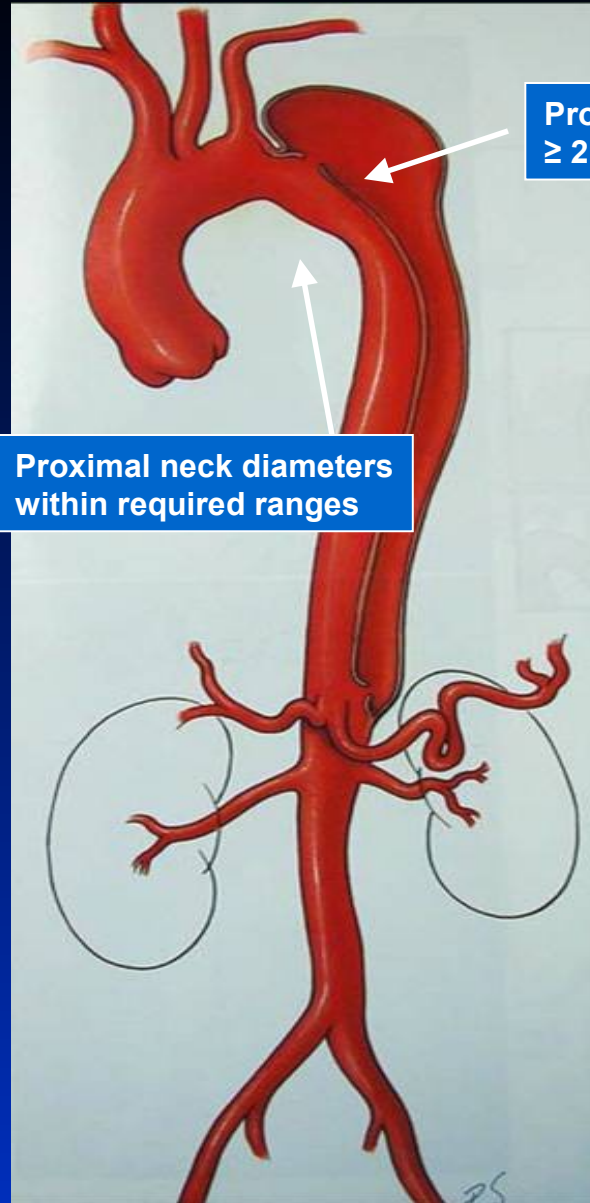
**MUST Confirm wire in true lumen**





# Anatomical Requirements for ACUTE Dissection

- Proximal neck diameters within required ranges  
*Distal neck diameters **NOT** used for sizing*
- Proximal neck  $\geq 2$  cm of length
  - Distance from primary proximal entry site to either left subclavian or left common carotid artery
- Distal neck length will depend on patient anatomy – goal to have 10cm of coverage distal to primary entry site
- Adequate iliac/femoral access



Proximal neck  
 $\geq 2$  cm of length

Proximal neck diameters  
within required ranges

**Assess for excessive thrombus and/or calcium in seal zones**

Note: IMH proximally and Chronic

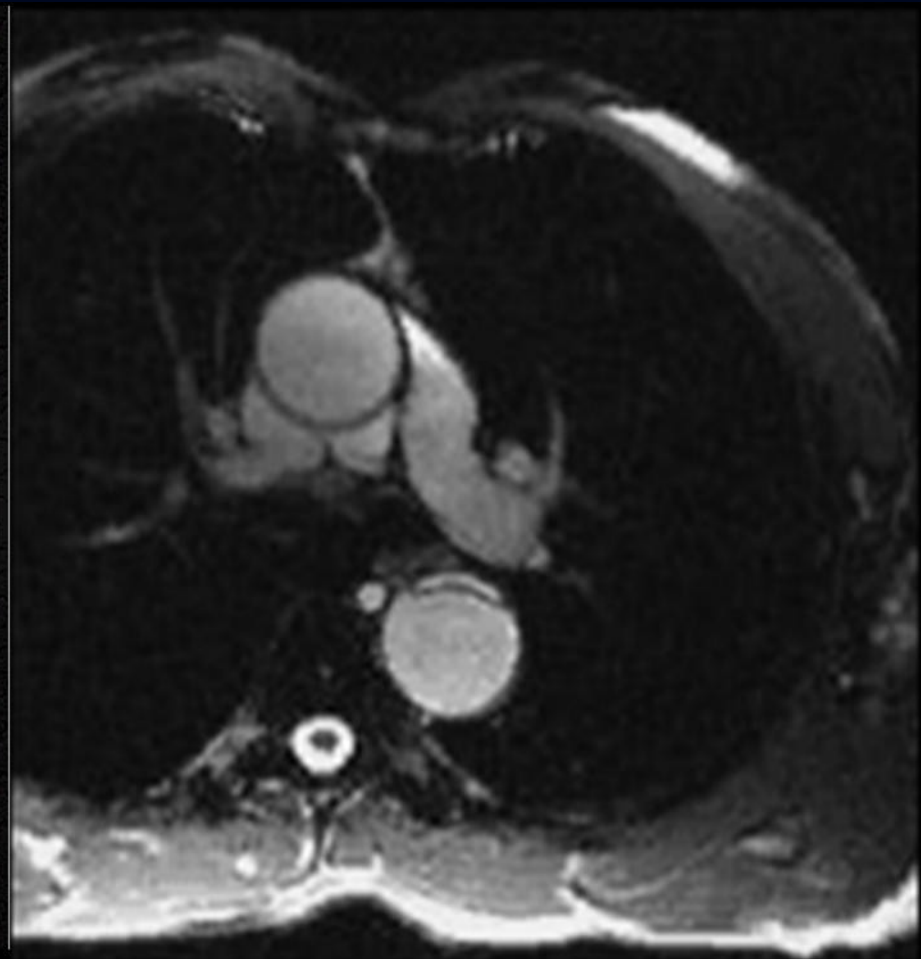


# Complex Stent Cases

- Case Planning is the *SAME* for the following:
  - Aneurysmal rupture, or aortobronchial or aortoesophageal fistula
  - Traumatic transection
- Case planning is *DIFFERENT* for the following:
  - Acute complicated distal dissection



# Free Floating Mesenteric Segment: Severe SMA Malperfusion



- Patient transferred directly to HUP OR





- Thoracic aortic stenting done but have Residual Infra-renal inflow stenosis:
- Received Medtronic EVAR

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# Stent Graft Complications

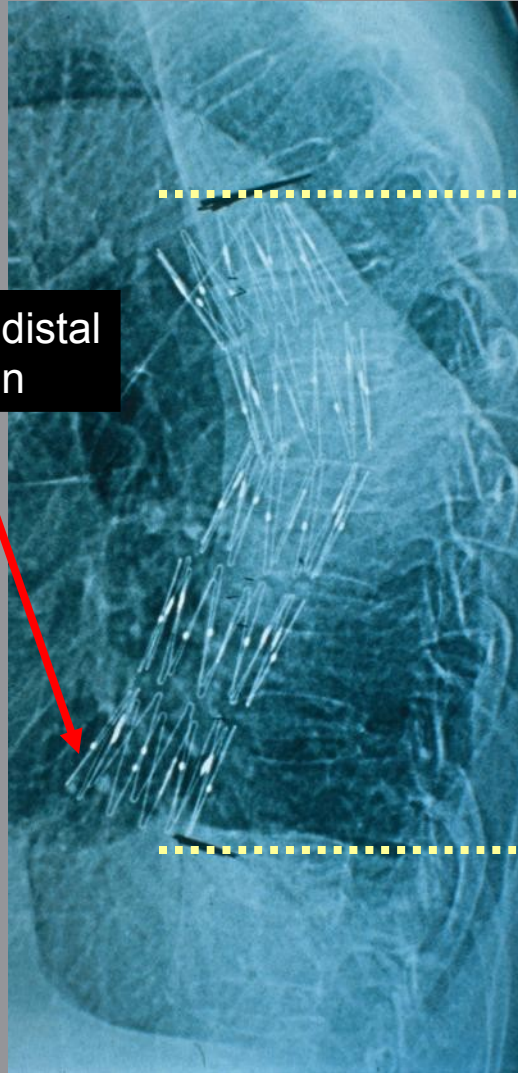
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# Migration: Importance of Sufficient LZ



Initial distal fixation



Stable proximal fixation

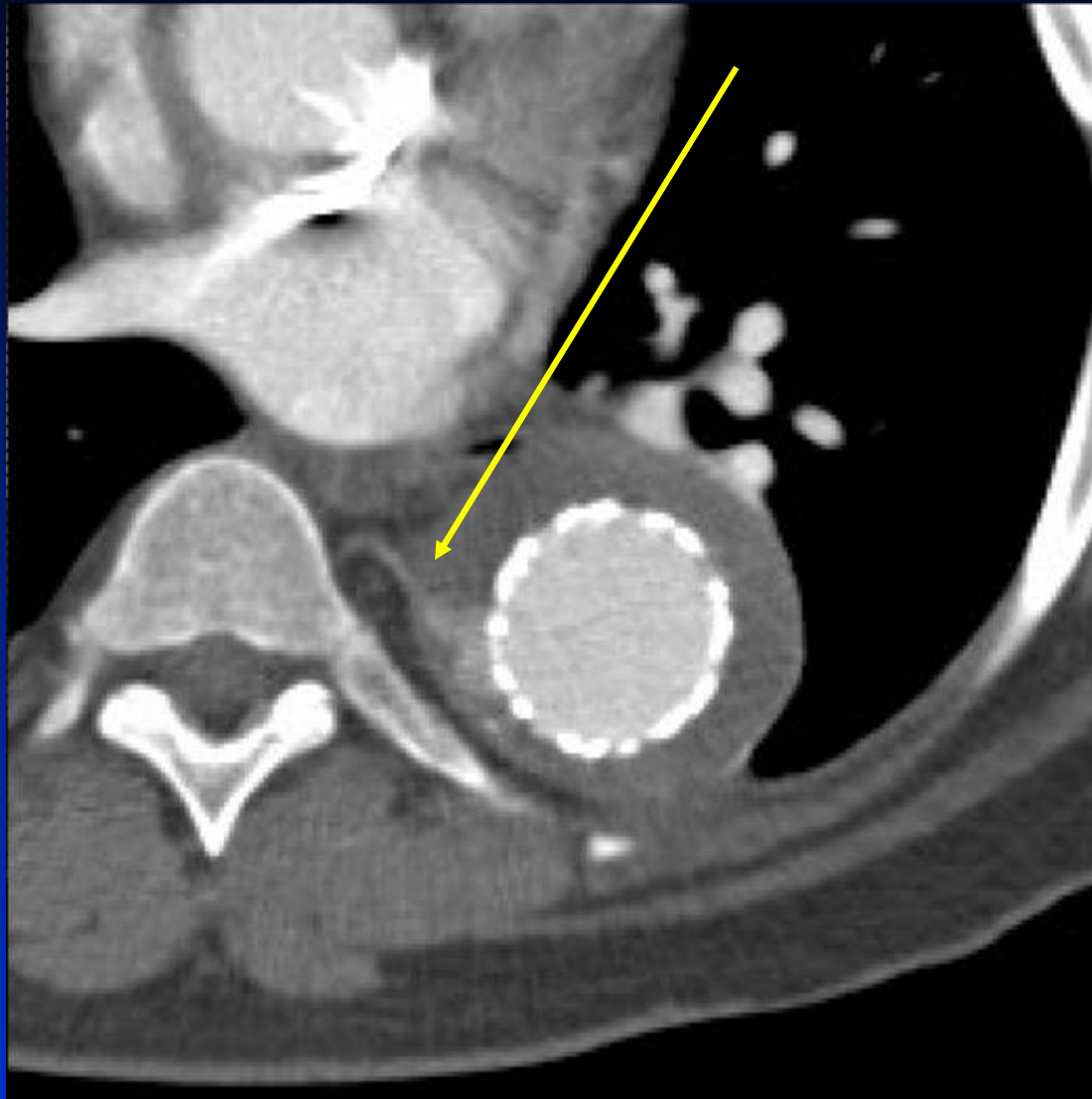
Follow-up distal position



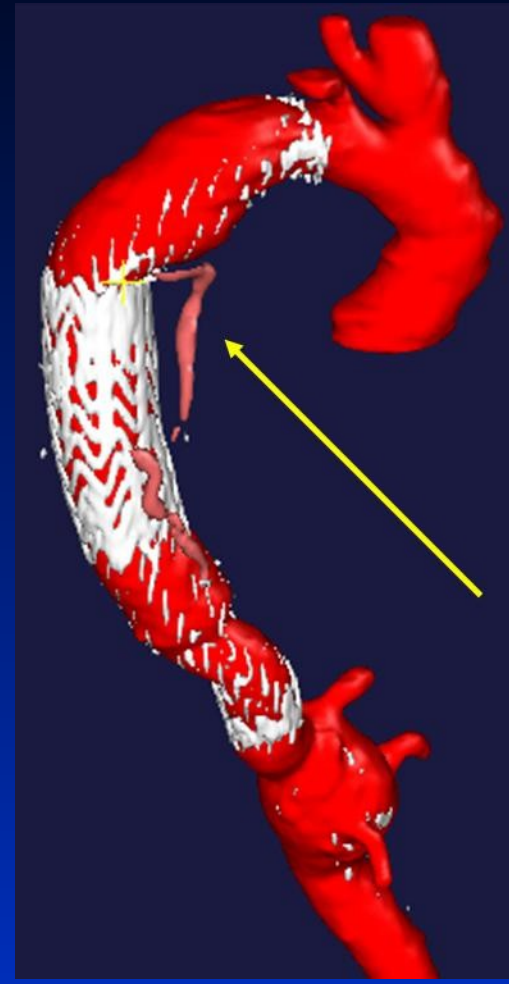
# Intraop Angiogram: Type I Leak Endoleak



# TAA Endoleak Type II

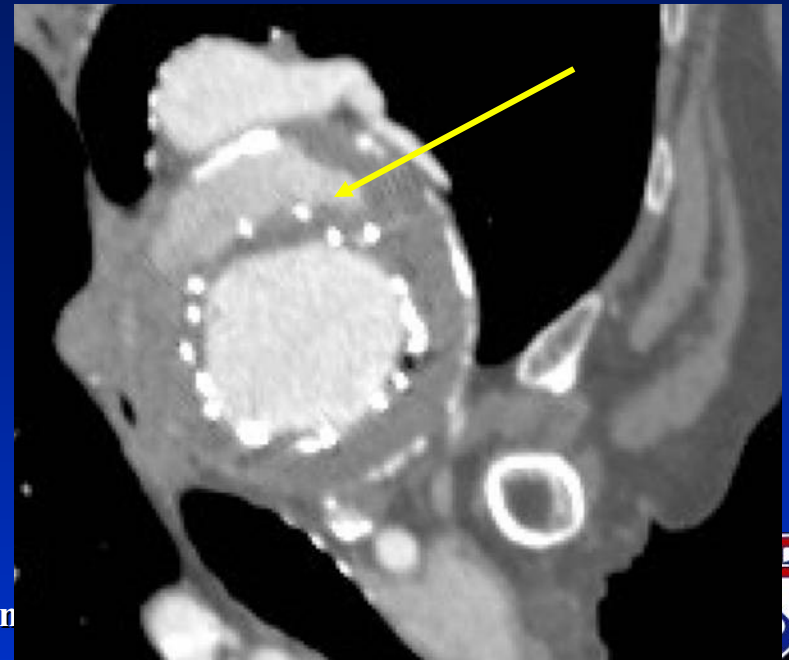
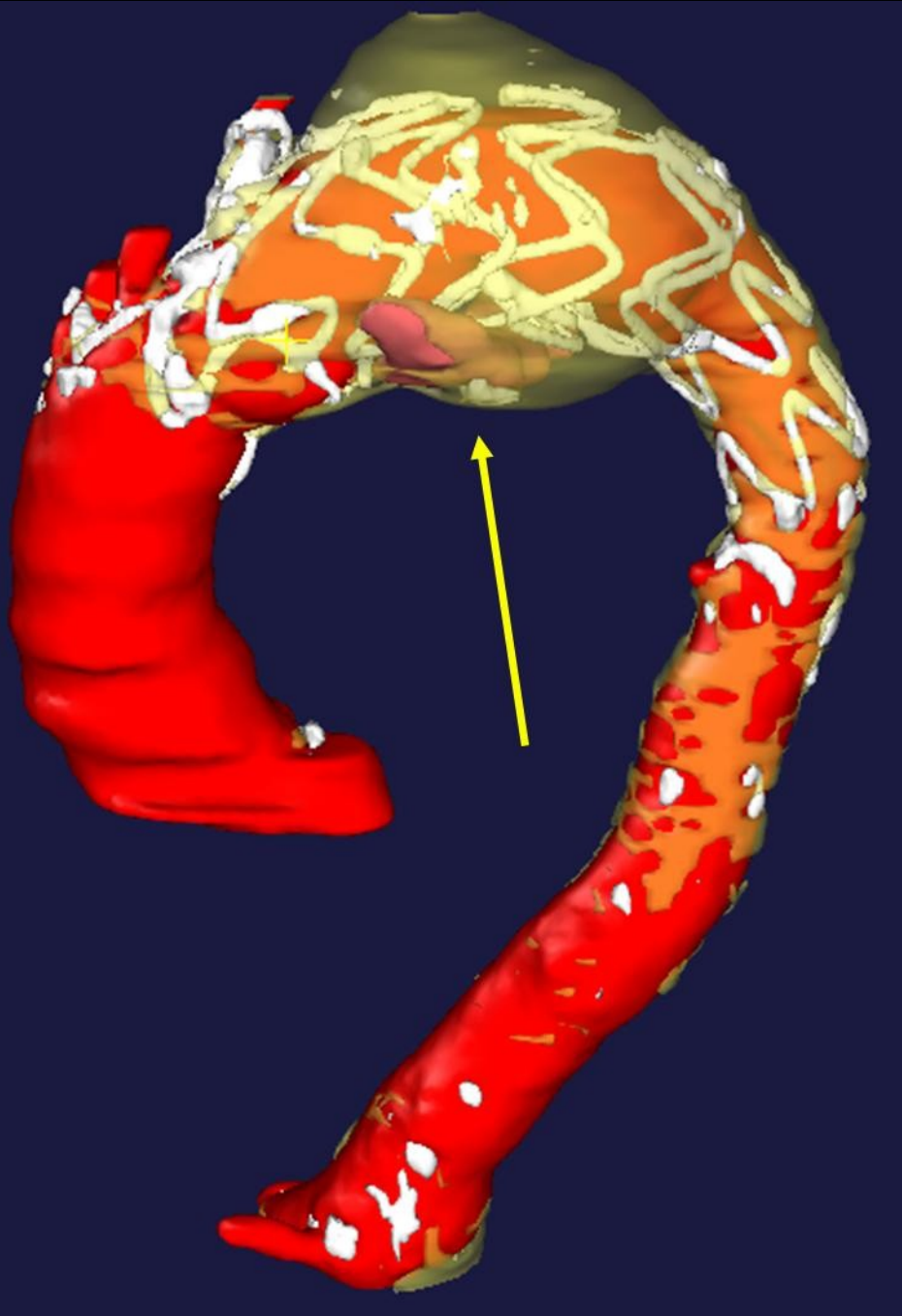


# TAA Endoleak Type III





# TAA Endoleak Type III

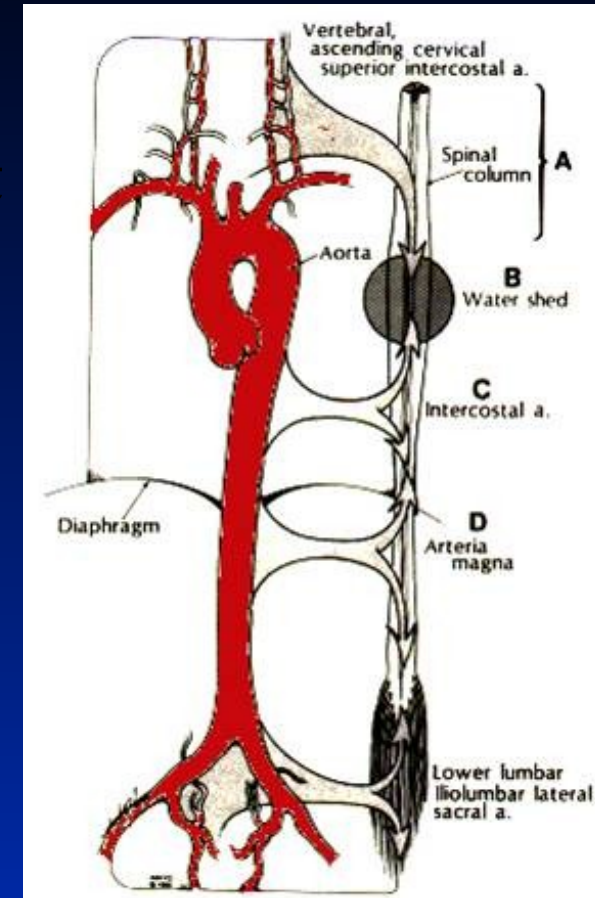


# Dissection Procedure – Conversion of Type B to Type A



# Gore Tag Pivotal FDA Study: Paraplegia

- Endograft cohort, 140 pts, vs. Non randomized but matched concurrent cohort of 94 pts. at 17 North American Centers
- Identical inclusion & exclusion criteria
- **Paraplegia Rate: 2.9% vs. 12.8%** (P=.003)
- Note: **4.9%** with prior AAA





## Pivotal Study (TAG 99-01)

# Operative Results

30 days or In-Hospital Events (Bavaria, Mitchell, et al; JTCVS 2007)

### TAG Device

### Surgical Control

- **Operative Mortality** 2% 6%
- **Paraplegia / paraparesis** 3% 14%
- **Stroke/CVA** 4% 4%

European Data/Recent Series 5-9%

AHI Atherosclerotic=11%

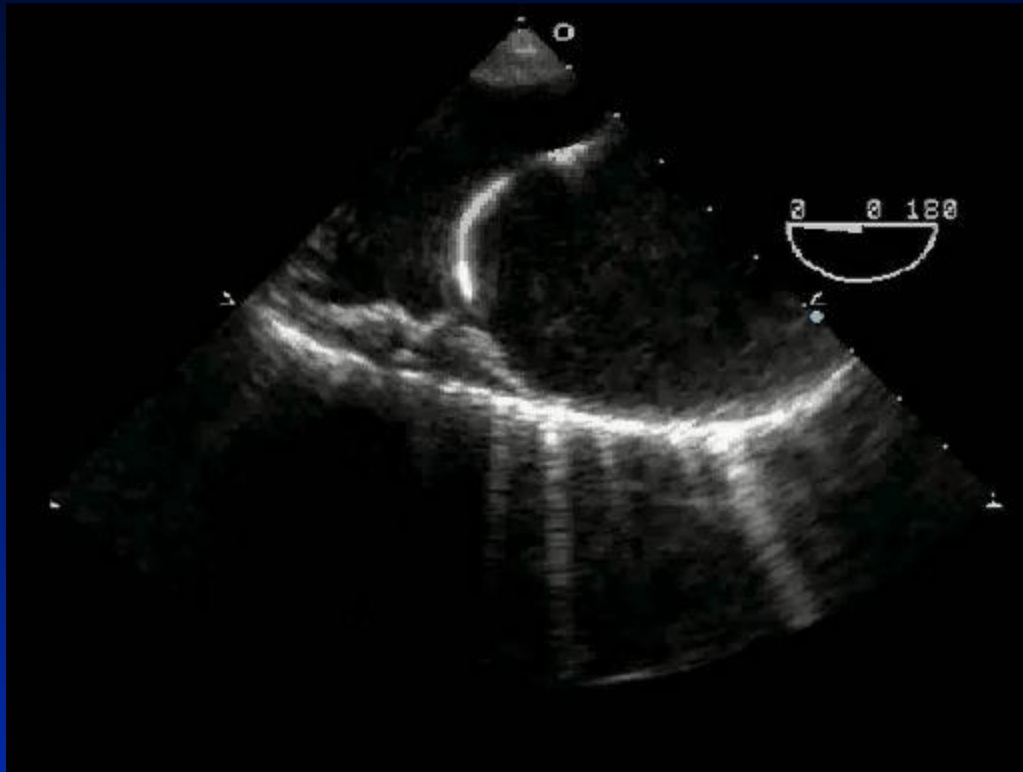


# What Kind of Anatomy can Increase the Risk of Stroke?



# Risk Factors for Perioperative Stroke after Thoracic Aortic Endovascular Repair (TEVAR)

University of Pennsylvania Thoracic Aortic Surgery Group



Jacob T Gutsche, M.D.

Albert T Cheung, M.D.

Michael L. McGarvey, M.D.

G. William Moser, MSN

Wilson Szeto, M.D.

Jeffrey P. Carpenter, M.D.

Alberto Pochettino, M.D.

Joseph E. Bavaria, M.D.



Presented at STS 2007; Ann Thor Surg 2007

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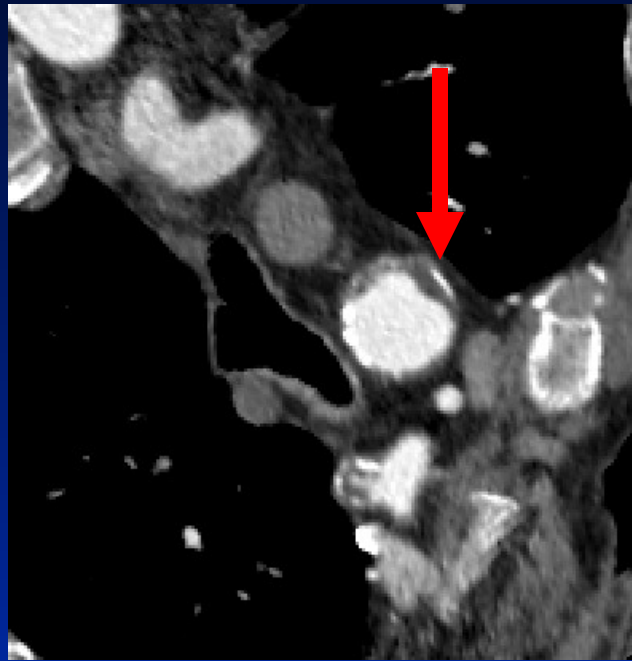




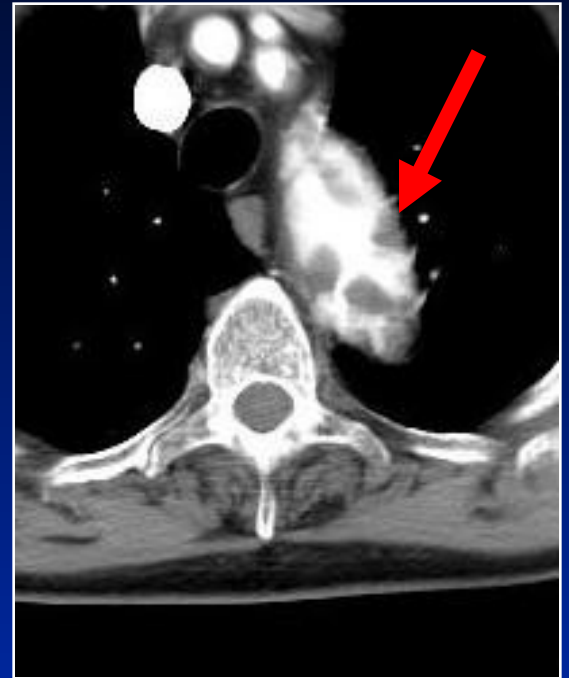
# Chest CT Aortic Atheroma Grade



Grade II



Grade III



Grade IV

Analyzed from Aortic Valve to 2 cm distal to L subclavian  
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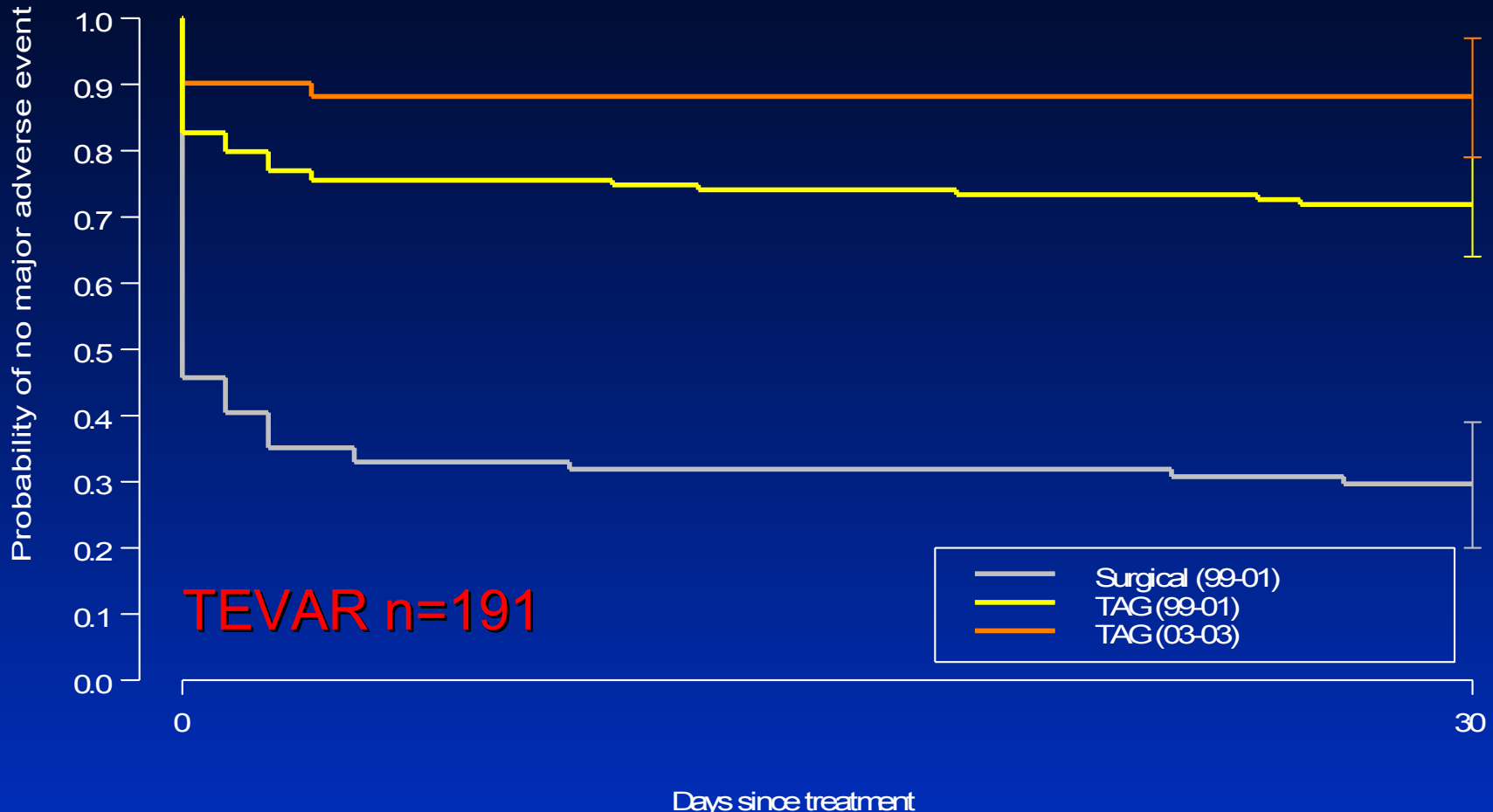
# Stent Graft Study Results

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# Freedom from a Major Adverse Event Through 30 Days

J.Bavaria, S.Mitchell: AATS 2005, JTCVS 2006



TEVAR n=191





# Key Results: Valiant

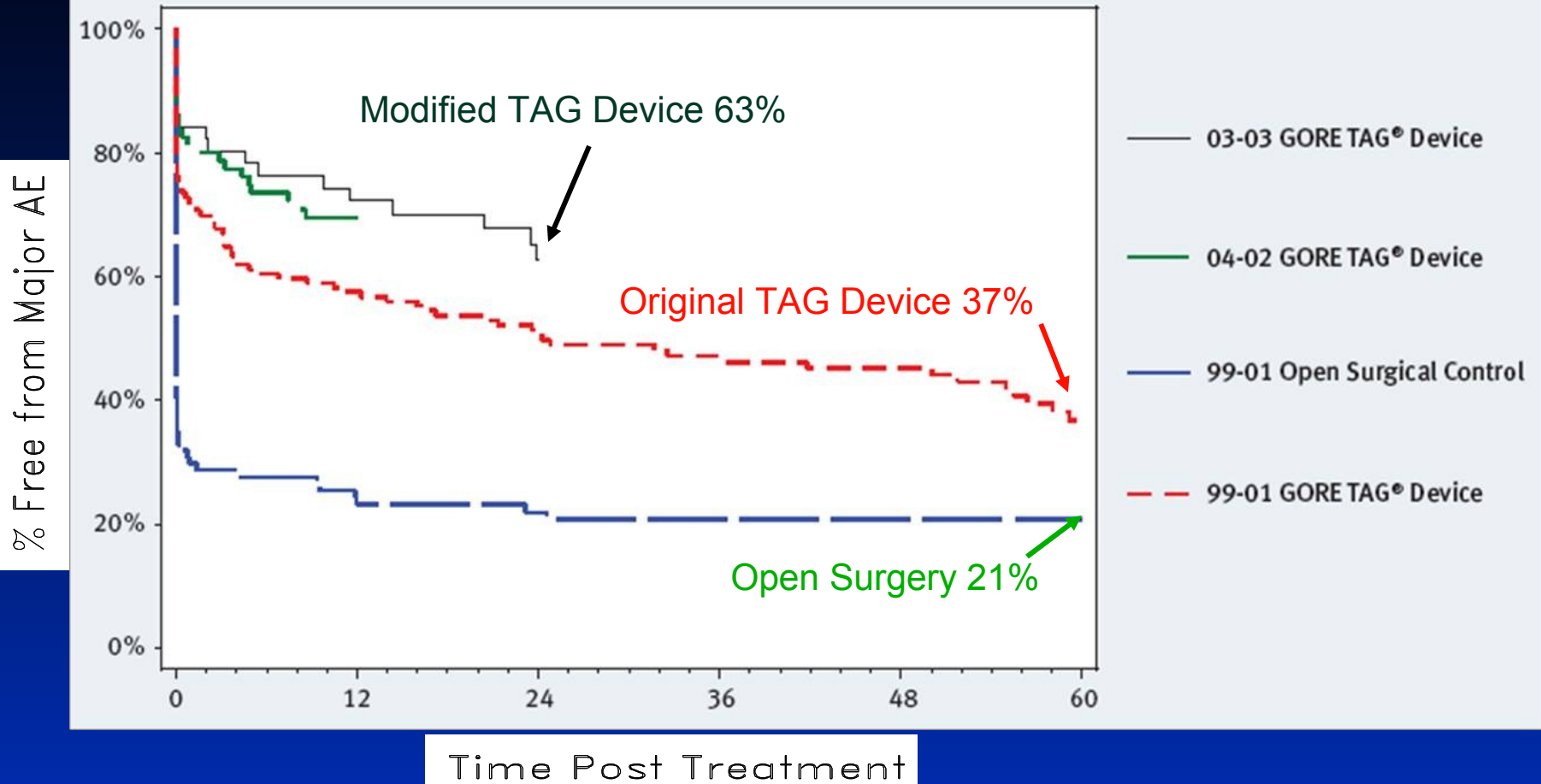
**Table 4** Comparative results from the present study (Valiant) with and without the results from treatment of thoraco-abdominal aneurysms (not TAAA)

	Talent	Valiant	Valiant, not TAAA	<i>p</i> : Talent vs Valiant, not TAA
Elective mortality	14/344 (4.1%)	8/117 (6.8%)	3/101 (3.0%)	0.77
Emergency mortality	9/113 (7.9%)	5/63 (7.9%)	4/57 (7.0%)	1.0
Stroke	17/457 (3.7%)	7/180 (3.8%)	6/158 (3.8%)	1.0
Paraplegia	8/457 (1.7%)	6/180 (3.3%)	2/158 (1.3%)	1/0
>2 stents	40/457 (8.7%)	40/176 (22.7%)	31/154 (20.1%)	0.0004
Fixation proximal LSCA	54/457 (11.8%)	78/153 (50.1%)	70/134 (52.2%)	<0.0001
Renal insufficiency	72/457 (15.7%)	39/155 (25%)	37/117 (31.6%)	0.0002
COPD (%)	102/457 (22.3%)	81/155 (52%)	63/136 (46.3%)	<0.0001

- Valiant study was biased due to the inclusion of patients with thoraco-abdominal aneurysms with high mortality rates.
- Patients in Valiant study had a significantly higher incidence of renal insufficiency and pulmonary dysfunction



# Freedom from Major Adverse Events Through Five Years (n=273)



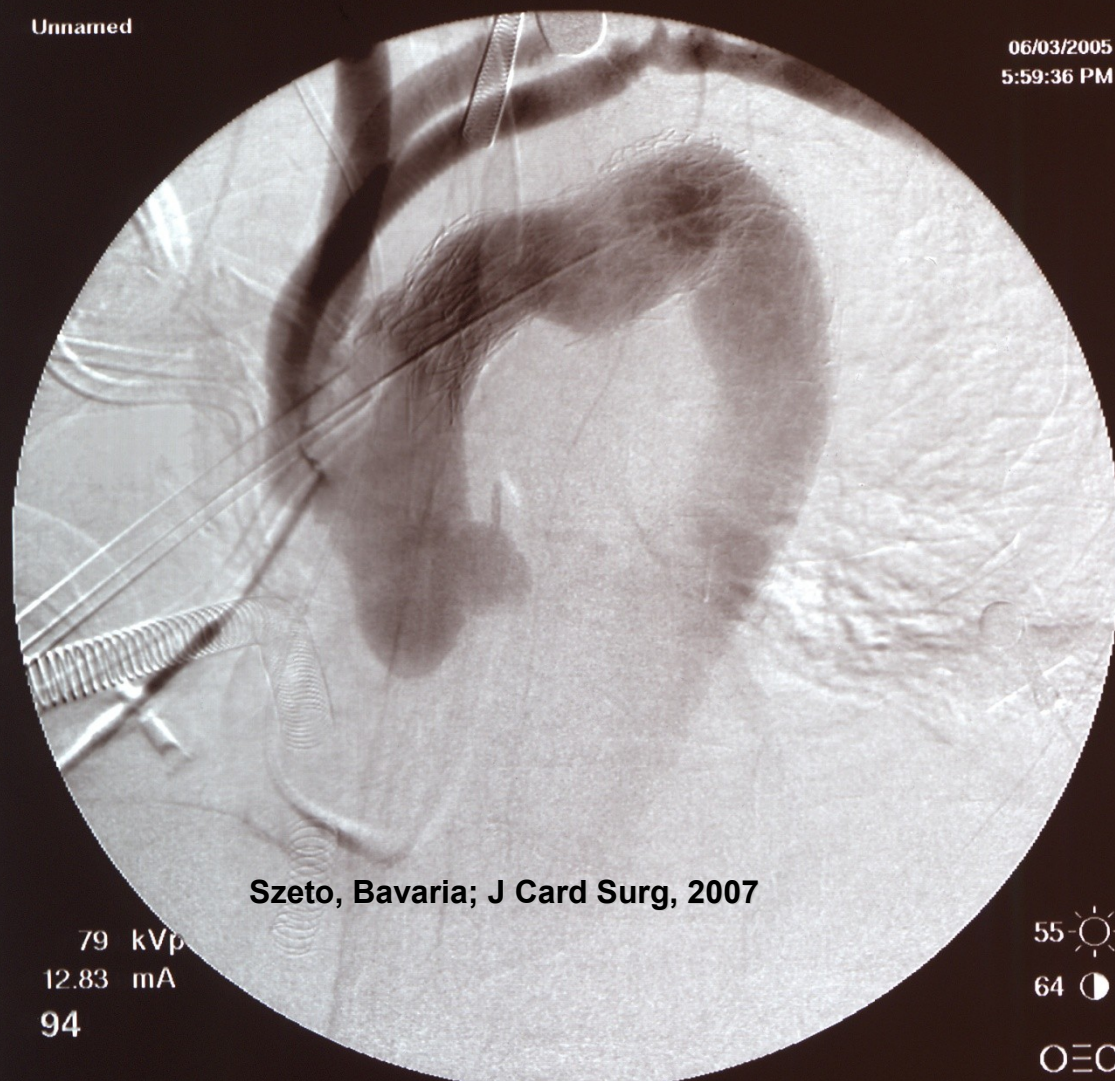
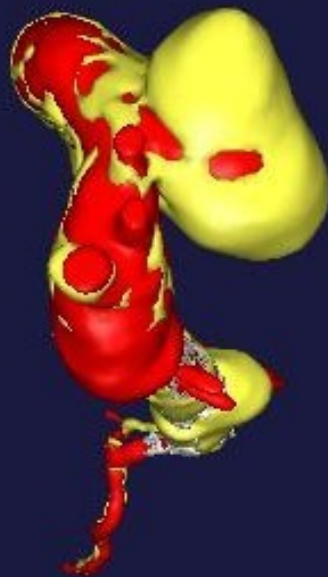
# The Future and Newer Suff!

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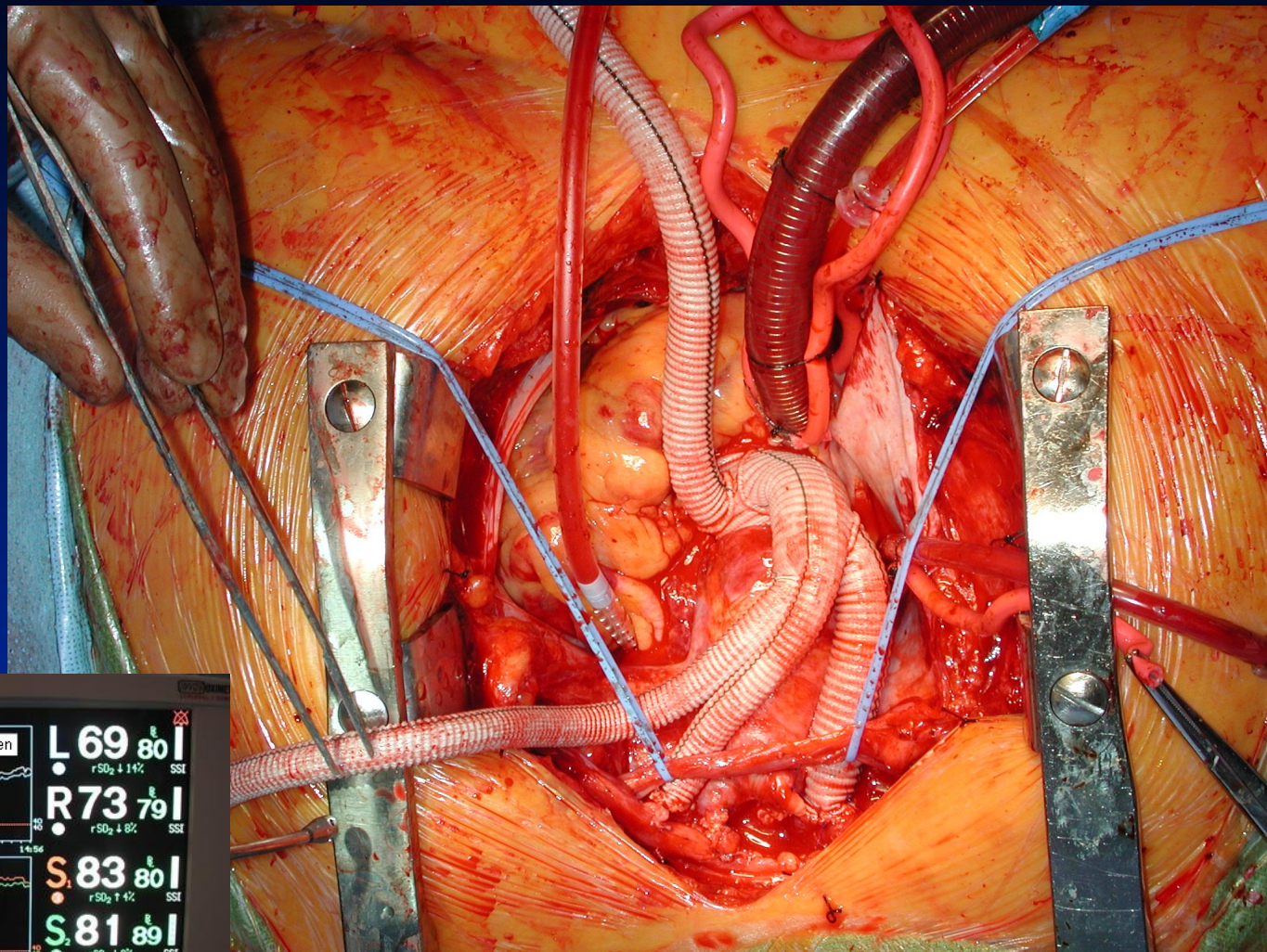
# Hybrid Giant Saccular Arch Aneurysm with Brachiocephalic Transposition: Completion Angiogram



part



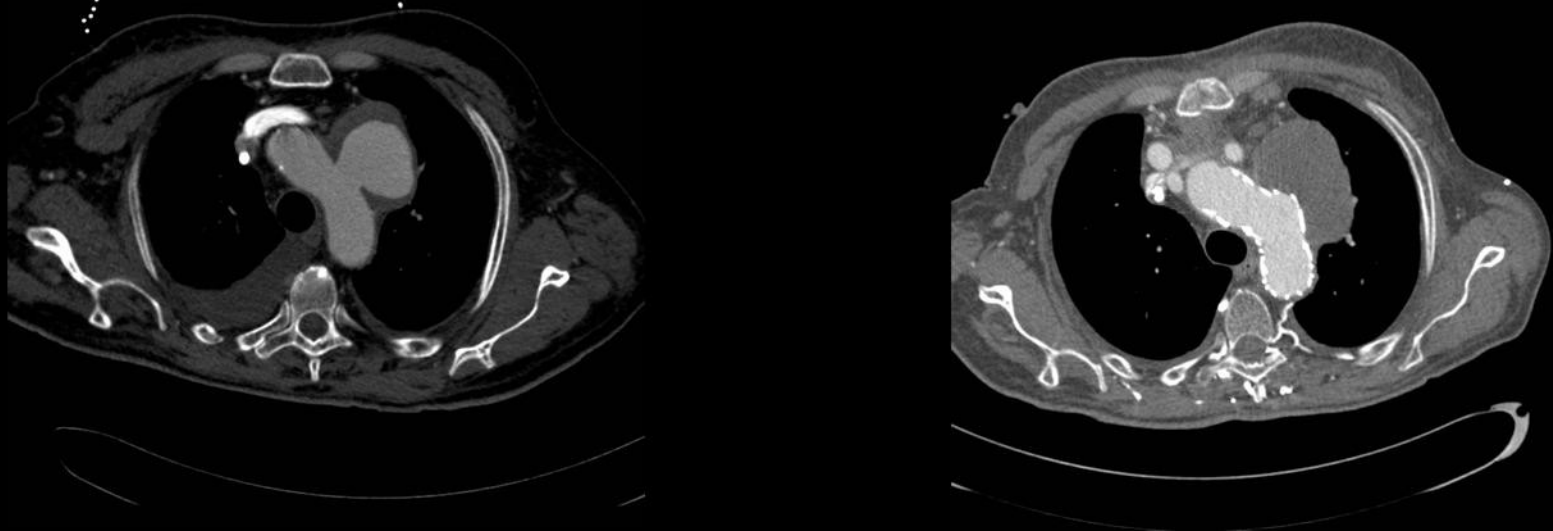
# Hybrid Arch Debranching: Antegrade Delivery of TEVAR via Sternotomy



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# Hybrid Arch Procedure: Post-op Result



# “The Elephant in the Room”

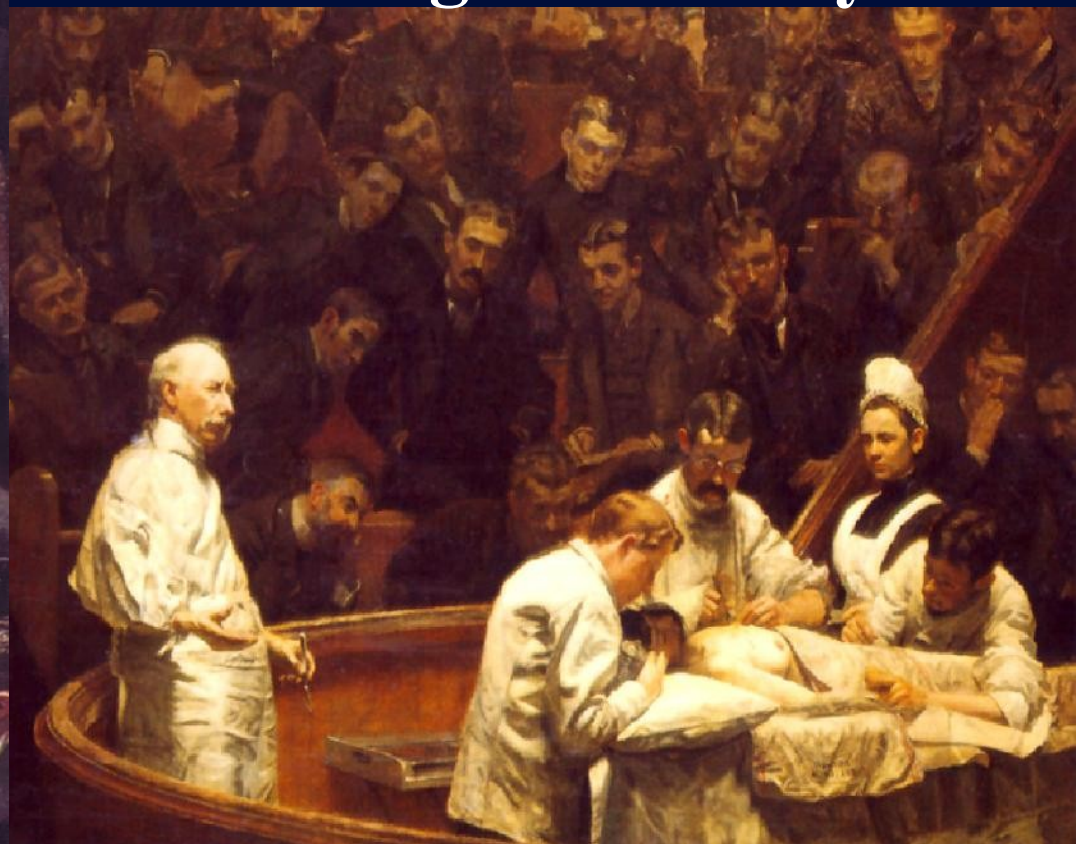
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# Thomas Eakins: Gross Clinic (1878@JEFF) and Agnew Clinic (1888@PENN)

Great Progress in 10 years!



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# Examples of Thoracic Stent Graft Collapse

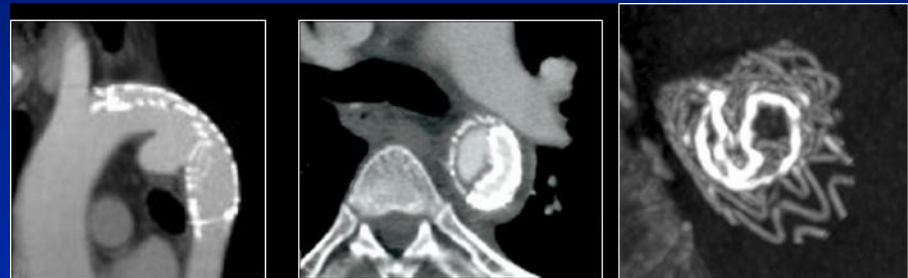
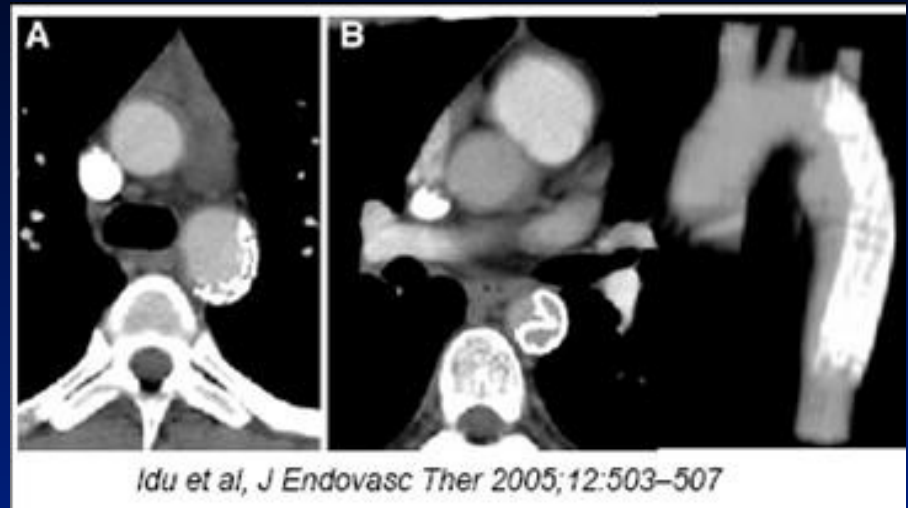
## Cook TX2 collapse & fracture



Fig. 4. Radiograph of collapsed thoracic aortic stent-graft and thoracic aorta explanted *en bloc* from deceased patient. Note multiple collapsed stents and migration of the stent-graft.

Hinchliffe & al, EJVES 2007

## Gore TAG collapses



Muhs & al, JVS 2007



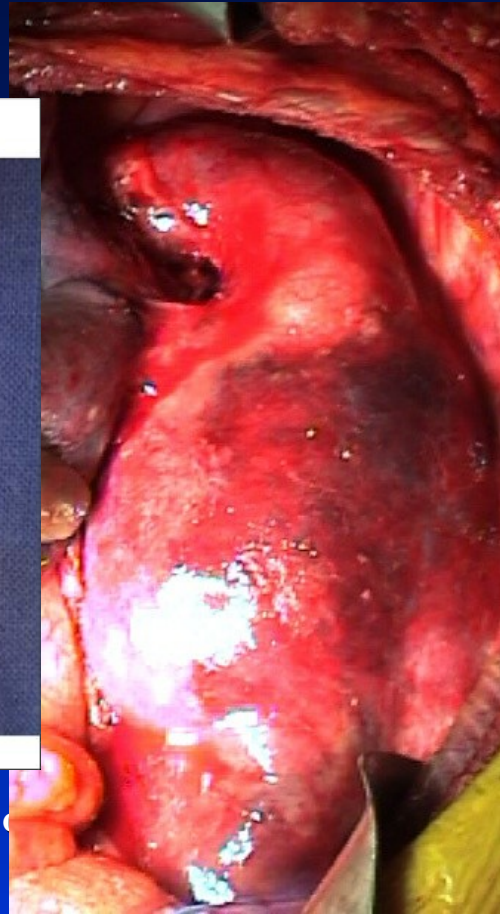
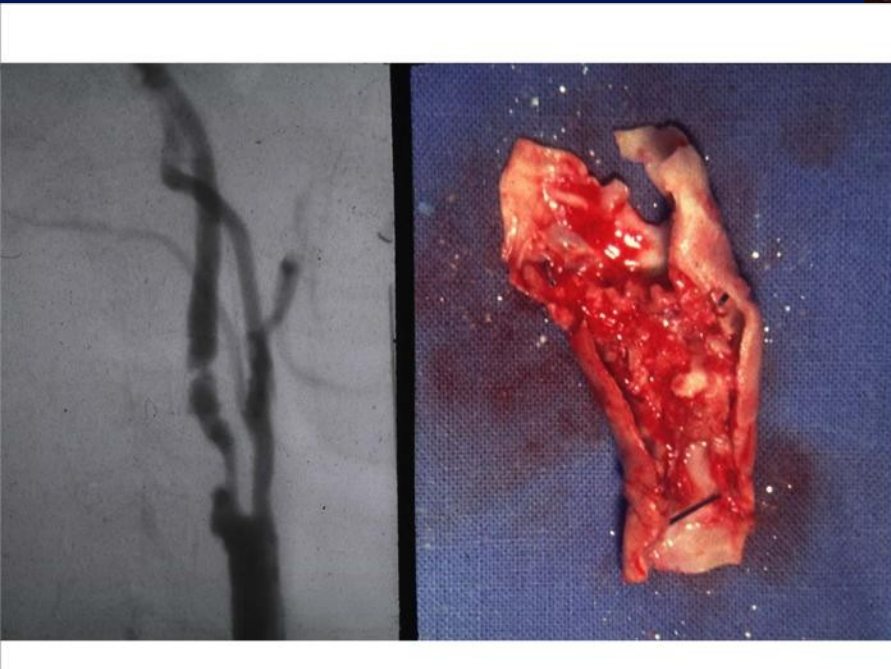


# Six Month Follow-up Stent Migration, Pseudo-aneurysm



**“The Treatment is best provided by specialists who are great open surgeons AND great endovascular surgeons”**

Juan Parodi, MD; STS 2006



Department of



# Thoracic Aortic Stent Graft Diasters

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# Acute Type B Dissection



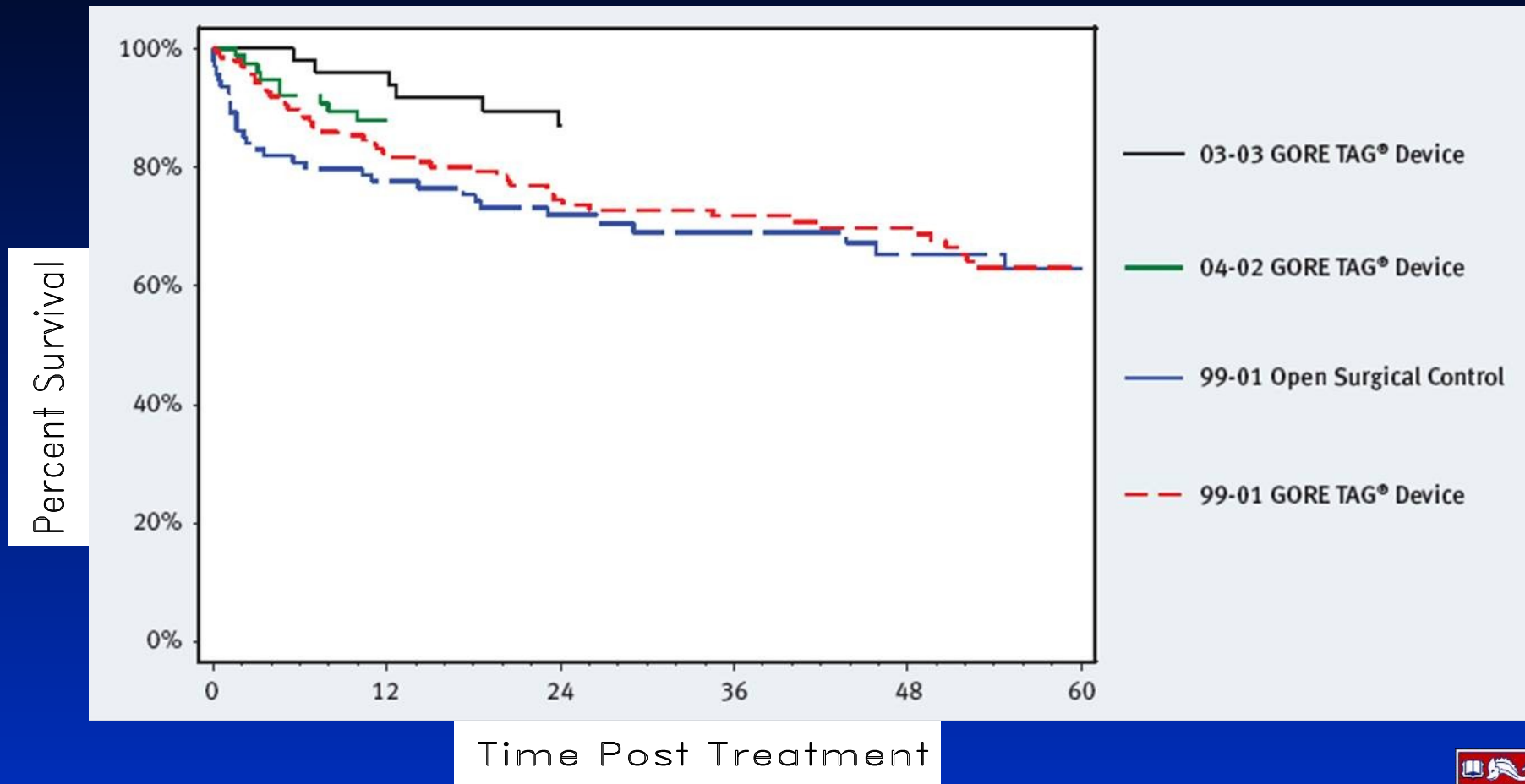
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# Post-Stent Repair Type B Dissection: What “not to do”



# All-Cause Mortality Through Five Years (n=273)





# Secondary Outcomes

## Pivotal Study

Secondary outcomes	TAG Device	Surgical Control	P
Procedural blood loss (ml)	250	1850	∞
ICU stay (days)	1	3	< 0.001
Hospital stay (days)	3	10	< 0.001
Time to return to normal activity (days)	30	78	∞

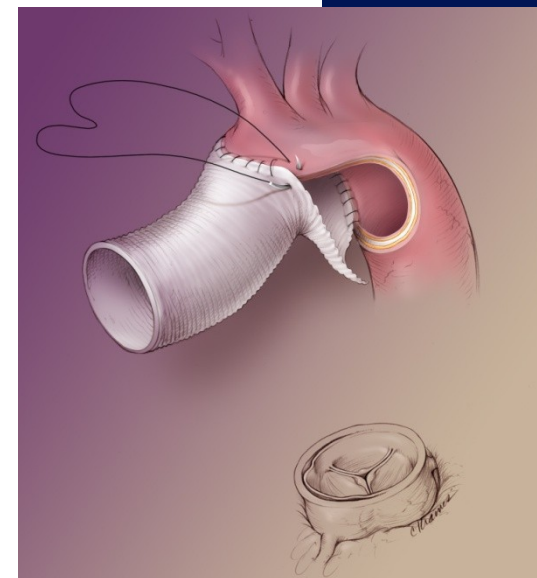
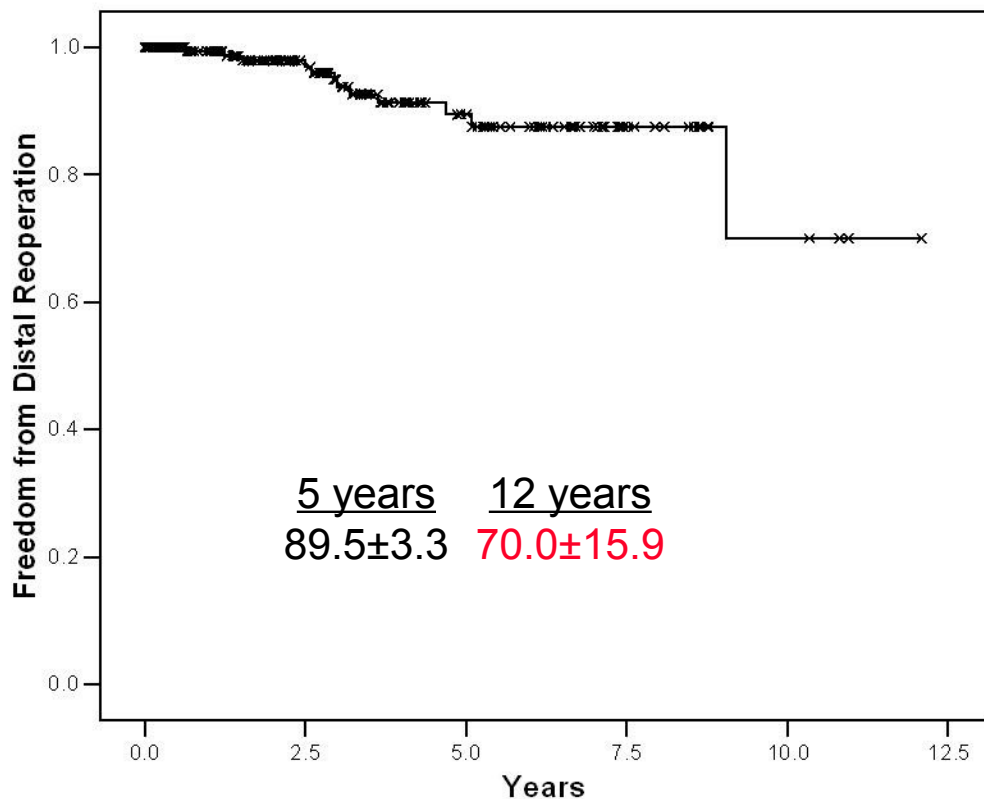
Median values reported. ∞ No test of significance due to insufficient Control data



# Freedom from Distal Reoperation after Repair of Acute Type A Dissection with Hemi-Arch

Geirsson, Bavaria, et al: Ann Thor Surg 2007  
Presented at STS 2007

N=237

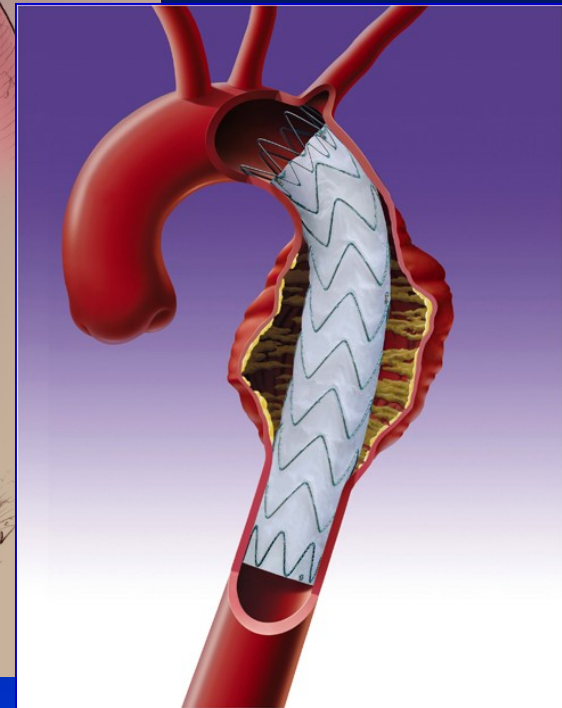
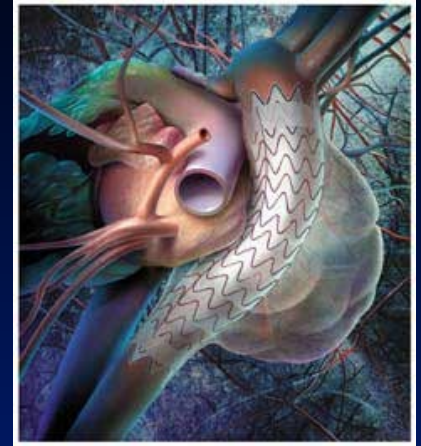
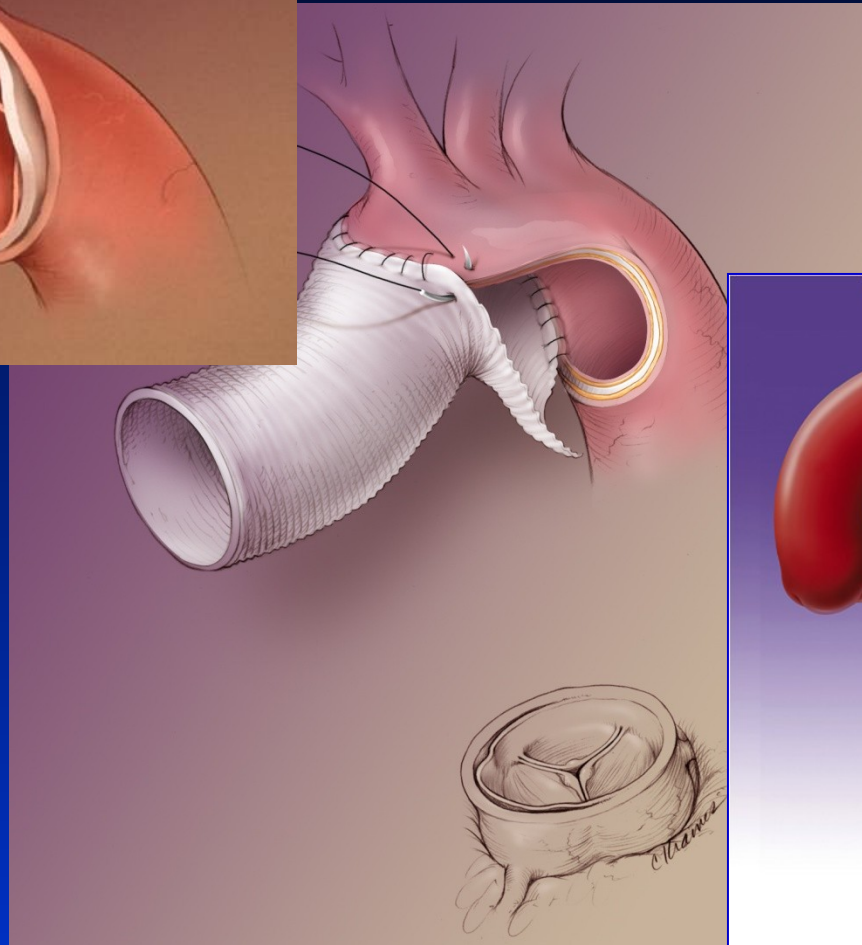
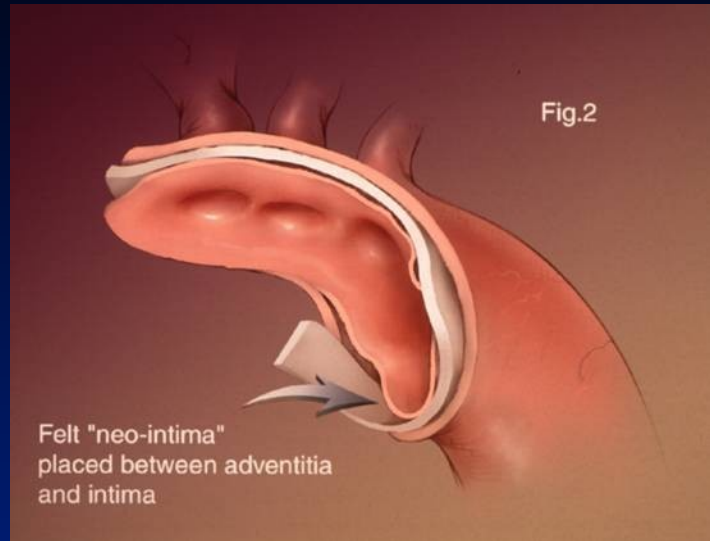


Years	1	2	3	4	5	6	7	8	9	10	11	12
At risk	147	117	83	59	46	36	22	11	4	3	1	0
Events	1	3	7	9	10	11	11	11	12	12	12	12

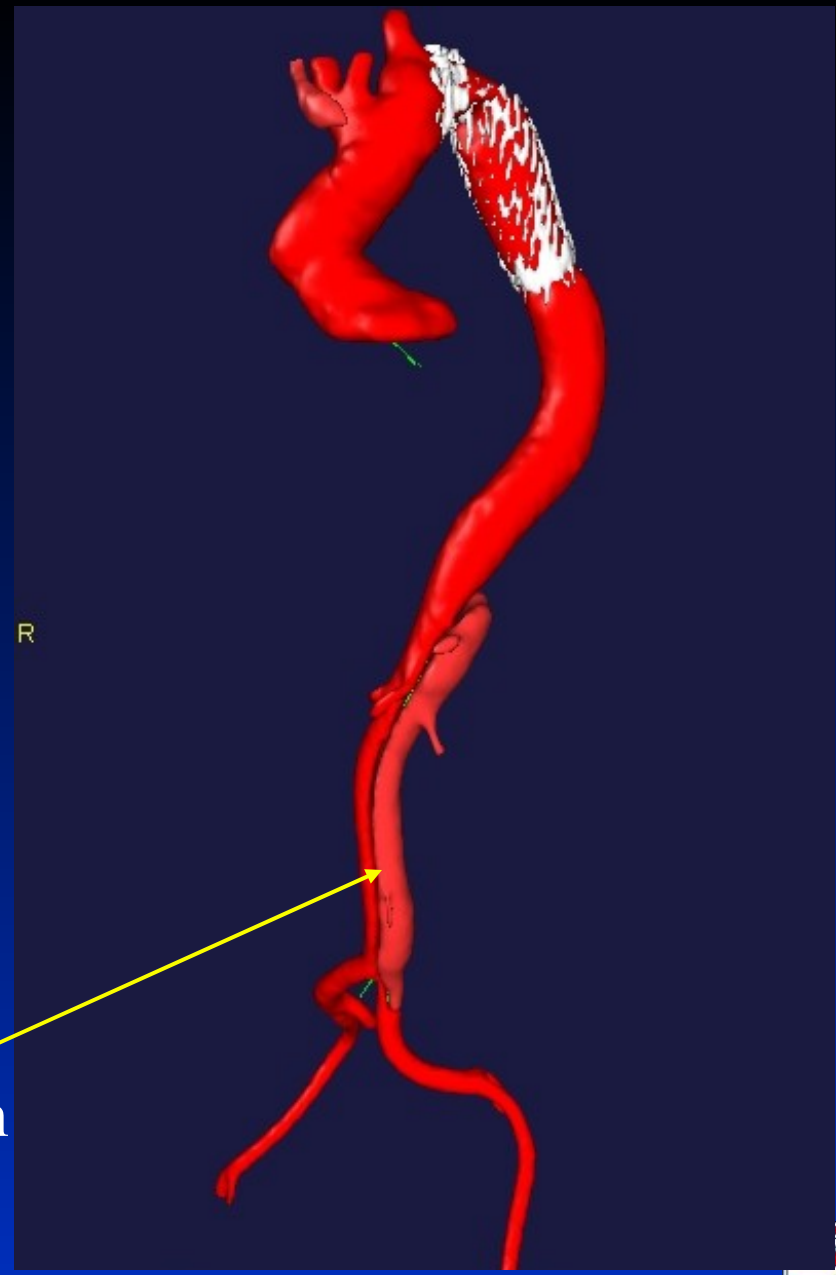
stem



# Acute Type A Dissection Hybrid “Stent Elephant Trunk” Procedure



- **Post-op CT angio  
(MMS 3-D  
reconstruction)**



Residual abdominal type B dissection

F.Bowen, J.Bavaria, et al; AATS 2006

