

# Key Factors in Developing Strategies for Type B Dissection

## Therapy:

**TEVAR for Dissection in 10 min!**

Joseph E. Bavaria, M.D.  
Roberts-Mealy Professor and Vice Chief  
CardioVascular Surgery  
Director: Thoracic Aortic Surgery Program  
University of Pennsylvania, USA



# Thoracic Aortic Dissection:

## Total Understanding

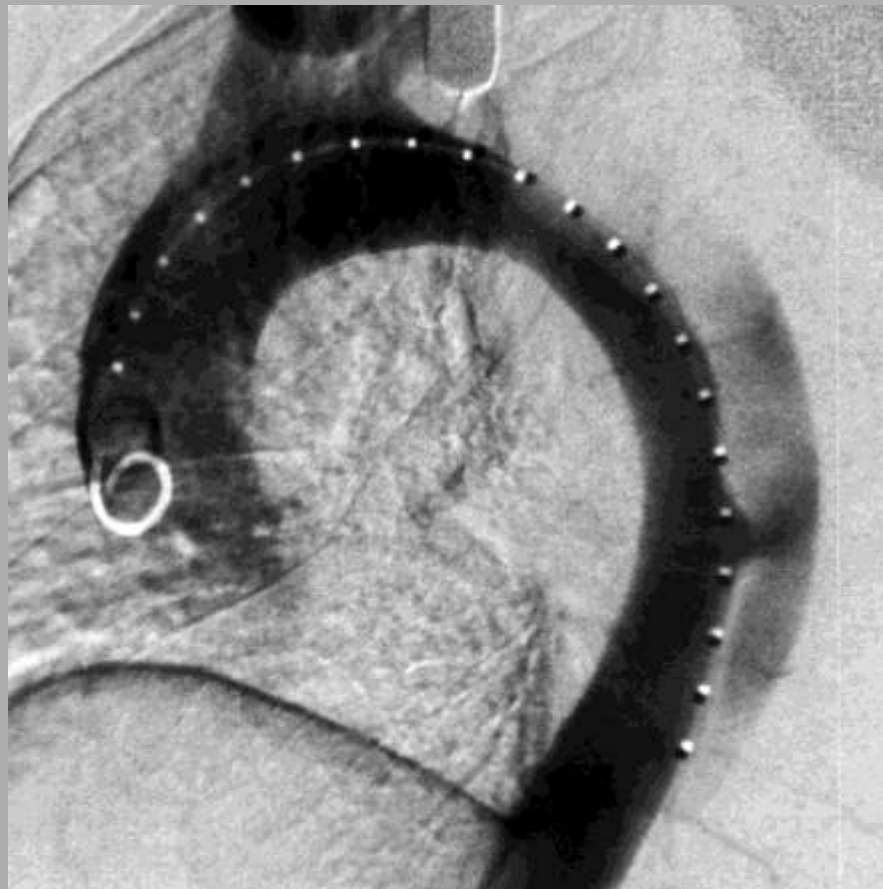
The Type B Dissection “Universe” as presented to the CV surgeon on a daily basis

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6. Acute Type A “Adjunct” Frozen Elephant trunk



# Pre & Post GORE TAG Device Implantation

It all started with these early pictures!!



Pre-Implant



Post-Implant

**Excellent Aortic Remodeling !!**

Early case: courtesy M. Dake



# Results of a New Surgical Paradigm: Endovascular Repair for Acute Complicated Type B Aortic Dissection

Wilson Y. Szeto, MD, Michael McGarvey, MD, Alberto Pochettino, MD, G. William Moser, CRNP, Andrea Hoboken, BS, Katherine Cornelius, BSN, RN, Edward Y. Woo, MD, Jeffrey P. Carpenter, MD, Ronald M. Fairman, MD, and Joseph E. Bavaria, MD

Divisions of Cardiovascular Surgery and Vascular Surgery, Department of Surgery, and the Department of Neurology, University of Pennsylvania Medical Center, Philadelphia, Pennsylvania

## Acute Type B Aortic Dissection (n=35)

**Rupture**

**18 (51.4%)**

**Malperfusion**

**17 (48.6%)**

**Mesenteric / Renal**

**5 (29.5%)**

**Iliofemoral**

**3 (17.6%)**

**Both**

**9 (52.9%)**

# Type B Dissection and Malperfusion: The Algorithmic Approach

1. Must cover primary tear site
2. Evaluation and treatment of persistent malperfusion
  - Adjunct stent grafts /mesenteric stents
    - Infrarenal stents
    - Iliofemoral stents
3. Goal: Expansion of true lumen and correction of malperfusion
4. There is no rupture



# Operative Outcome

- Technical success defined as coverage of primary tear site 97.1% (34/35 patients)
- No conversion to open repair
- Left SCA-carotid bypass in 1 patient
  - \*On POD # 6 for left arm ischemia

- Distal adjunctive procedures performed in 12 patients (34.3%)



**Example: Distal Malperfusion in right leg after Primary thoracic TEVAR and opening up MESENTARIC SEGMENT: Role of Additional Distal endovascular procedures**



**Pre Repair**



**Post Repair**

# Type B Malperfusion Decision Algorithm

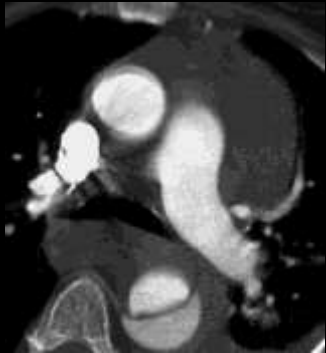
- 1. TEVAR cover Primary Tear (entry) site, Usually in proximal Descending Aorta
- 2. IF there is still Malperfusion, THEN need Second Stent to the Celiac Axis (25-30%)
- 3. IF there is still Malperfusion THEN need DIRECT stenting of the Malperfusion artery
- 4. If this not working then fenestration.....  
Bad!!





# Type B Dissection and Rupture

- Must cover primary tear site
- And must cover site of rupture (usually entire thoracic aorta from LSCA to celiac)



**Drain  
blood  
in Left  
Chest!!**



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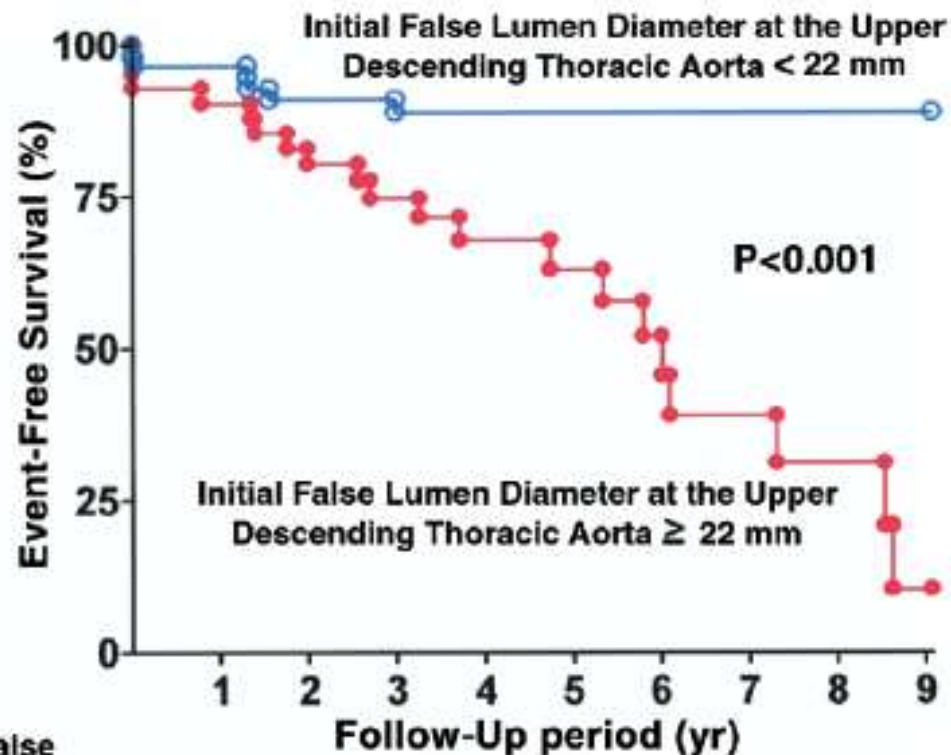
# The Concept:

Many Un-Complicated Type B Dissections are at “High Risk” for Late Aortic events

1. What characteristics do they have?
2. In this Group maybe we can “Tolerate” a 3% periop mortality?



# False Lumen Diameter > 22mm at Time of Initial Acute Type B Dissection Predictive of Late Death



Initial False Lumen Diameter	Patients at Risk				
	0	1	2	3	4
< 22 mm	58	48	30	11	2
≥ 22 mm	42	32	17	8	3

Song et al. JACC, 50:799-804, 2007



# Aortic Diameter at Presentation

## A Prospective Study of Medically Treated Acute Type B Aortic Dissection

A. Winnerkvist,\* U. Lockowandt, E. Rasmussen<sup>a</sup> and K. Rådegran

*Department of Cardiothoracic Surgery and Anesthesiology, Karolinska University Hospital and  
Department of Molecular Medicine and Surgery Karolinska Institutet, Stockholm, Sweden*

- Freedom from aortic event (dissection-related death, aneurysm formation >6cm, new Type A dissection) 75% @ 5yrs & 67% @ 10yrs
- Significant predictors of aortic event
  - **Maximal aortic diameter >4.0 cm at first CT scan (hazard ratio 3.5; 95% CI 1.2-9.7; p=0.018)**
  - IMH with localized PAU (hazard ratio 14.5; 95% CI 1.8-13.1; p=0.0018)

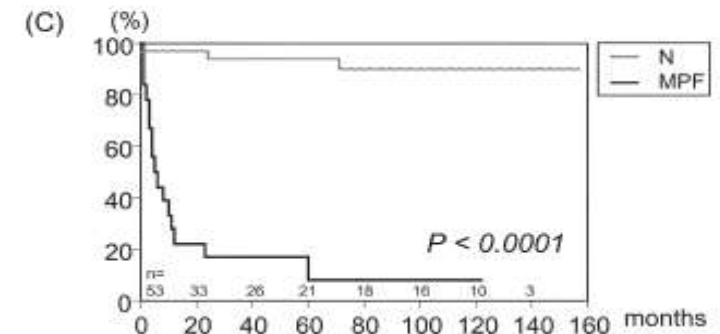
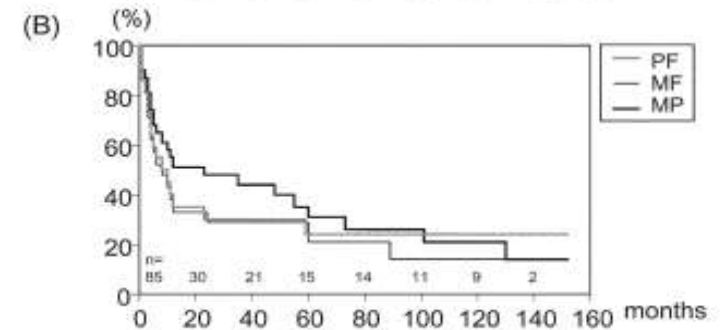
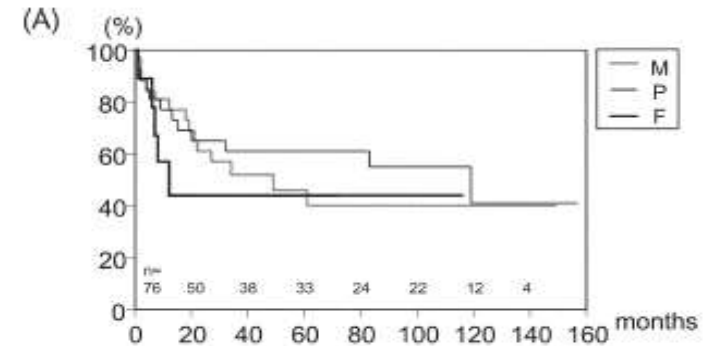


# Predictor of Late Aortic Events: Acute Uncomplicated Type B Aortic Dissection

TABLE 3. Statistical analysis of predictors for late aortic events

Predictive factor	Univariate		Multivariate	
	$\chi^2$	P	P	Hazard Ratio (95% CI)
Sex	0.27	.60		
Age $\geq$ 70 y	0.66	.42		
Hypertension	1.83	.18		
Diabetes mellitus	2.40	.12		
Ischemic heart disease	4.38	.036	.45	1.67 (0.96-2.81)
Cerebrovascular disease	4.10	.043	.63	1.53 (0.78-2.67)
COPD	0.61	.44		
Hemodialysis	1.46	.23		
LVEF $\geq$ 70%	2.61	.11		
Type (DeBakey IIIa/b)	0.19	.66		
Patent false lumen	9.70	.0018	.024	2.64 (1.62-4.03)
Aortic diameter $\geq$ 40 mm	15.2	<.001	<.01	3.18 (2.12-5.05)
FI $\geq$ 0.64	10.9	<.001	.013	2.73 (1.85-4.60)
Mean systolic blood pressure during follow-up ( $\geq$ 140 mm Hg)	1.75	.19		

CI, Confidence interval; COPD, chronic obstructive pulmonary disease; LVEF, left ventricular ejection fraction; FI, fusiform index.



# Proximal Entry Tear Size

**Circulation**

JOURNAL OF THE AMERICAN HEART ASSOCIATION



American  
Heart  
Association®

**Long-Term Outcome of Aortic Dissection With Patent False Lumen: Predictive Role of Entry Tear Size and Location**

Artur Evangelista, Armando Salas, Aida Ribera, Ignacio Ferreira-González, Hug Cuellar, Victor Pineda, Teresa González-Alujas, Bart Bijmens, Gaietà Permanyer-Miralda and David Garcia-Dorado

*Circulation*. 2012;125:3133-3141; originally published online May 21, 2012;

doi: 10.1161/CIRCULATIONAHA.111.090266

*Circulation* is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231

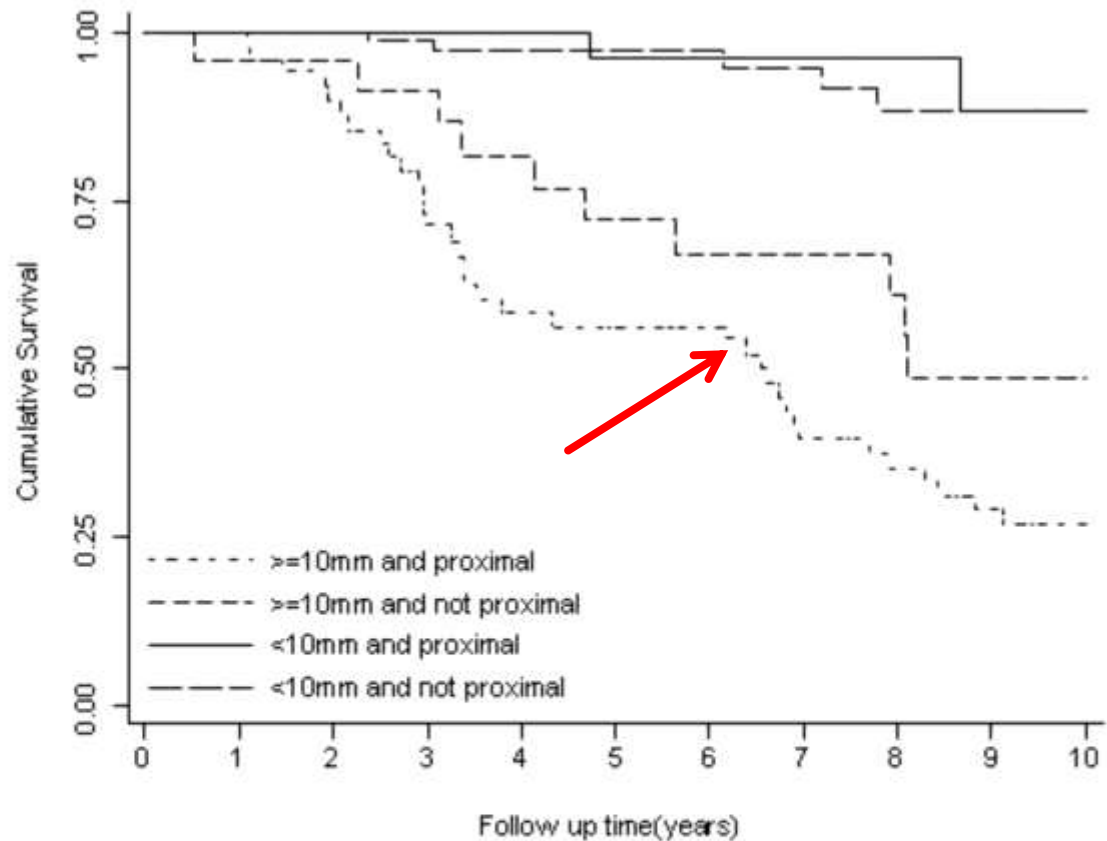
Copyright © 2012 American Heart Association, Inc. All rights reserved.

Print ISSN: 0009-7322. Online ISSN: 1524-4539



# Entry Tear Size and Proximal Location

Evangelista A et al. *Circulation*. 2012;125:3133-3141



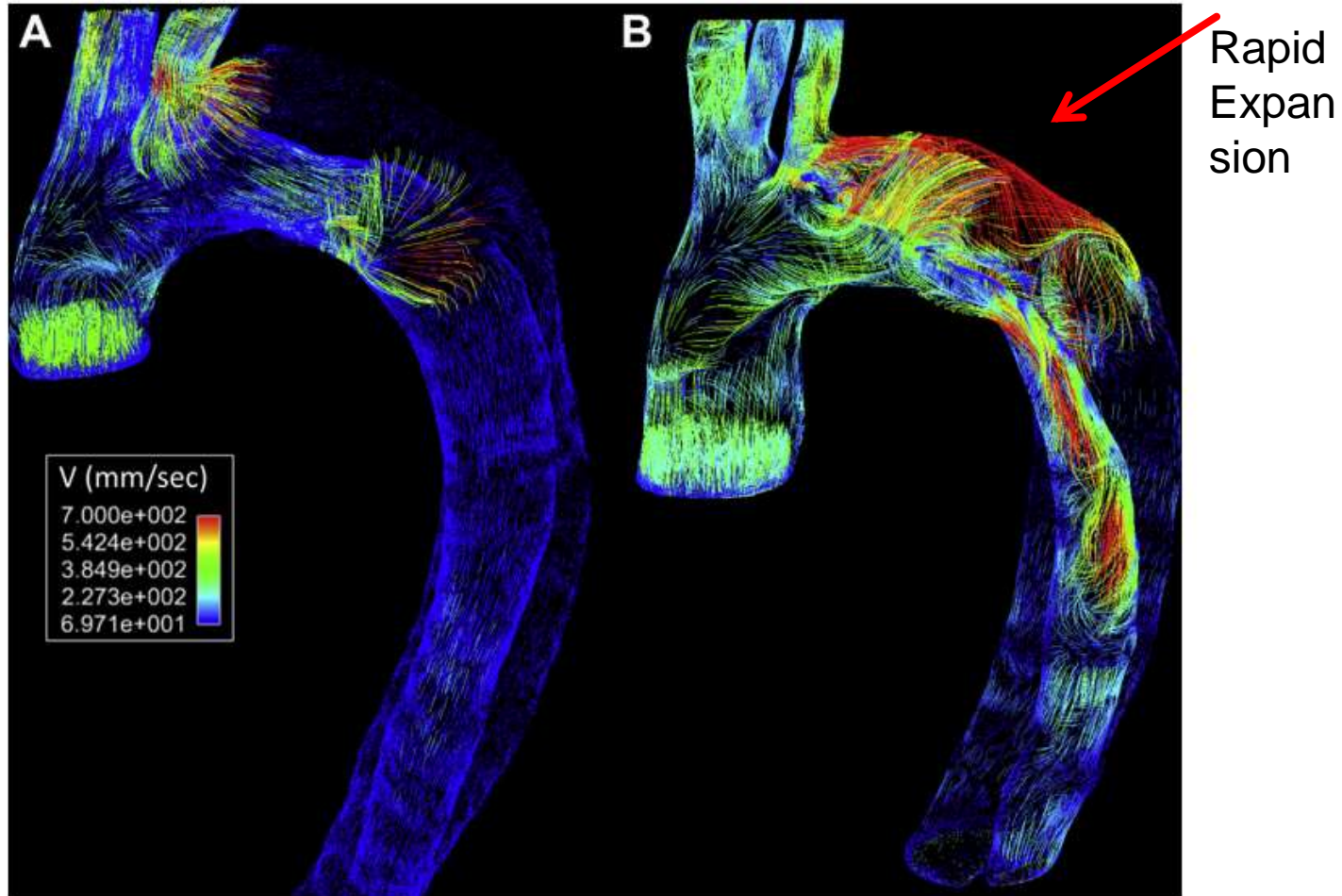
	0	1	2	3	4	5	6	7	8	9	10
$\geq 10\text{mm}$ prox	49	49	43	34	28	27	27	19	17	13	12
$\geq 10\text{mm}$ not prox	23	22	21	19	17	14	12	12	10	8	8
$< 10\text{mm}$ prox	38	38	35	31	29	24	20	15	12	11	10
$< 10\text{mm}$ not prox	74	74	66	58	54	48	41	34	28	27	24



# Rapidly Expanding False lumen

Larger Tear site = More Time Averaged Wall Shear Stress

E.Shang, B.Jackson, J.Bavaria, et al (JVS 2015)

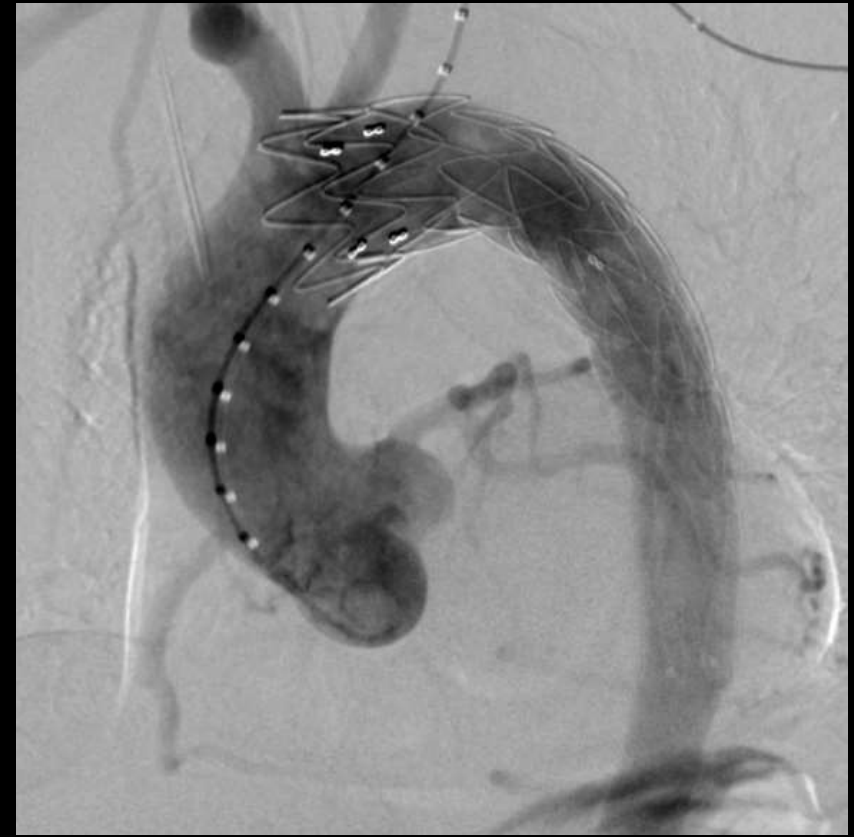
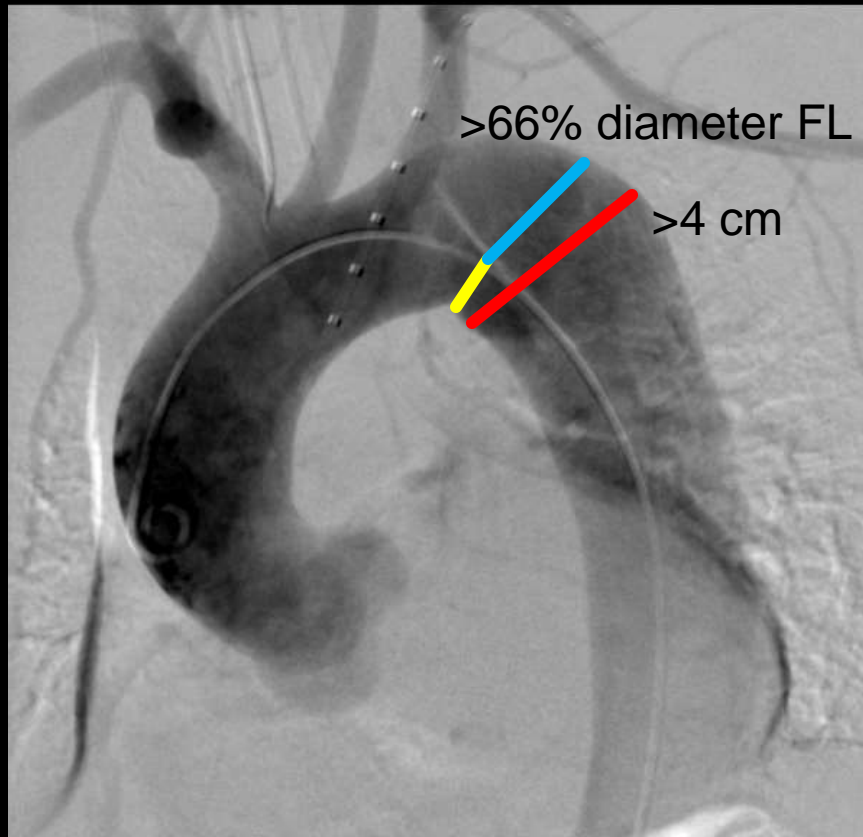


**Fig 2.** Flow velocity maps of the thoracic segments of the aortic dissections in Fig 1 showing the acceleration of blood through dissection tears and its subsequent impingement on the far aortic wall. **A**, An aortic dissection with a stable transaortic diameter. **B**, An aortic geometry that demonstrated rapid expansion.



# Acute Type B “High Risk Un-Complicated” with Distal Aortic Remodeling

Very compelling !!



Also Young (44 yrs old) and on 4 drug anti HTN drugs



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# What is the **KEY** to TEVAR in Acute Un-Complicated Type B Dissection?

Performing the Initial Procedure with a Peri-operative mortality rate of **LESS** than 3% (<3%).....Why?

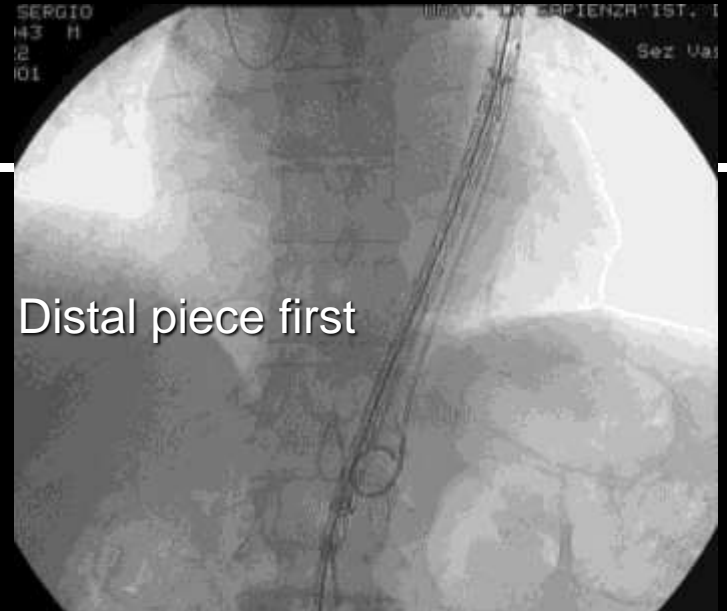
How do we do this? **Answer:** Better designed and disease specific grafts and optimum technical operations



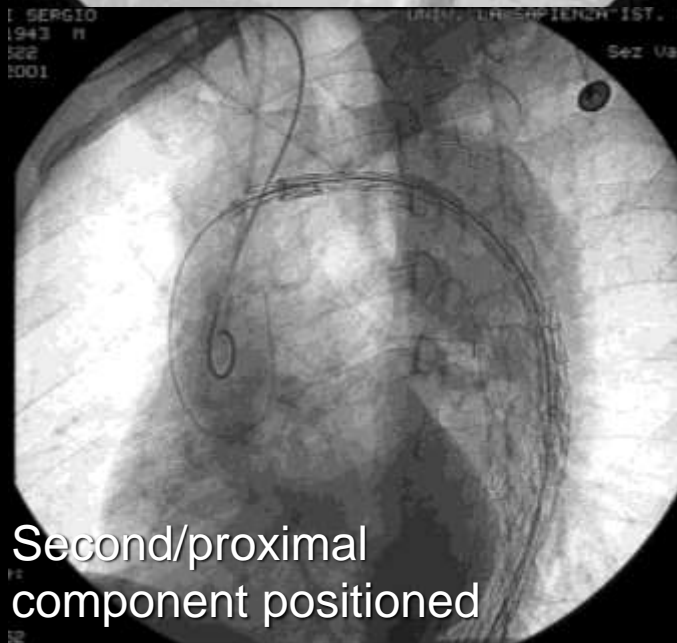
# Dissection Example of Deploying Distal Device First



Type B Dissection



Distal piece first

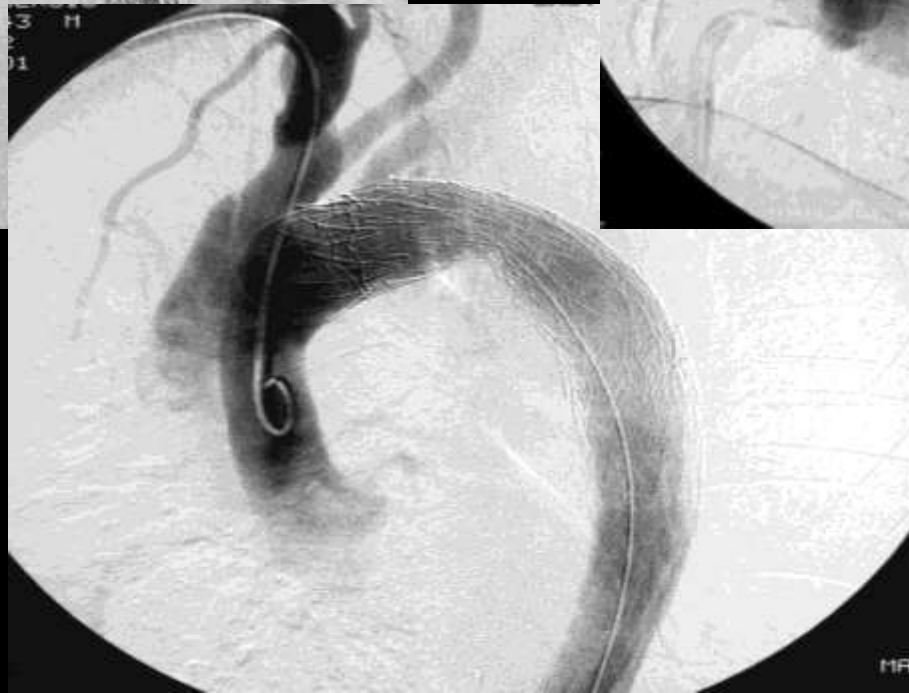


Second/proximal component positioned



Aortogram

# Dissection Procedure – Conversion of Type B to Type A



# Acute Type B Dissection and TEVAR: Retrograde Type A Dissection ....

## FDA IDE Trials

- Gore Complicated FDA Type B Dissection Trial (N=50)
- Medtronic Complicated FDA Type B Dissection Trial (N=50)
- Total Retrograde Type A Dissection Rate for Both FDA Trials (N=100)

**= 6%**



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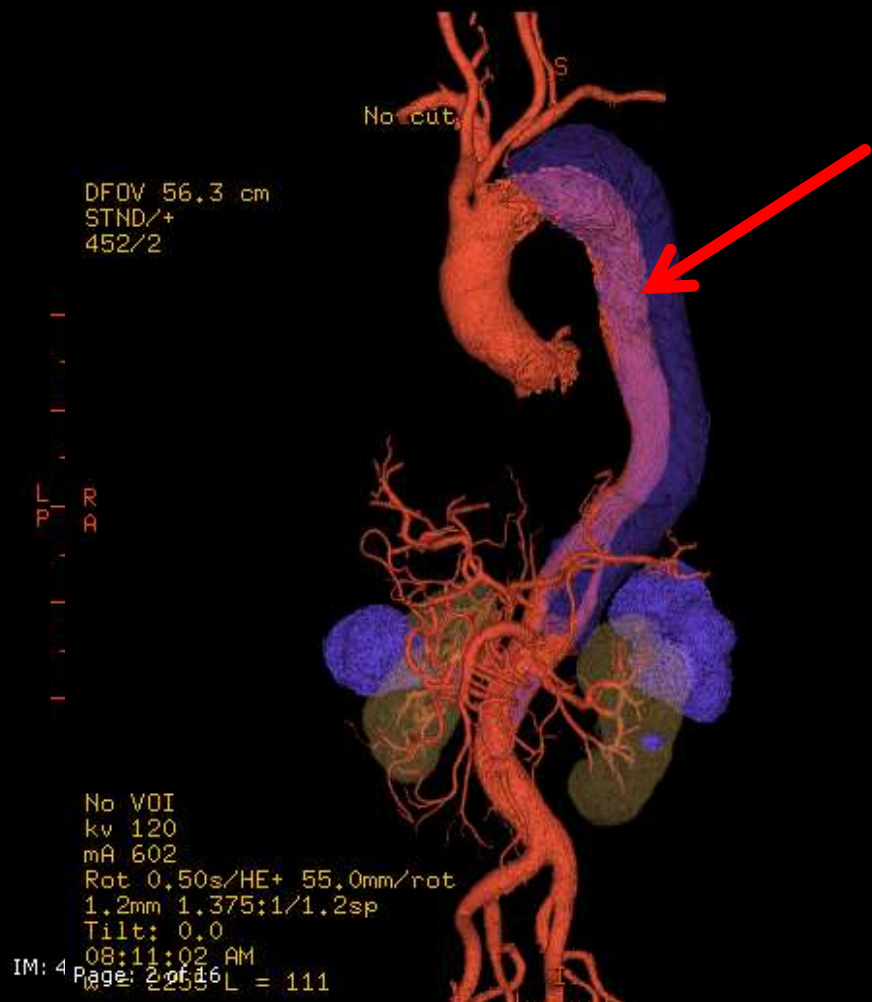




# Chronic Type B aortic dissection: Again **all 4 vessels** off true lumen



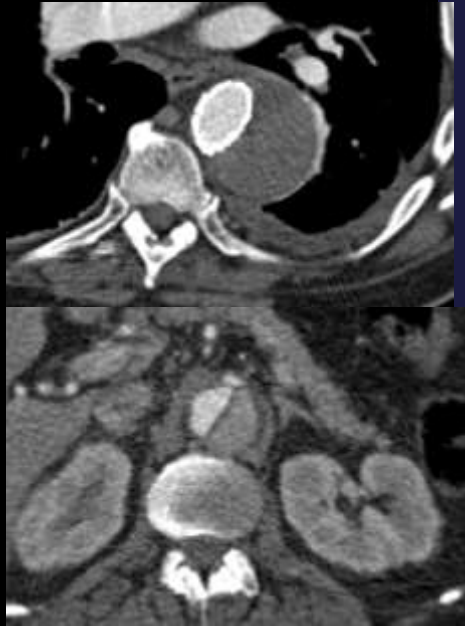
**Pre-stenting**



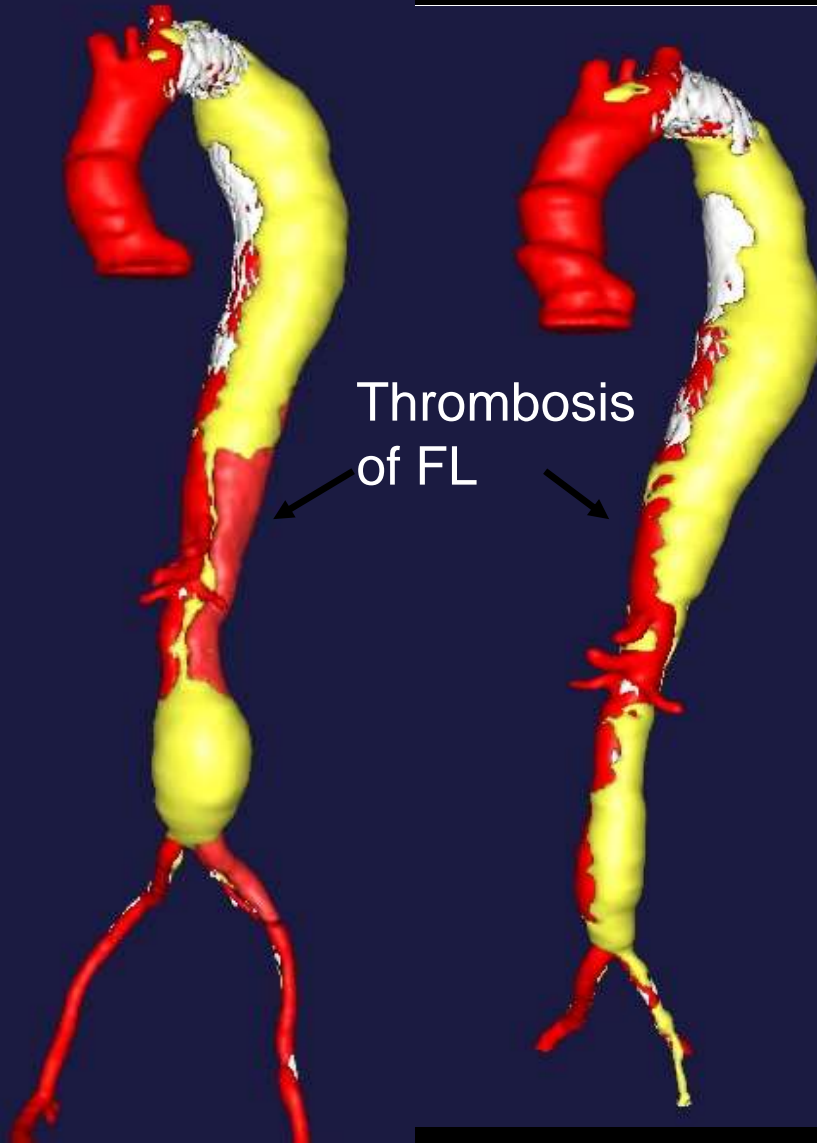
**Post-stenting**



# Aortic Remodeling: Thrombosis of FL



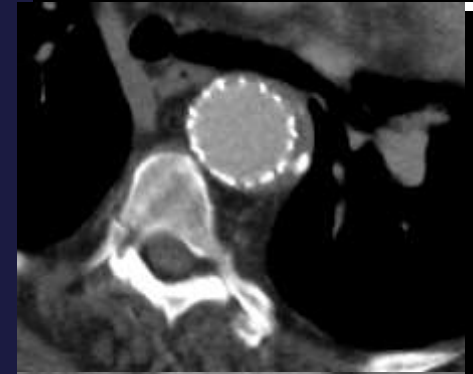
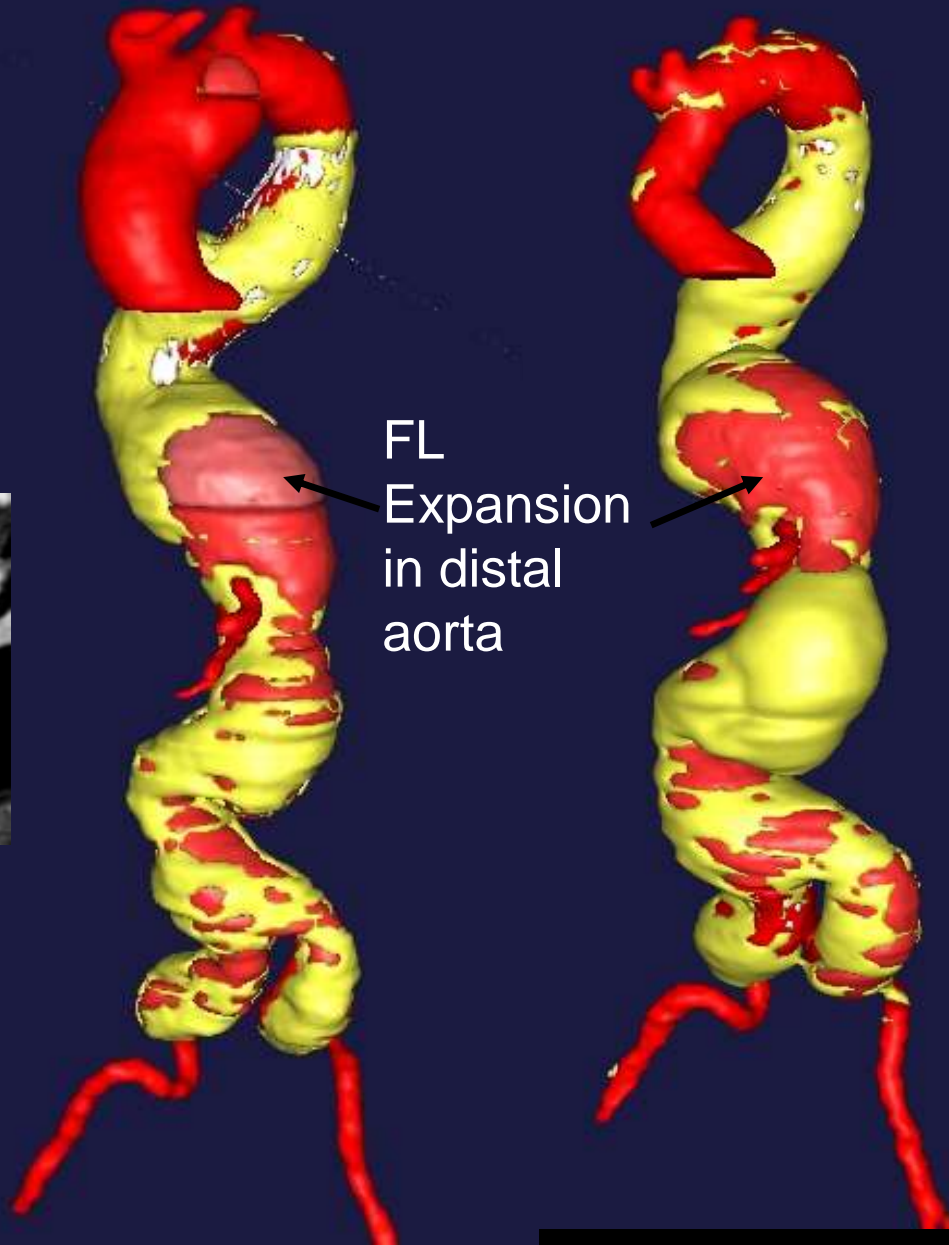
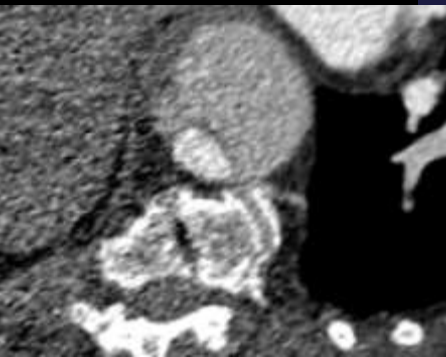
1 month

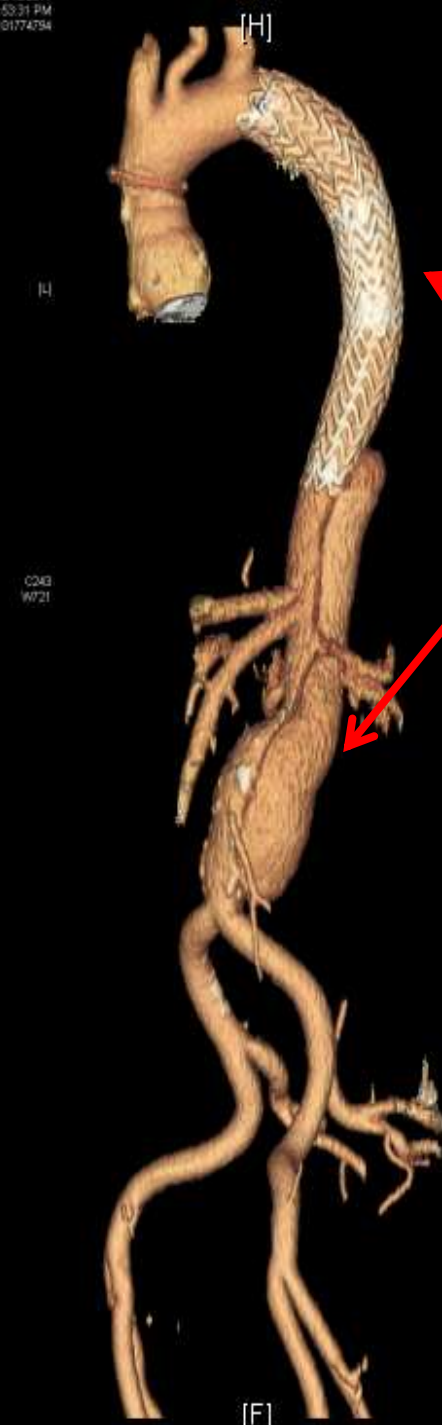


2 years



# Continued Distal Aortic Degeneration





False Lumen

Thoracic: Thrombosed  
Abdominal: Patent

S/P DeBakey Type I  
s/p Asc/Hemi



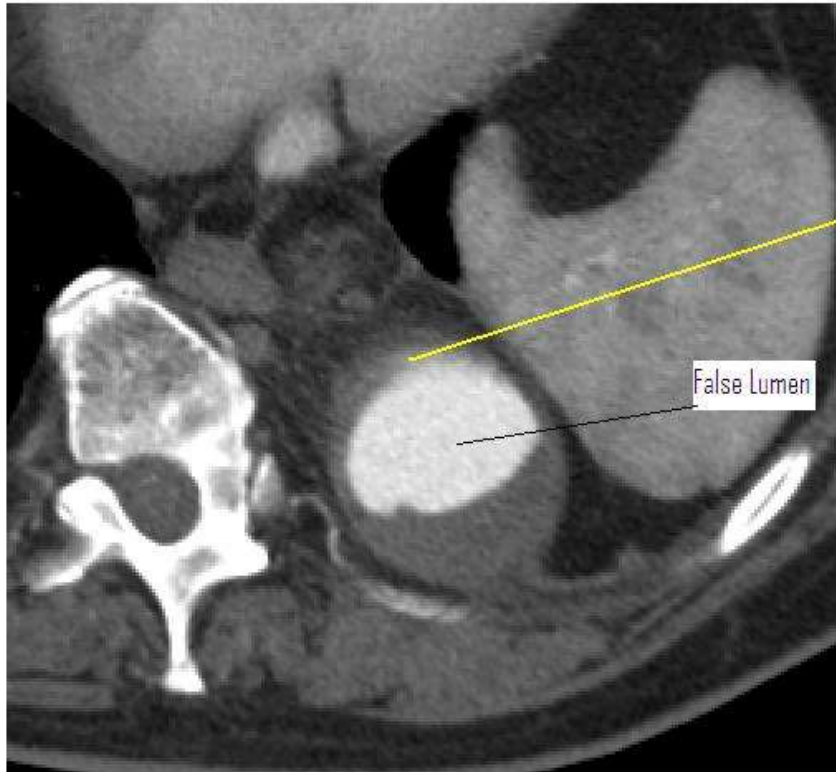
# C-TAG Dissection: Use of Two grafts down to Celiac: For Better Remodeling



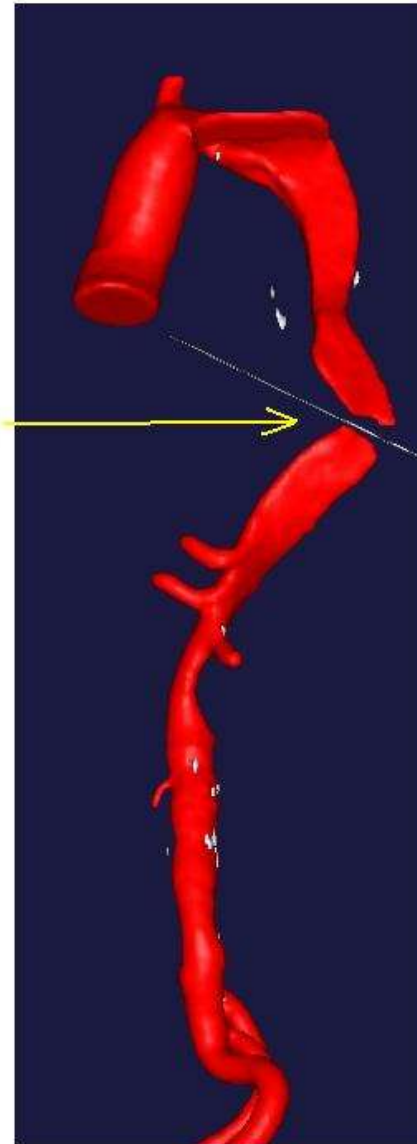
C-TAG for  
Dissection: To  
Celiac →



# Not Good!!



No True Lumen!



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Or .....

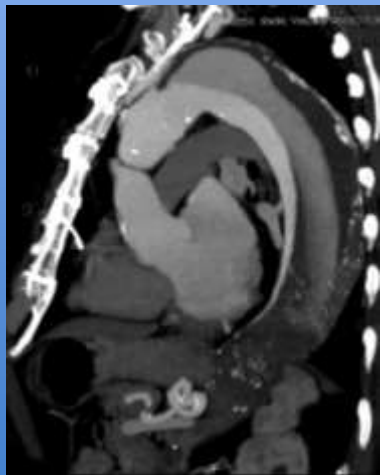
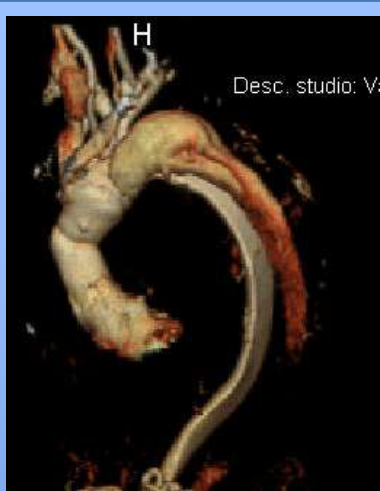
Dacron Zone 2 or  
3 LZ "prepared"

**Residual Type B  
Dissection AFTER  
completion of  
Primary Type A:  
Chronic**

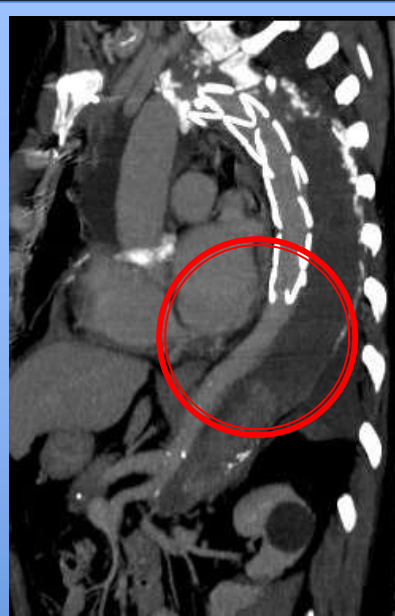




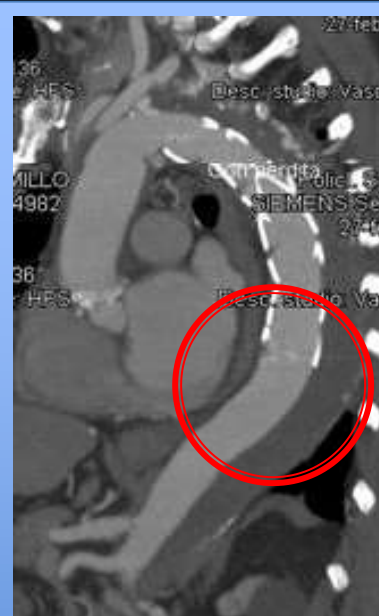
# Chronic Type A Aortic Dissection: Residual "Type B"



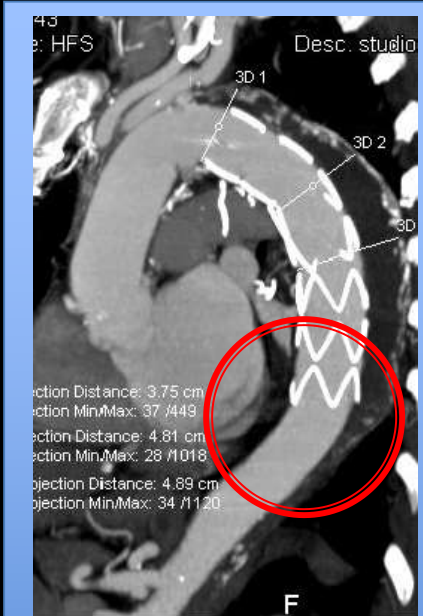
Pre-operative



1 week after surgery



After 3 months



After 2 years

**Note: All 4 vessels off TL and Distal LZ opening**

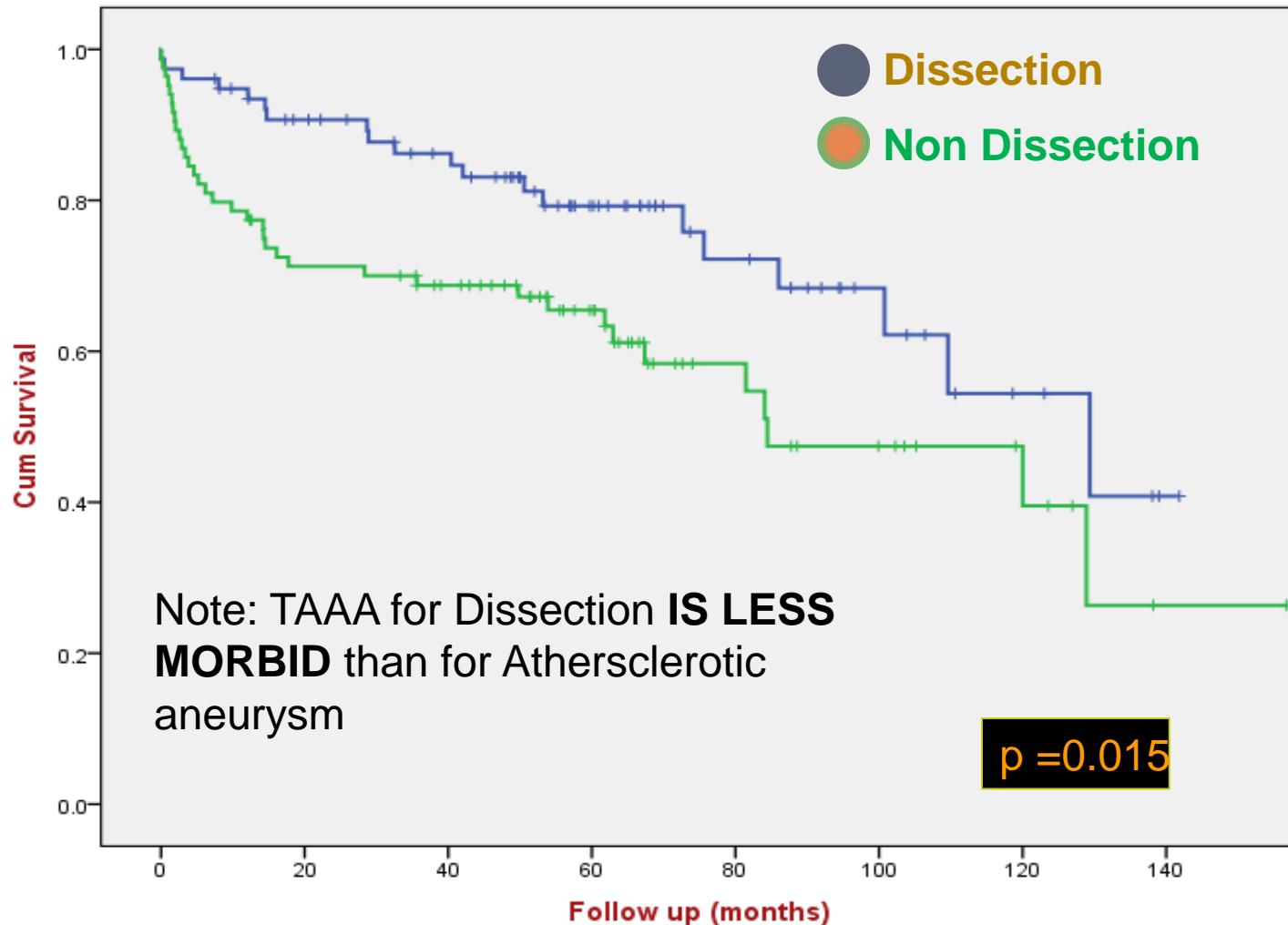
# Misconception (Open TAAA):

**TAAA Chronic Dissection is  
Very different than TAAA  
Atherosclerotic Aneurysm**

Results are better



# Important: Survival and TAAA Dissection(Open)



# Example: Dissection DHCA Results: Considerations

- Corvera and Fehrenbacher 2012 (Indiana)
  - N= 93 Chronic Dissections; mean age = 60
    - 50/50 Residual Type A vs Denovo Type B
  - 100% DHCA
  - 40% Type II

- Mortality = 2.2% (less than their non-dissected TAAA; 93/343)
- Paraplegia = 1%
- 8.8% Re-intervention at mean 54 months



# Dissection "Younger Patient" Results: Considerations

- Di Luozzo and Griep; 2013
- N= 107 Chronic Distal Dissections
- All < 60; Mean age = 48
- Mortality = 4.7%
- 43% DHCA
- CVA = 3.7% and Paraplegia = 1%
- 85% 5 year Survival with only 1 Re-intervention

These Results are better than the Standard  
Atherosclerotic TAAA series



# Results: Chronic dissections Penn Series Concurrent Series, "TEVAR Era" (2005-2014)

	Open n=80	TEVAR n=52	P
Death	6 (7%)	1 (1.9%)	0.37
Spinal Drain	69 (86 %)	26 (50%)	
Post-Op Neurologic Deficits	9 (12%)	1 (2%)	0.0045
Stroke	2 (3%)	0	1
Perm Paraplegia	7 (9%)	0	0.1
Post-op Renal Failure	7 (9%)	1 (2%)	0.18
New Post-op Dialysis	5 (7%)	1 (2%)	0.52
Ventilator requirement (Hrs)	145	6.1	0.02
ICU LOS (Hrs)	301	54	0.005
Hospital LOS (days)	19.2	6.9	0.0003

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**This is Highly Selected**

**Our Approach and  
Algorithm towards  
Chronic Type B  
Dissection TAAA?**





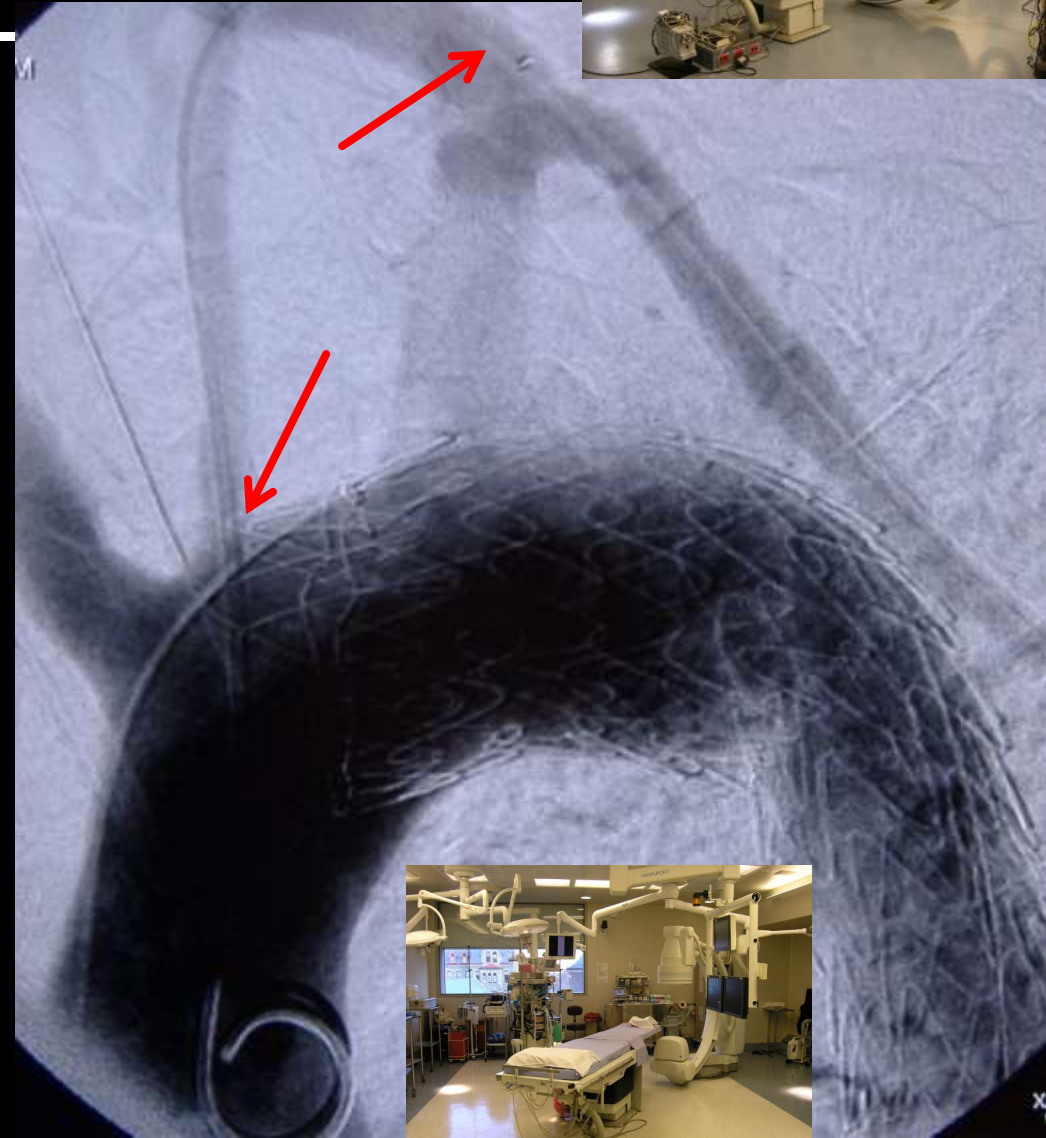
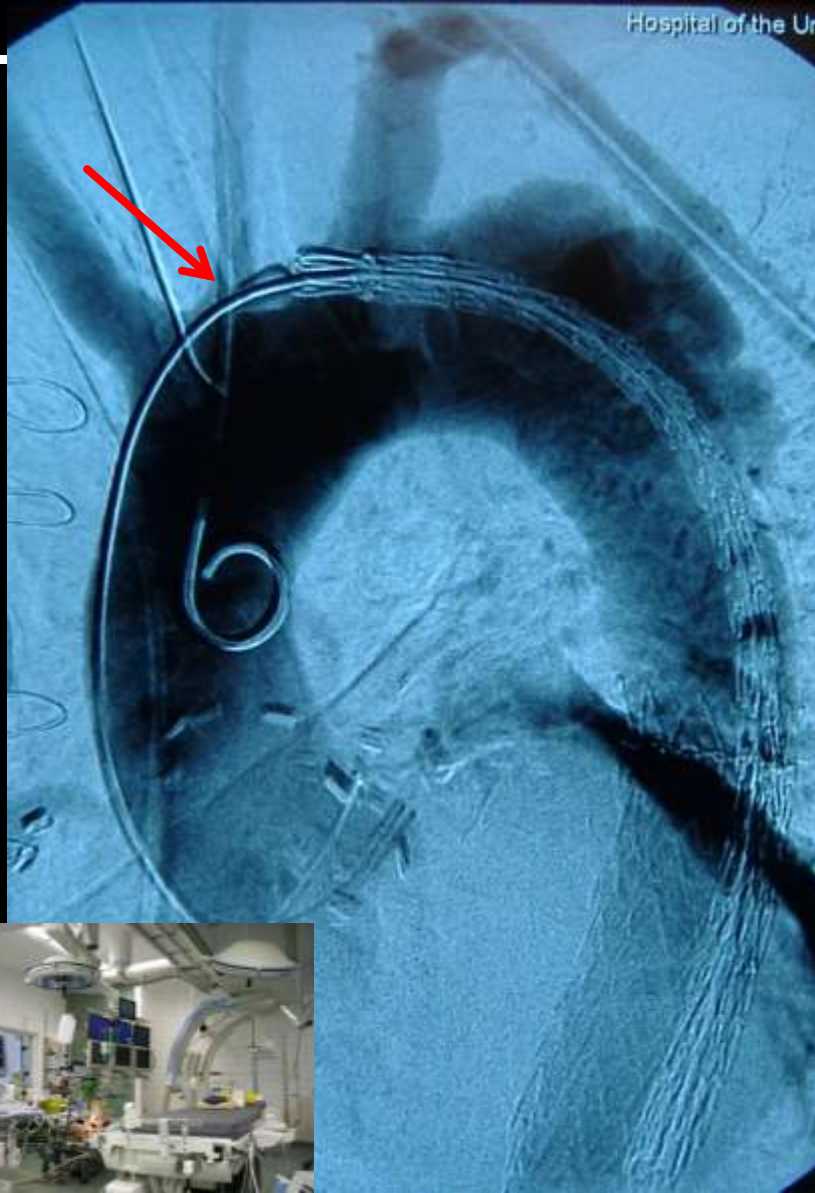
# OPTIMIZATION of TEVAR Results in Chronic Type B Dissection: Anatomic Constraints

## Rules of Engagement !

- As many Abdominal Vessels off True lumen as Possible. Best is ALL 4 (Celiac, SMA, both Renals). This anatomy **Minimizes** distal large re-Entry sites
- Solid (Good) Caliber **Proximal** LZ
- Large Primary Tear site or Fenestration that can be Covered by TEVAR Proximally
- No “Pseudo-Coarctation” of Distal LZ



# Technical Advantages of Subclavian bypass/Transposition @ Zone 2



# Management of Acute Aortic Dissection (Type A): Best Surgery?

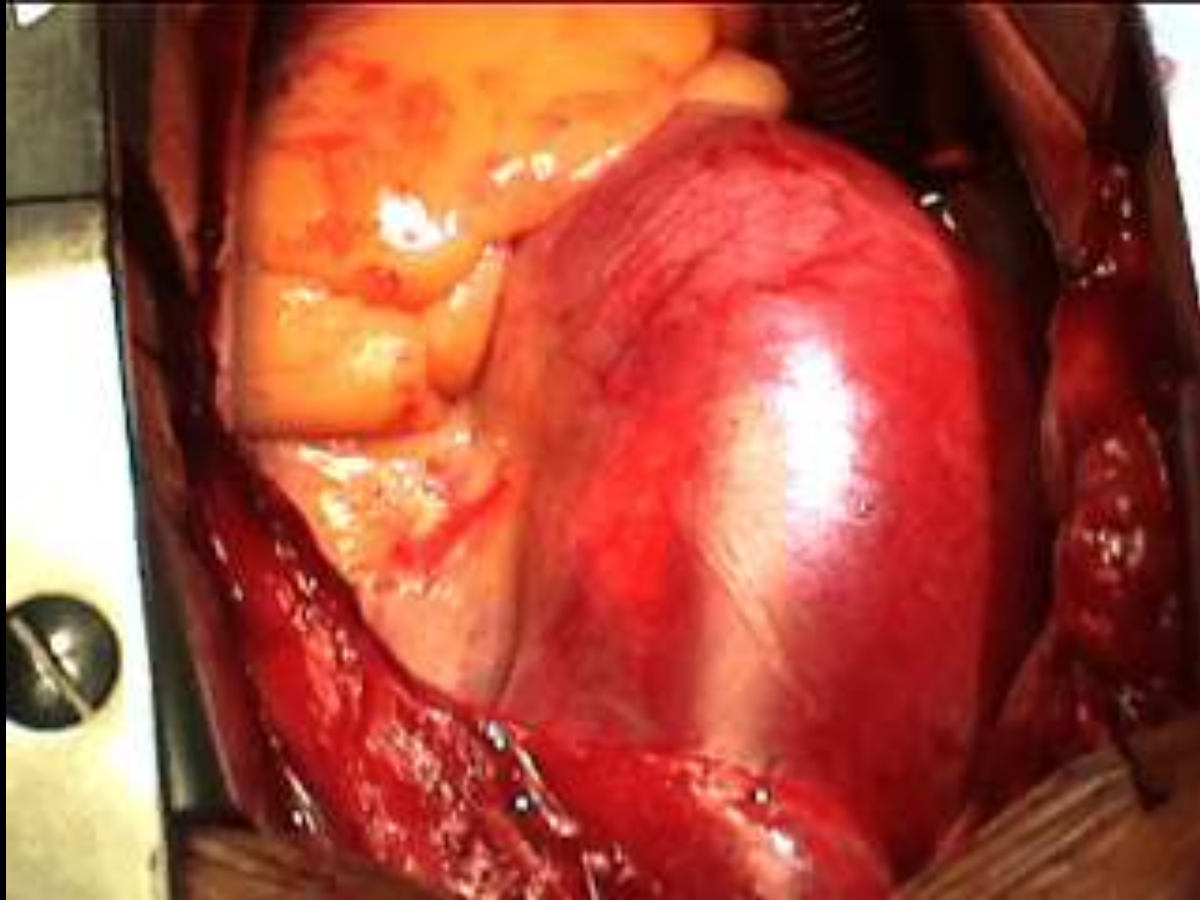
## A New Landscape is Emerging!

Joseph E. Bavaria, M.D.  
Roberts-Mealy Professor and Vice Chief  
CardioVascular Surgery  
Director: Thoracic Aortic Disease Program  
University of Pennsylvania, USA



# What about Acute Type A Dissection?

- What is State of the Art??



# Perspective: Where we were ..... 1992-3

- Stanford (and my Review of Penn 1988-1992 data) reported basically 25/25 club
- We were in the “Crawford” arch algorithm ..... Disaster
  - Clamped Ascending, go into Arch IF “tear” extended past clamp. Nothing certain. Intra-op chaos ..... Bottom line: **Death**
- Total “equipoise” (really no understanding) of Resuspension vs Root
  - Concept of independent resuspension and proximal suture line **Non-Existent**



# Perspective: Where we were ..... 1992-3 (cont ....)

- Massive Bleeding, No good grafts, A rudimentary real understanding of the Circulation Management complexity needed to successfully prosecute this operation!, blood product administration nothing more than “Give a lot” ..... A lot of Dead RV's
- We admitted to ICU, had 4<sup>0</sup>% mortality while waiting for OR

**Result: Worldwide High Mortality and CVA**

- **The 30/30 club**

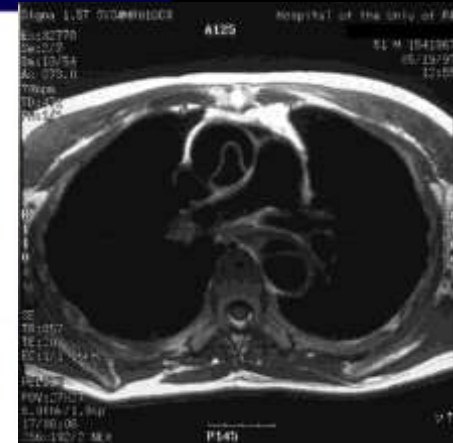
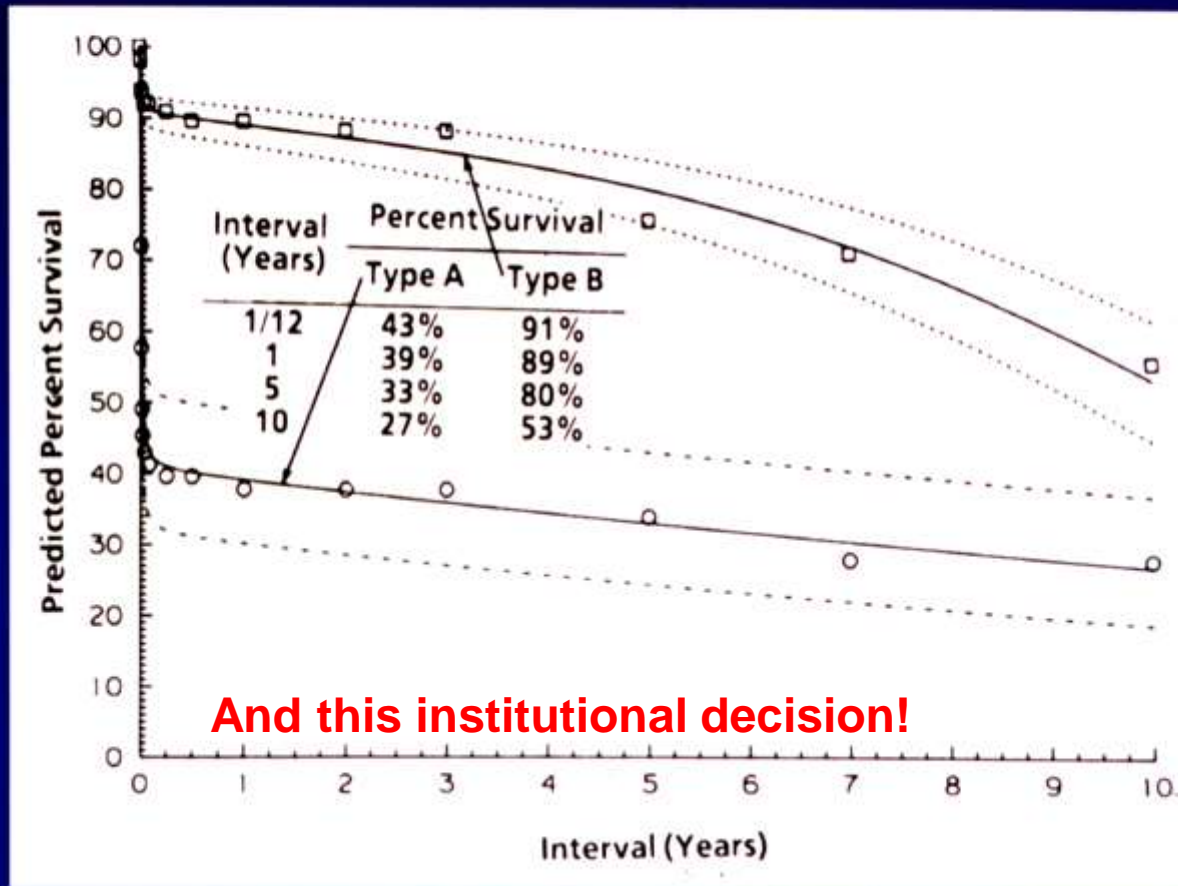
Most common Cardiology post op question: Arch vessels ....57%



# Why Do We Operate??!

## Natural History: Survival

From Masuda Y et. al. Prognosis of patients with medically treated aortic dissection. Circulation 1991; 84(suppl III):III-7



**And this institutional decision!**

**IRAD Data very Similar = 58% one month mortality in NON-Operated group!**

# The Concepts behind the Rational Design of a Therapeutic Operation for Type A Dissection (circa early- mid 1990's)





# Acute Type A Dissection: Design of an Operation

## Cause of death

Acute CHF due to AI

Coronary malperfusion

Cerebral malperfusion

Free Ascending rupture

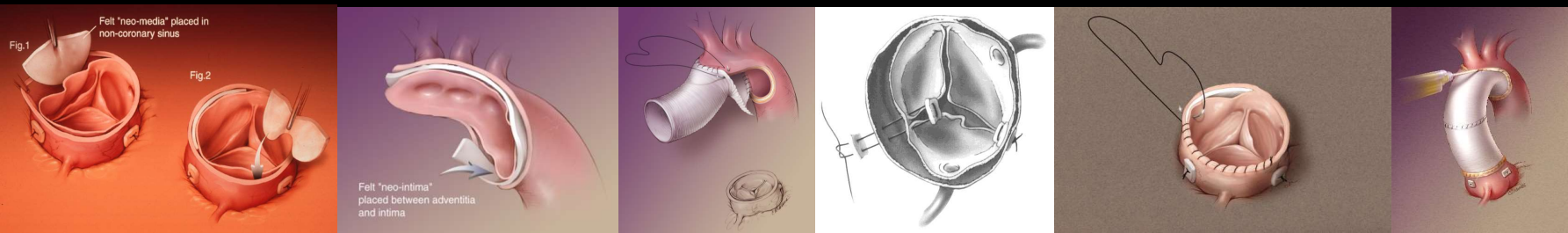
## Treatment

Aortic valve resuspension

Aortic root repair

Arch replacement

Asc aortic replacement



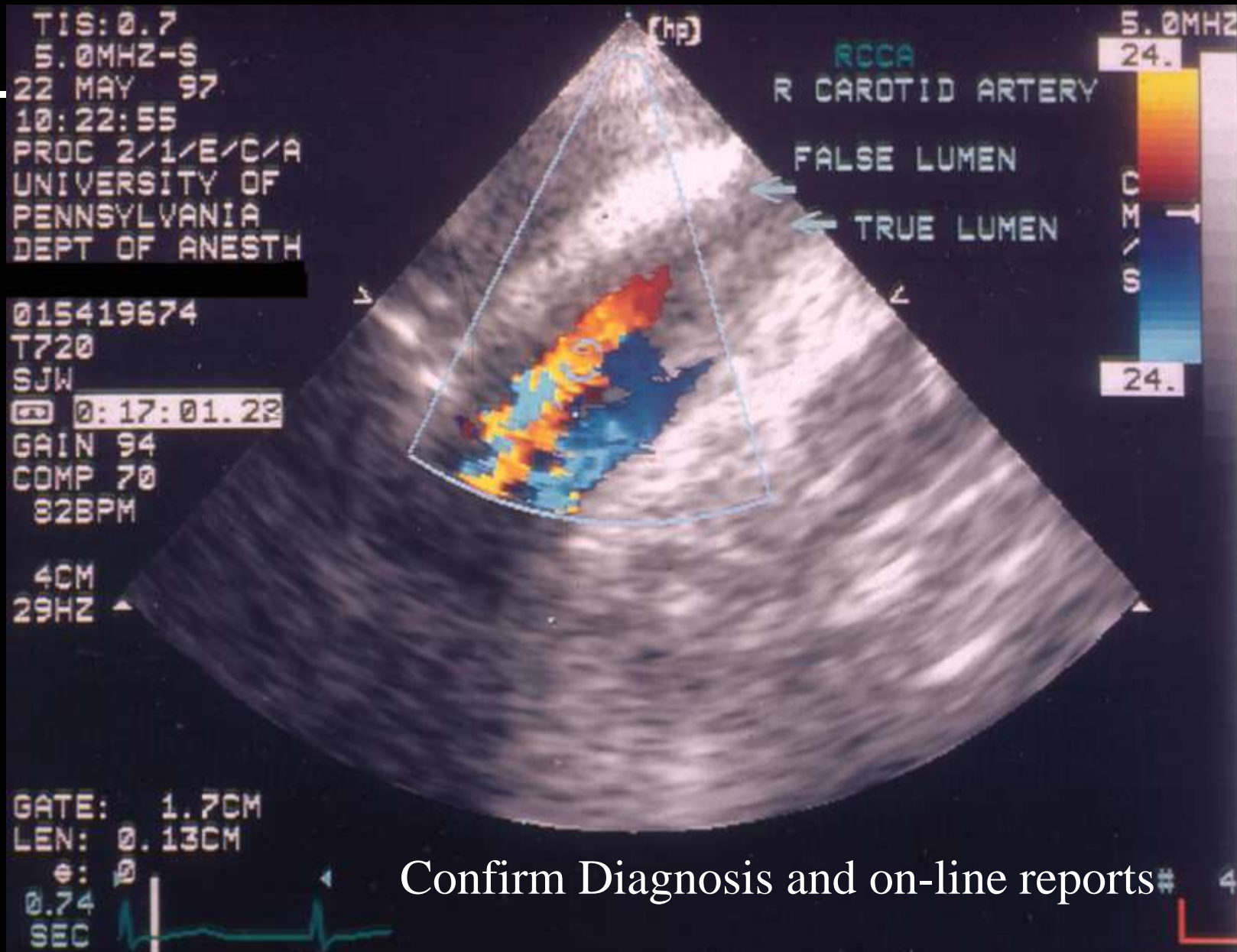
# Operative Reconstructive Strategy and Conduct of Operation

Note: Most Important was a Systems Based Approach  
Rather than multiple individual idiosyncrasies



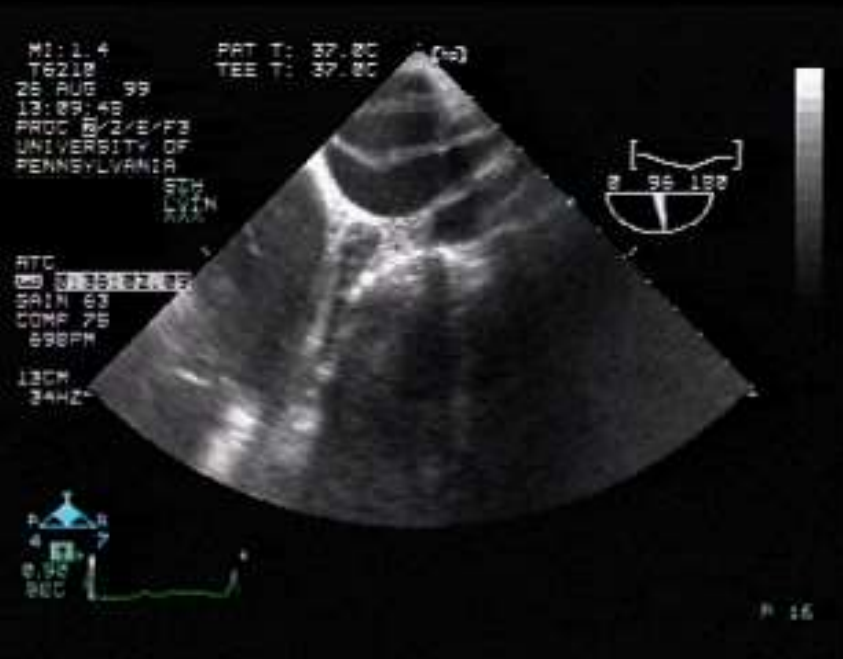


# Right Carotid Artery Doppler (TEE Probe): Acute Type A Dissection



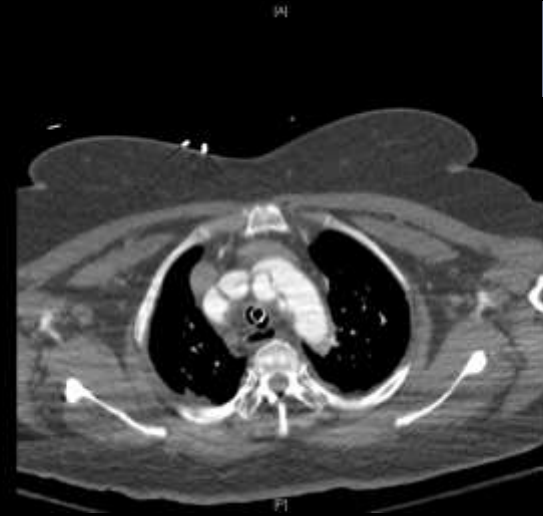
Arterial Cannulation Site: This can be a Difficult decision!

There is **NO** perfect cannulation site in acute Type A Dissection



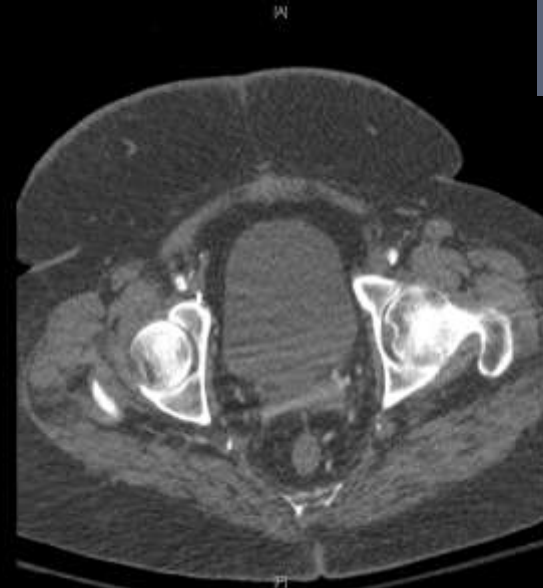
Left Subclavian dissection

10  
Se8  
In 70



Arch dissection

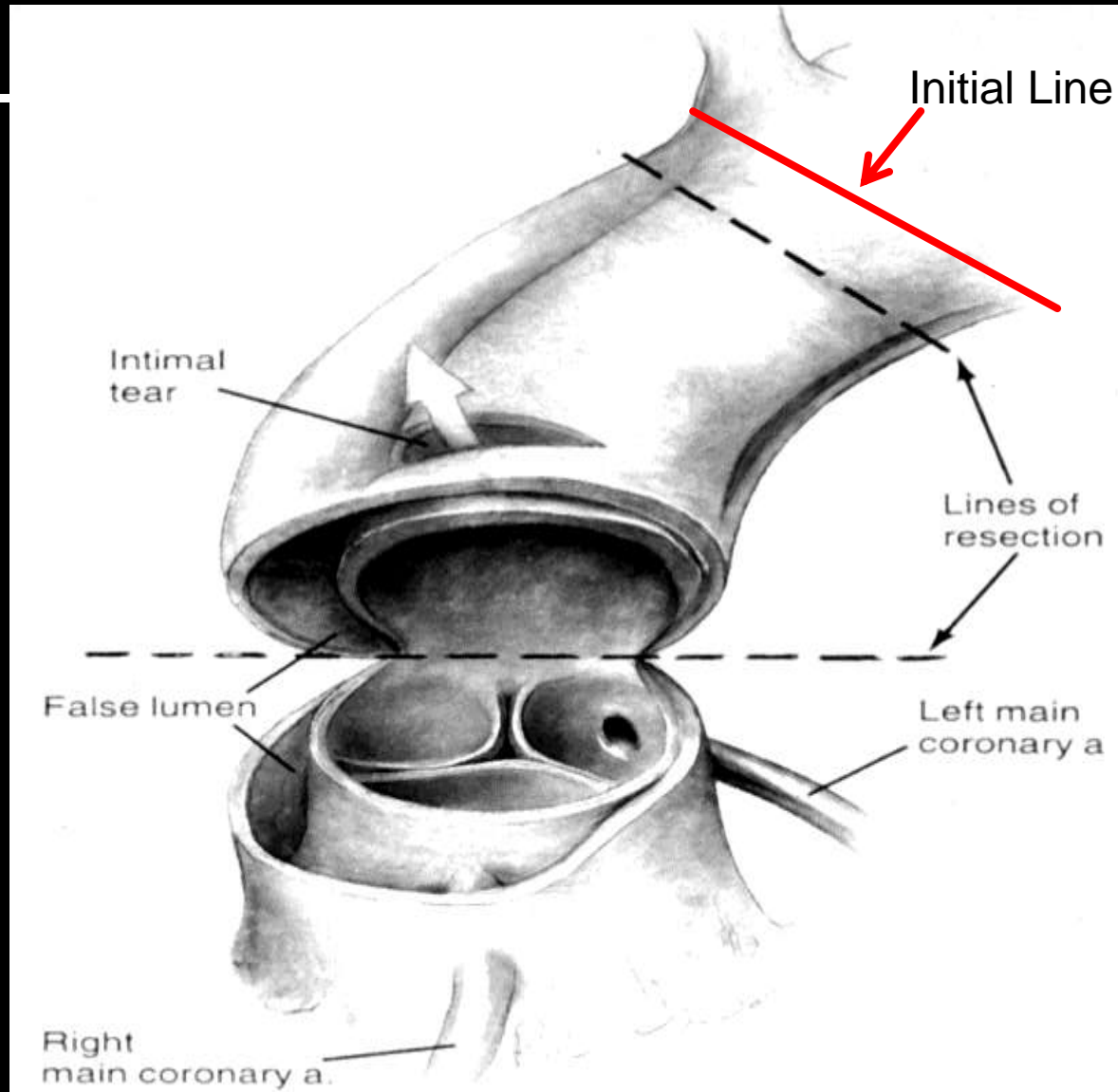
10  
Se8  
In 498



Calcified femoral artery



# Lines of Resection



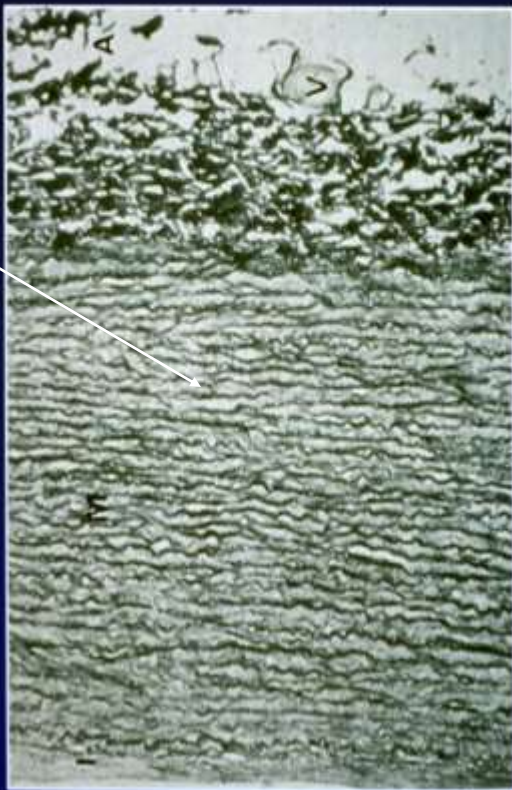
# Dissection is a “Medial” event

Usually 60-75% of medial thickness

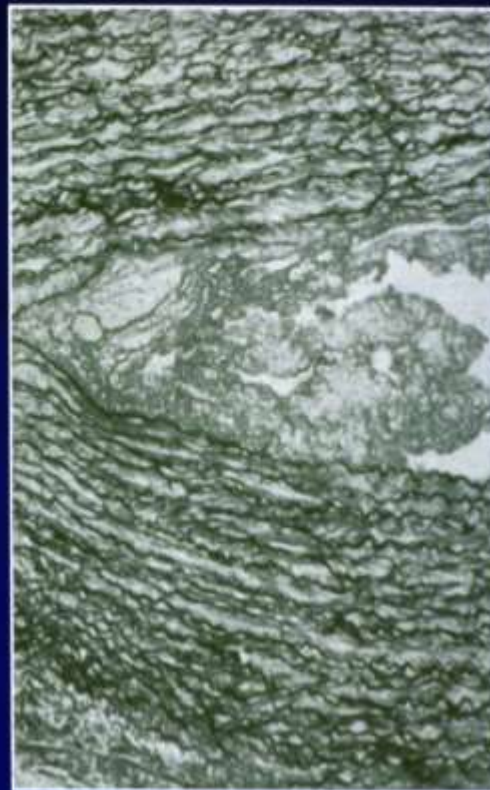
## Histopathology

---

**Normal Aorta**



**Dissection**



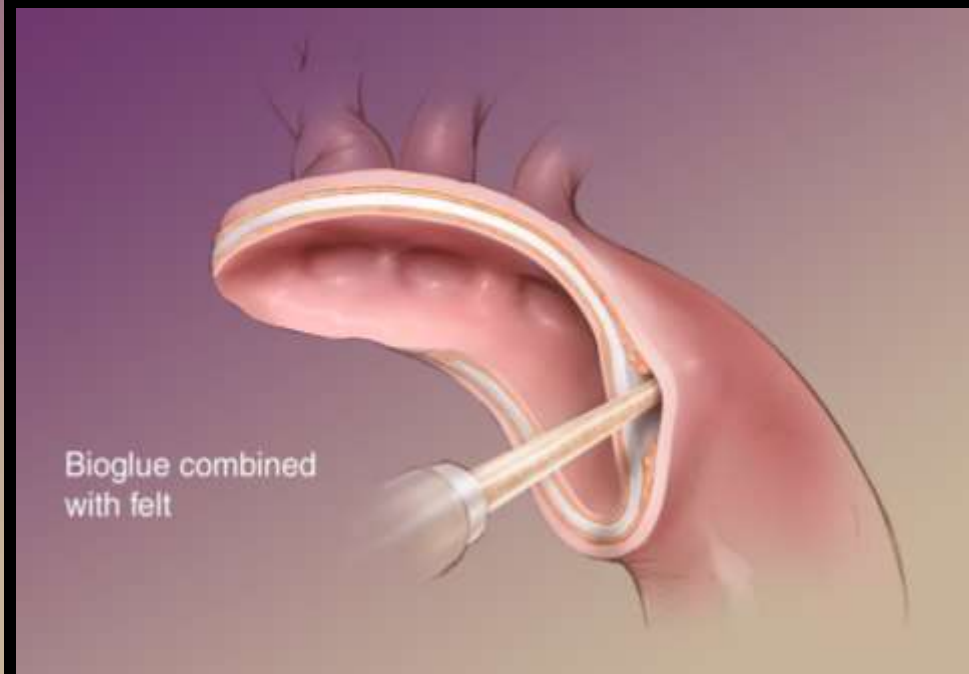
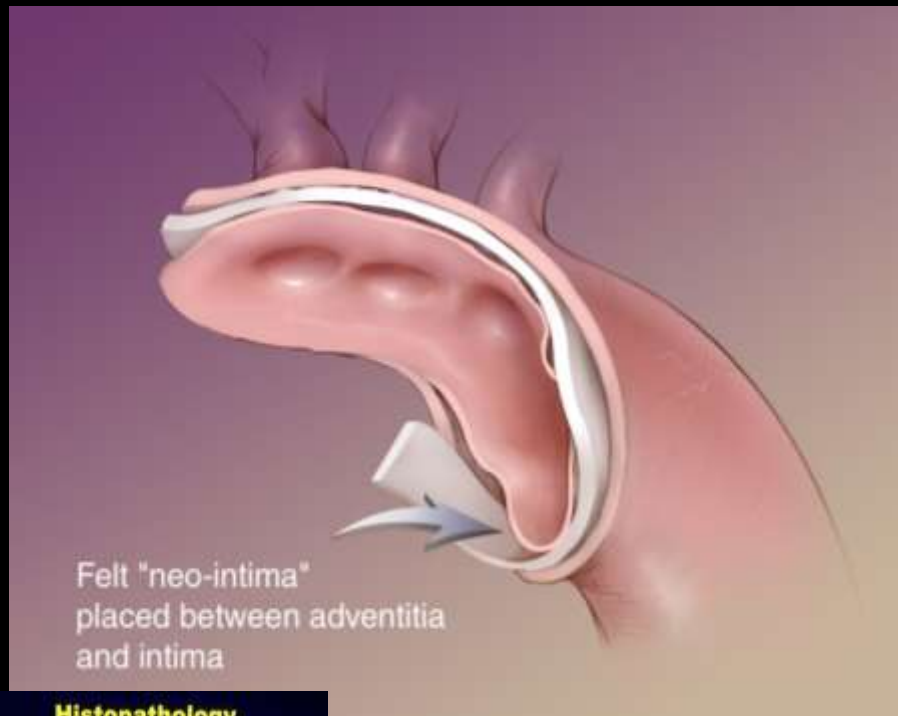
# What About The Arch!

“The Soul of the Human Body resides in the ARCH,  
halfway between the Heart and the Brain!”





# Obliteration of Distal False Lumen: Creation of "Neo-Media" and Make Sure of TRUE LUMEN BACHIOCEPHALIC BLOODFLOW



## Histopathology

Normal Aorta



Dissection

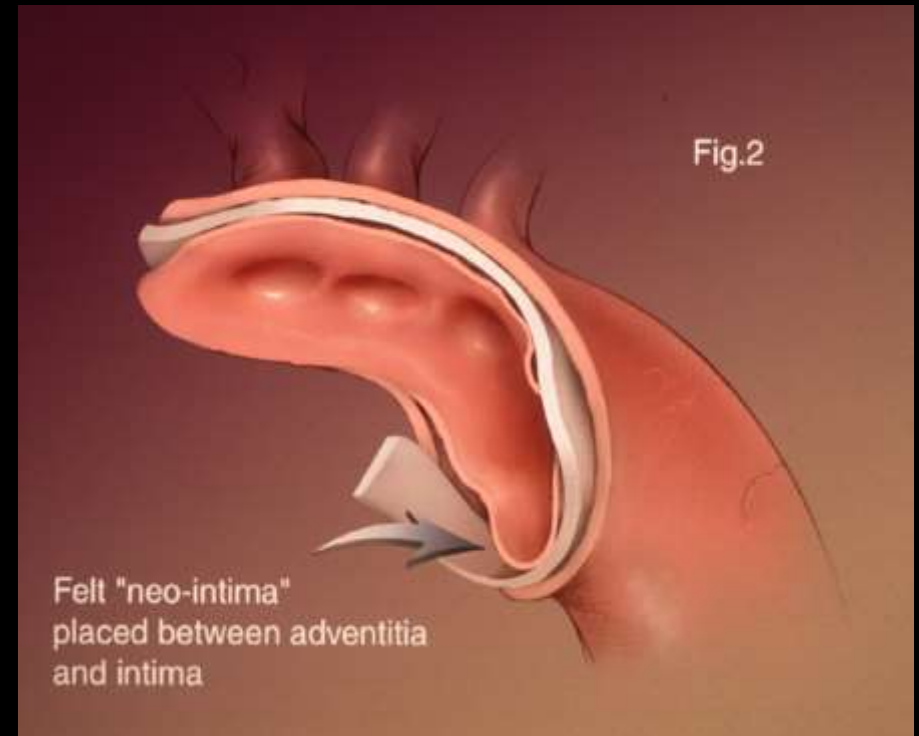
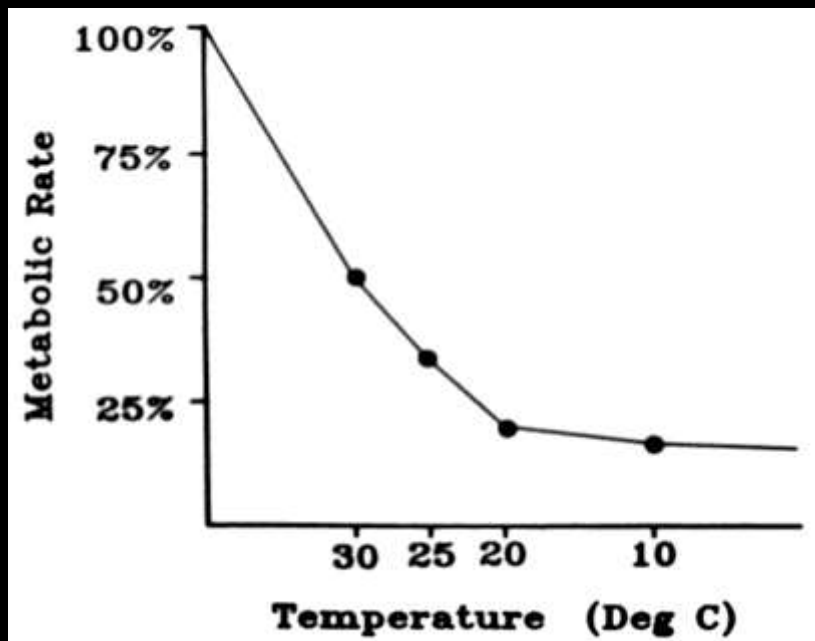


Occasionally small amounts of Bioglue (<5cc)



# Circulatory Adjuncts with an Open Aortic Arch: Options

- 1) HCA
- 2) HCA/RCP
- 3) ACP



NIRS +/- EEG



# What is the **KEY CONCEPT** Regarding Circulation Management of the Open Aortic Arch???

- The mortality and morbidity of **SHORT** arch reconstructive times (<30-35min) is **EMBOLIC** (lateralized CVA).
- The mortality and morbidity of **LONGER** arch reconstructive times (>35-40min) is **GLOBAL** neurological deficit.

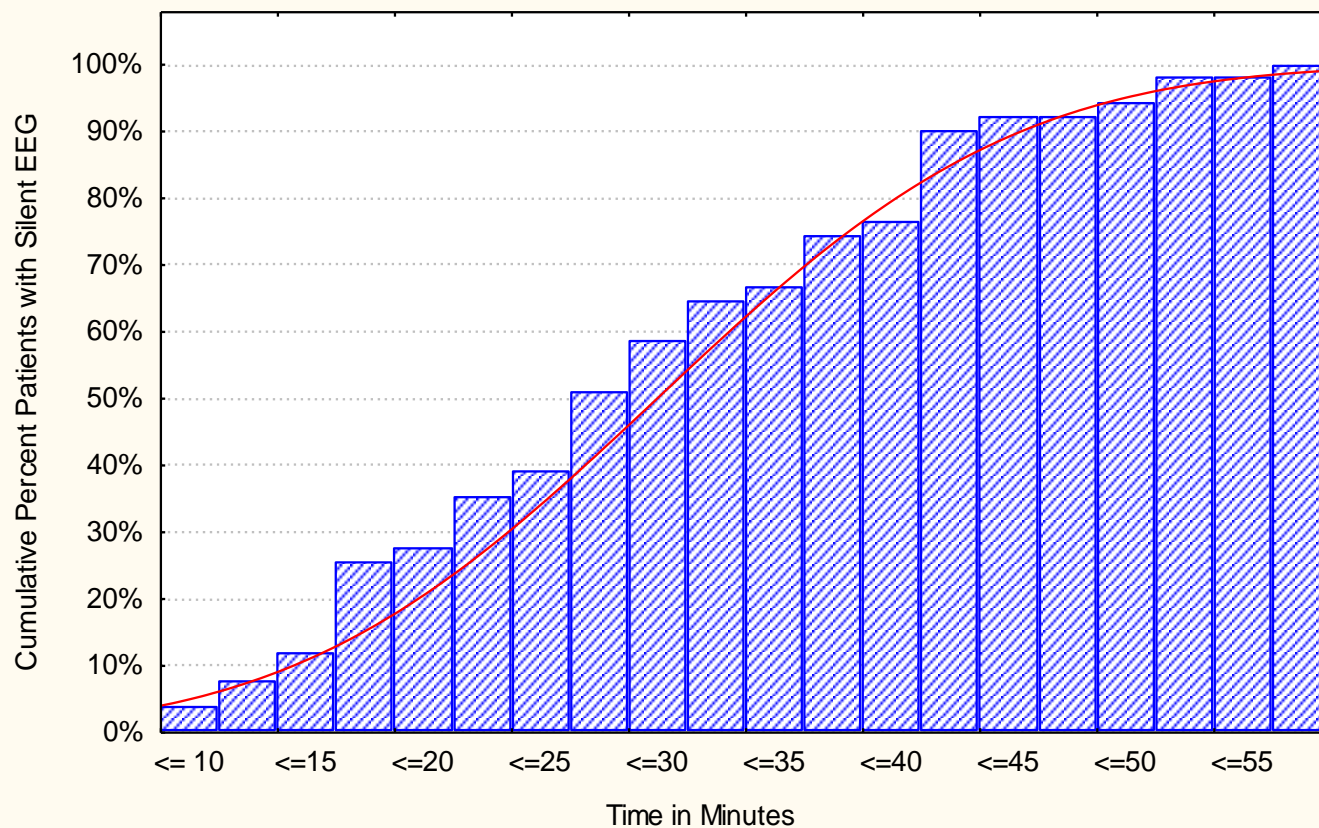


# Time to EEG Silence

Stecker and Bavaria, Ann Thor Surg 2002



Cumulative Percent of Patients with Silent EEG by Time



# Transient Neurologic Dysfunction (TND) after repair of Acute Type A Aortic Dissection with DCHA (n=104)

Bavaria JE, et al. Ann Surg 2001;234:336-43

## *Incidence of TND*

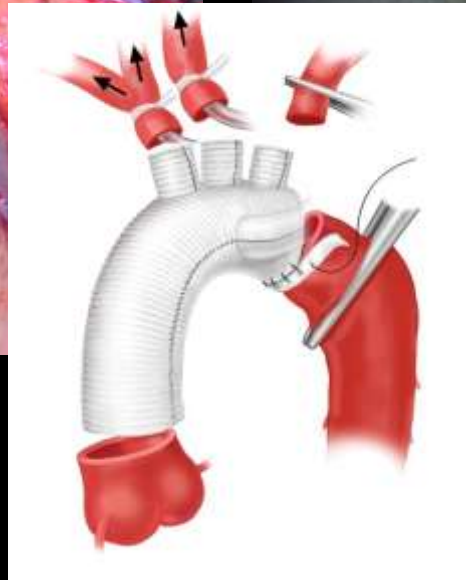
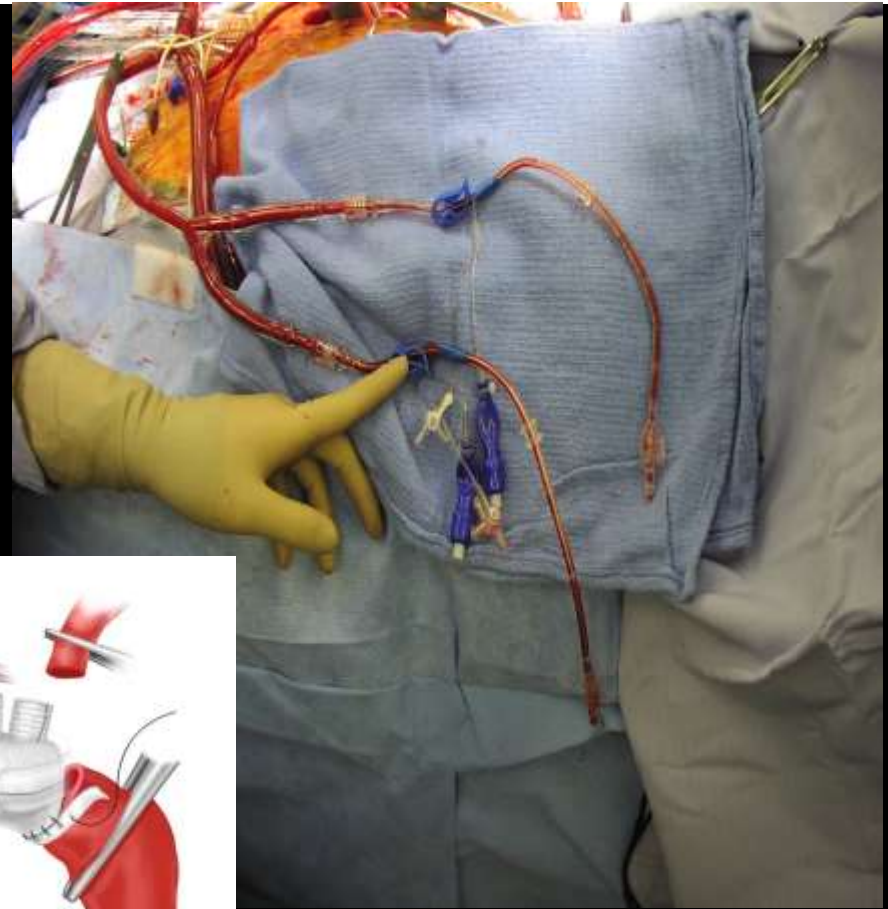
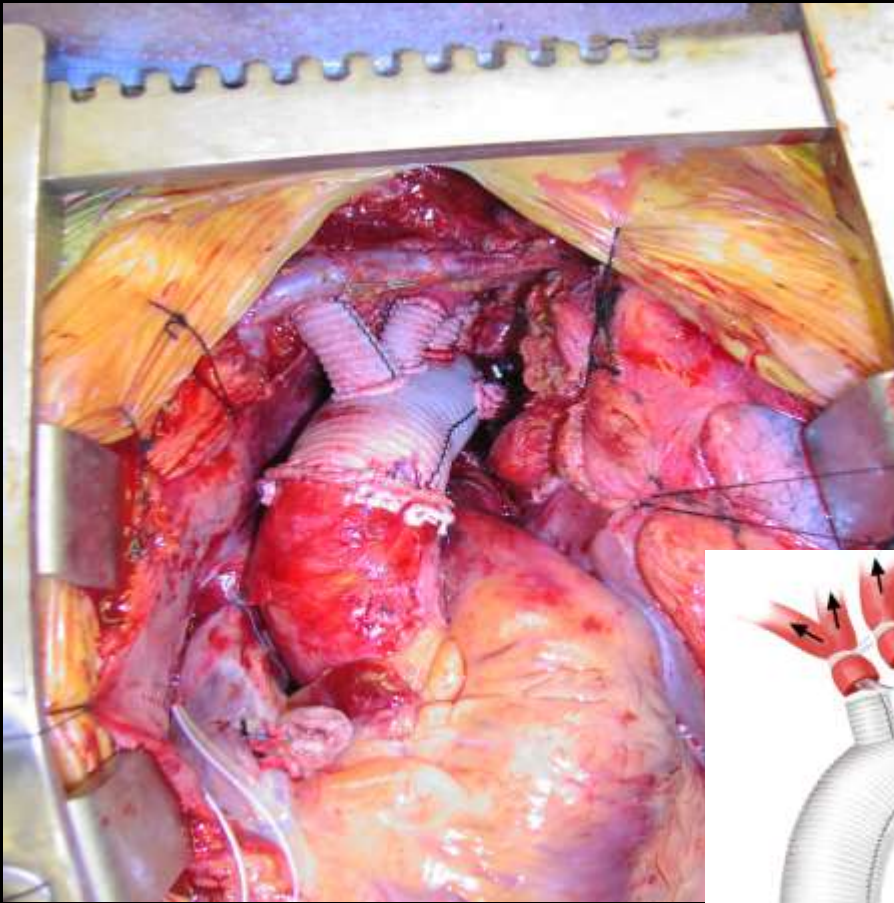
Total	10/104 (9.6%)
DHCA/RCP time > 50 min	6/20 ( <b>30%</b> )
DHCA/RCP time < 50 min	4/84 (4.7%)

## *Mean Duration of DHCA/RCP*

All patients	42 ± 12 min
Patients with TND	55 ± 13 min
Patients without TND	40 ± 11 min

# Management of the Open Aortic Arch

4-Branched Graft/ Antegrade Cerebral Perfusion (Kazui): limited RCP



# Cerebral Oximetry

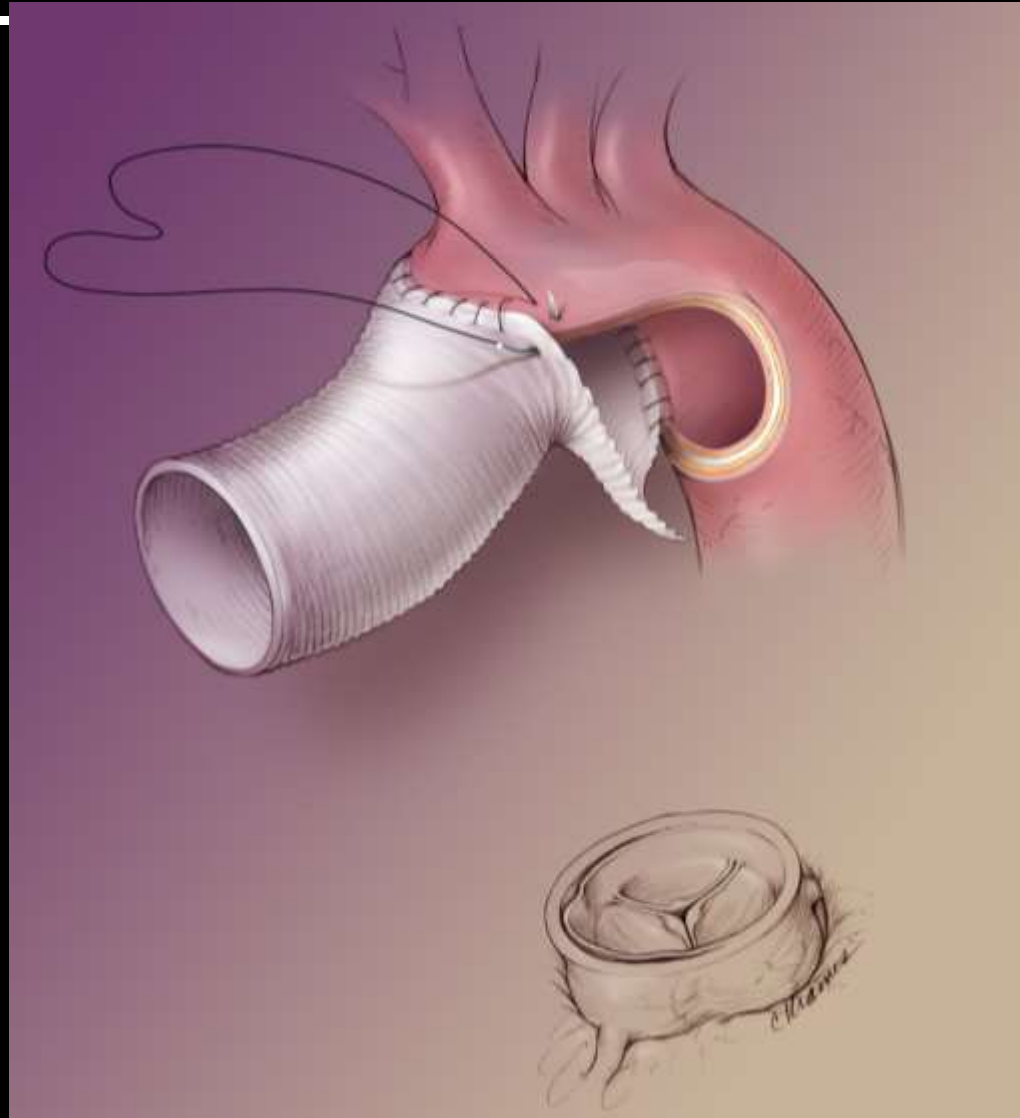


## TAA-Hybrid With AVR and CABG X 1



— Left Cerebral — Right Cerebral — Mid THX Spine — Distal THX Spine

# Distal Graft Anastomosis: “Aggressive” Hemi-Arch





# THE Arch Consensus

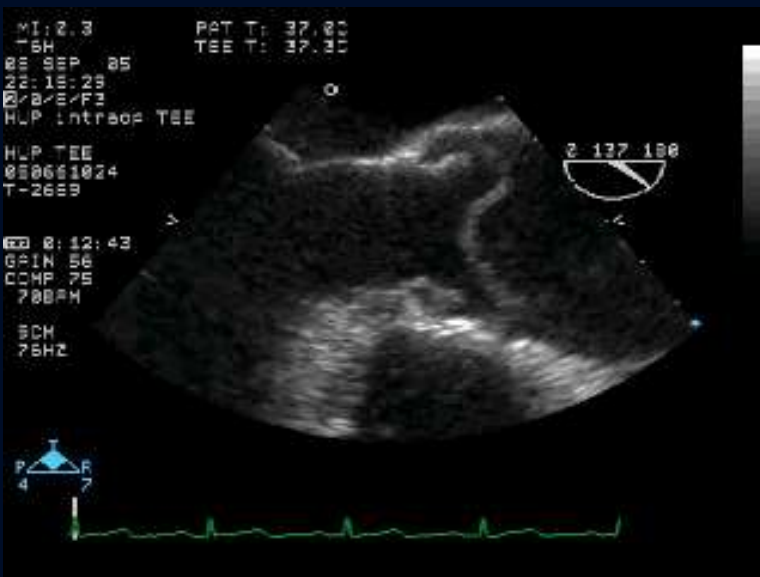
- An Open (Non-Clamped) Arch Procedure is basically “Standard of Care”
- This can be **EITHER** Hemi-Arch or “Some Variation” of Full (or Near Full) Arch
  - Two Branch, Locate Proximally with debranching, etc
- Some form of “Advanced” Circulation management is “Standard of Care”



# The Root!

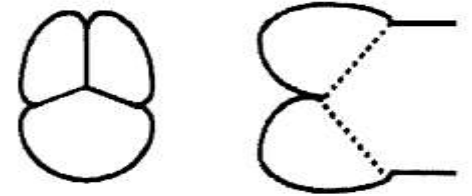


# Aortic Dissection: Mechanisms of Aortic Regurgitation

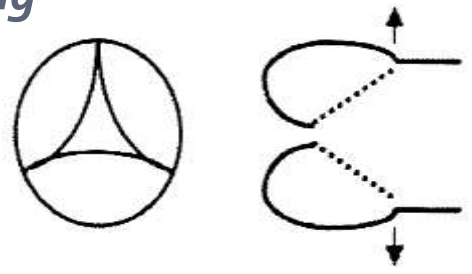


TEE ME AoV LAX

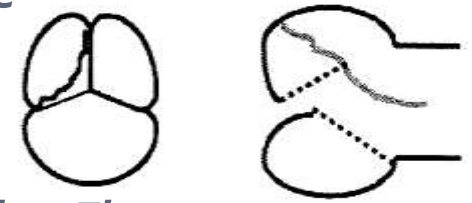
*Normal*



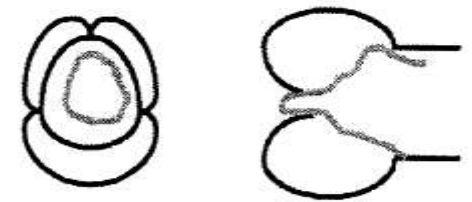
*Tethering*



*Prolapse*

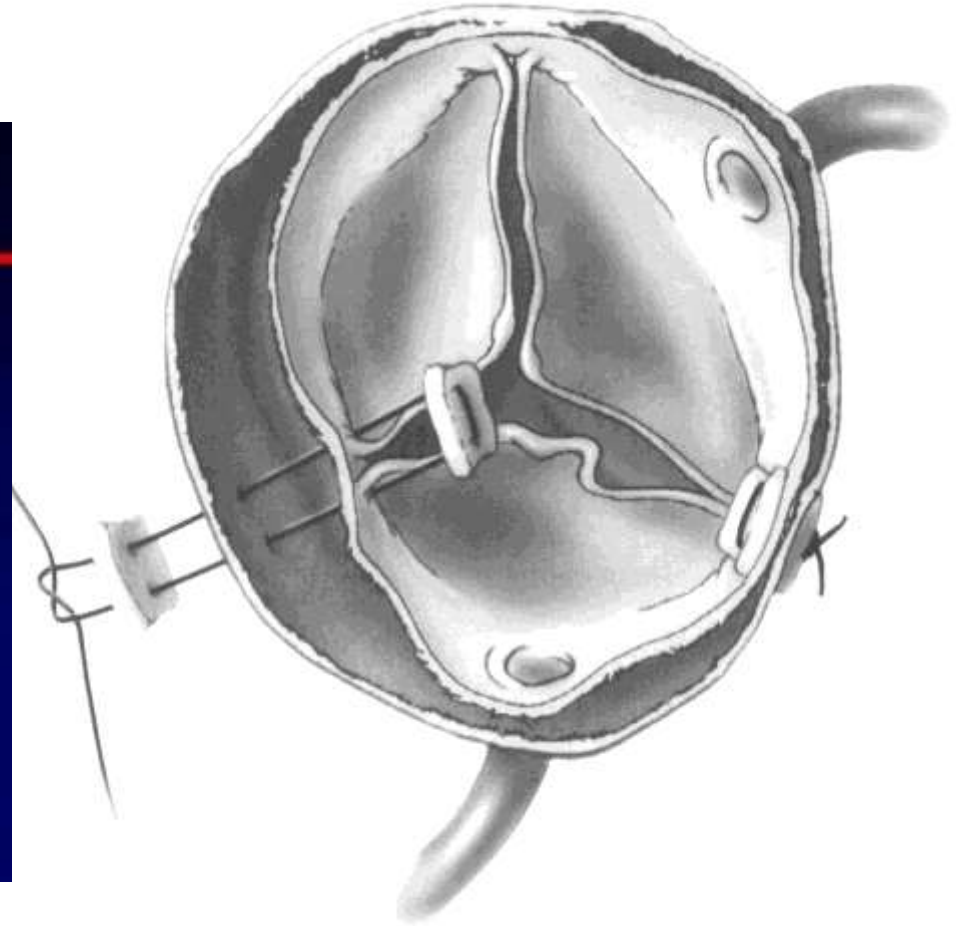
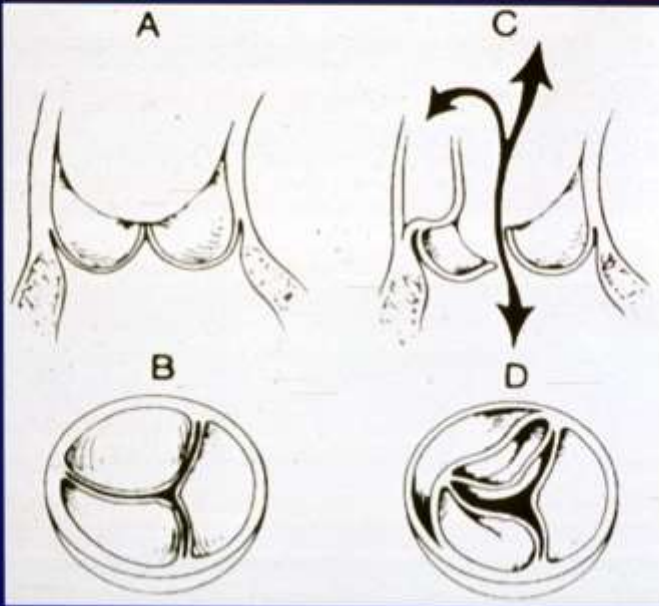


*Prolapsing Flap*



# Aortic Valve Resuspension

## Mechanism of Aortic Regurgitation in Type A Dissection

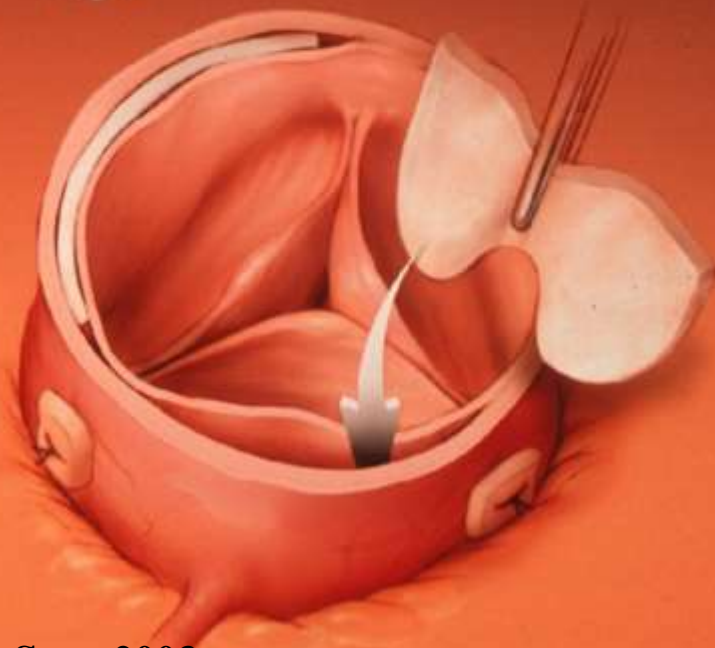


# ROBUST: Aortic Root Reconstruction/Sinus of ValSalva Repair

Fig.1 Felt "neo-media" placed in non-coronary sinus



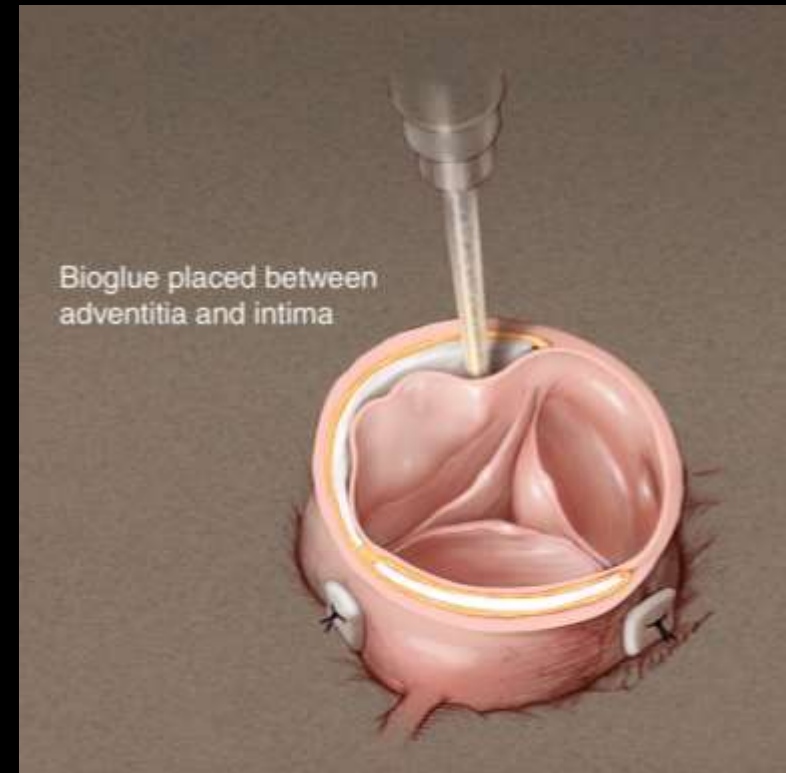
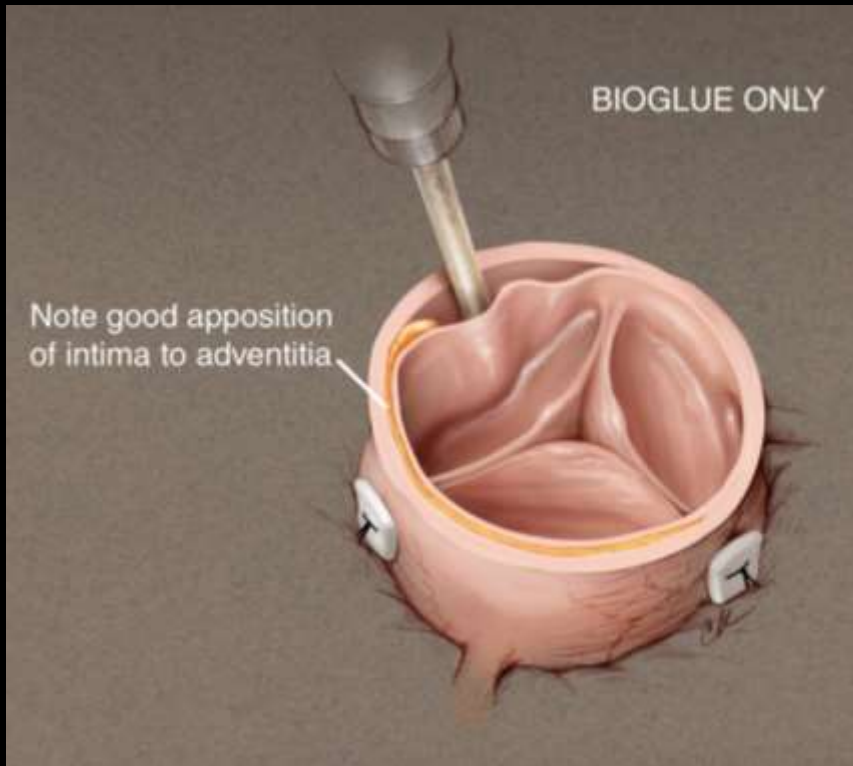
Fig.2



Bavaria, Pochettino, Gleason, et al; Ann Thor Surg 2003

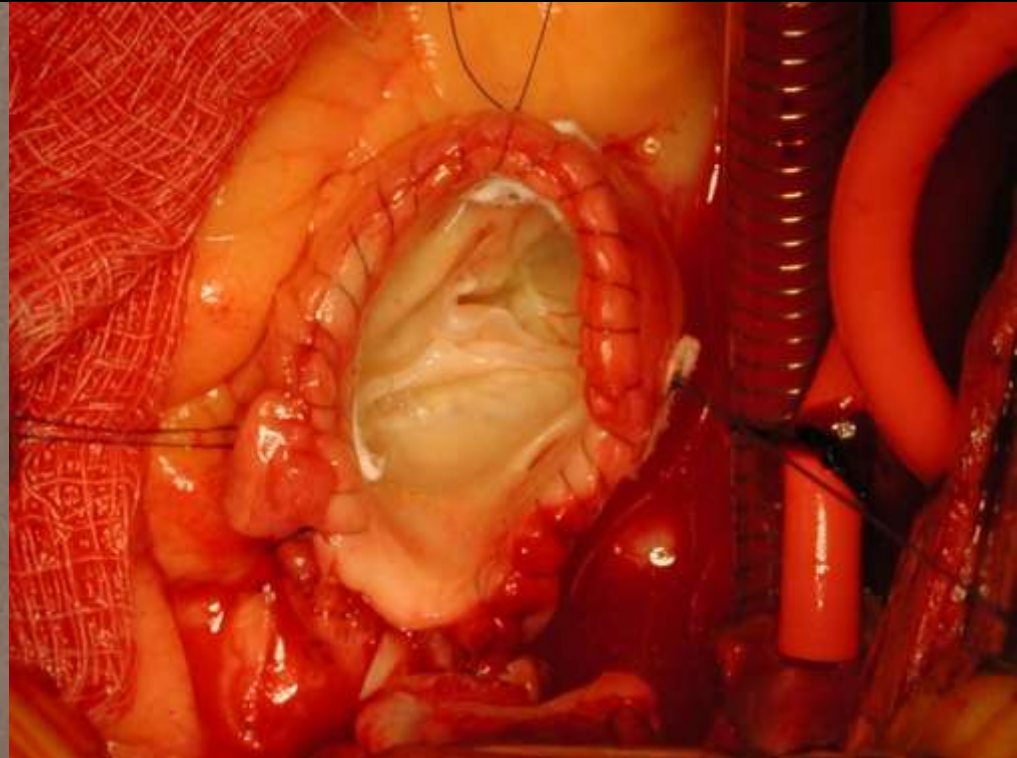


# Obliteration of Proximal False Lumen



# Completed Root Repair and Aortic Valve Resuspension with Neo-Media

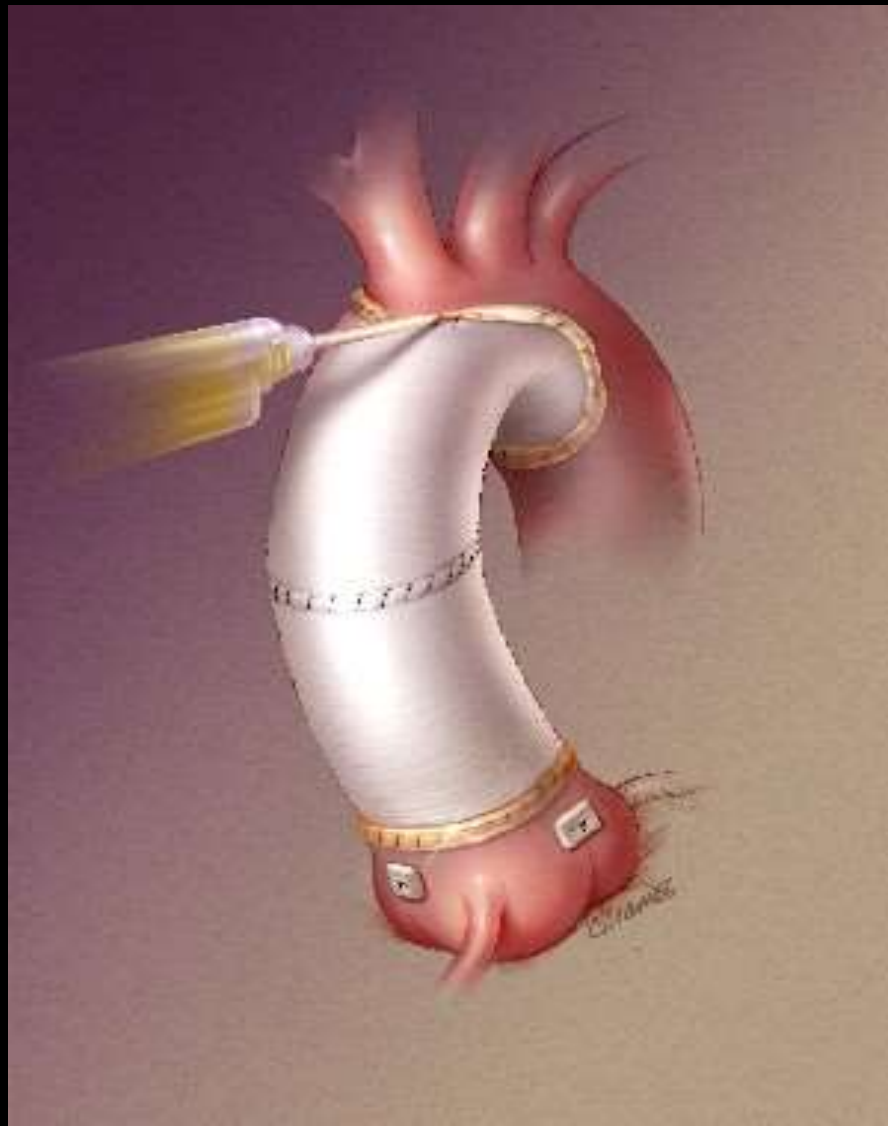
Bavaria, Pochettino, Gleason, et al; Ann Thor Surg 2003



IMPORTANT: **72%** of Aortic Roots/Valves were **NORMAL** prior to Dissection!

# Type A Dissection with Valve Resuspension and Ascending & Hemi-Arch (+/- Biogluue)

Note: Finished Product, Efficient Conduct of operation



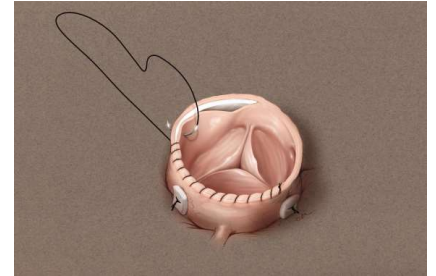
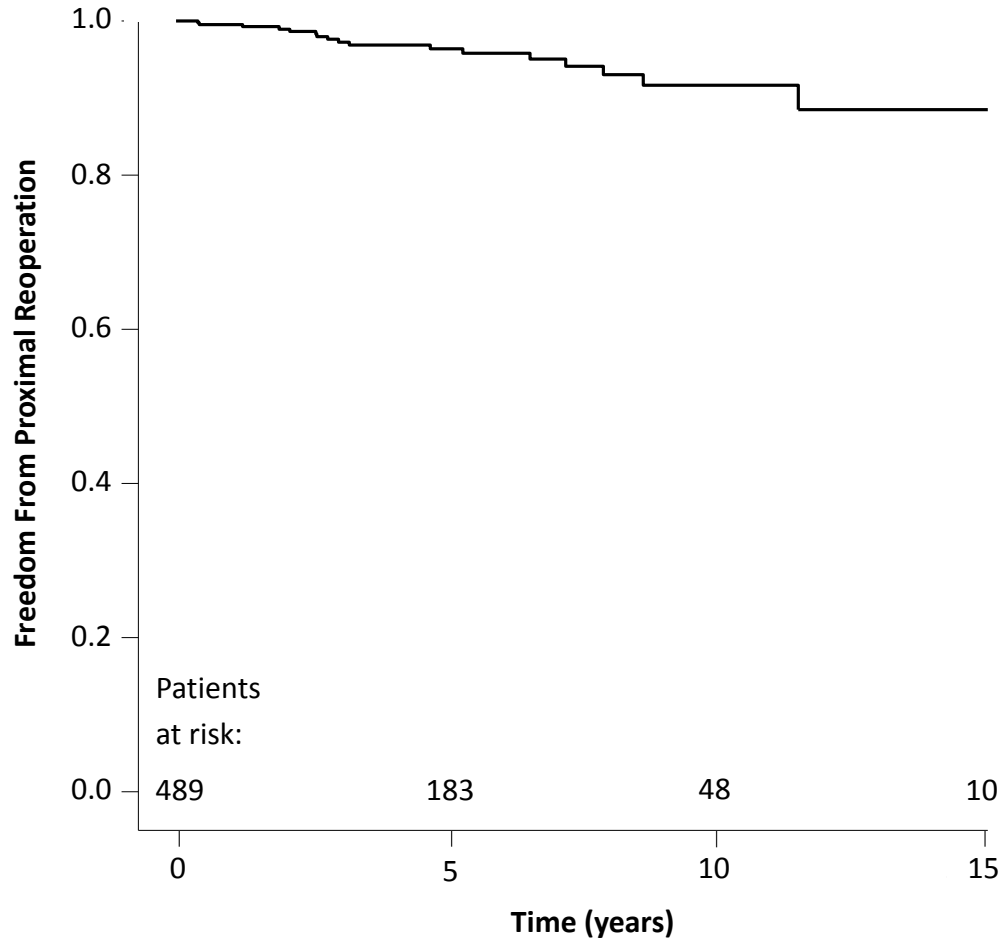


# Reasons for Not Performing a Valve Re-suspension and Doing a Root

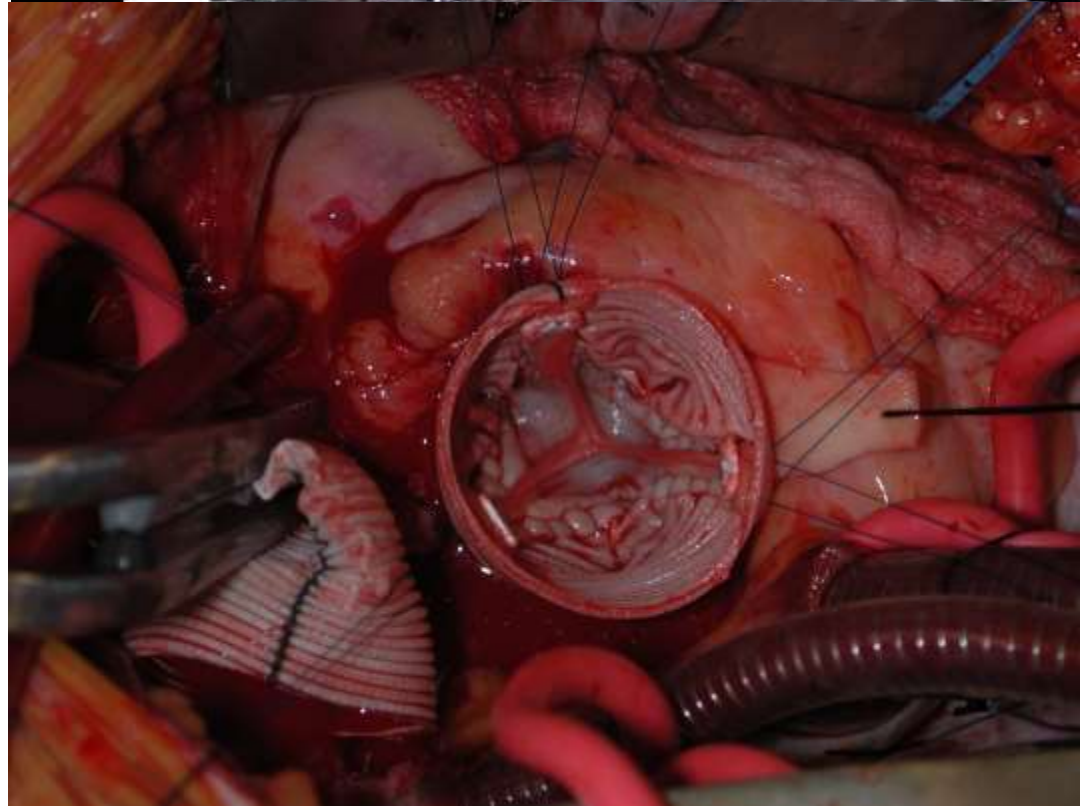
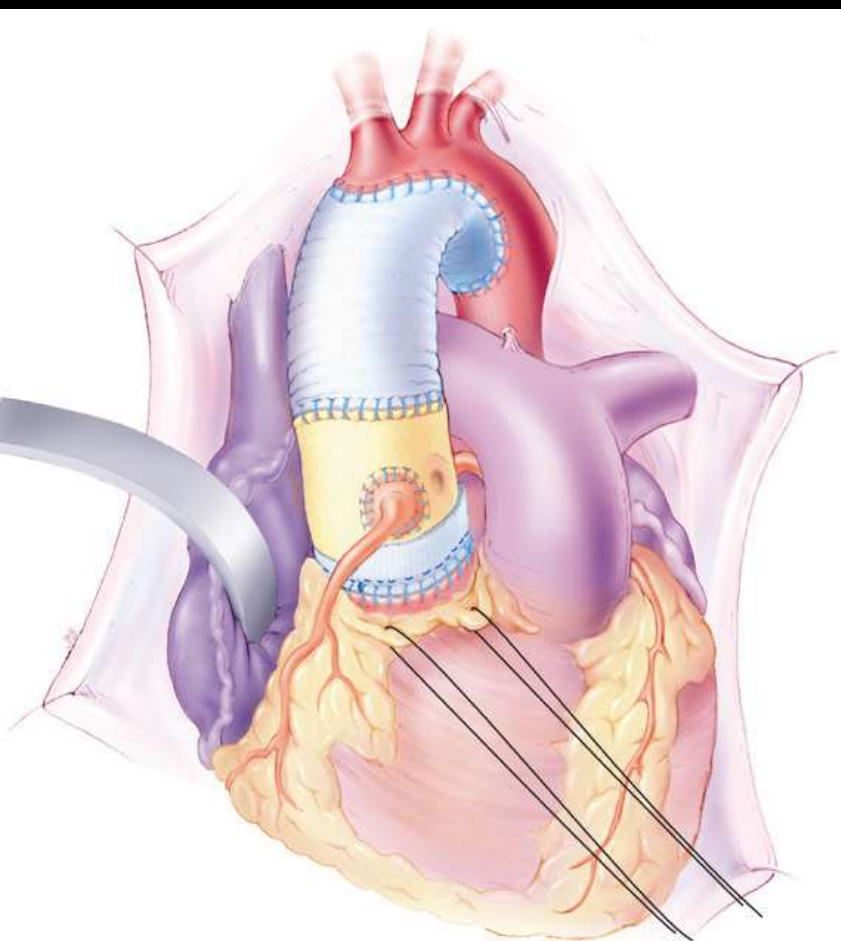
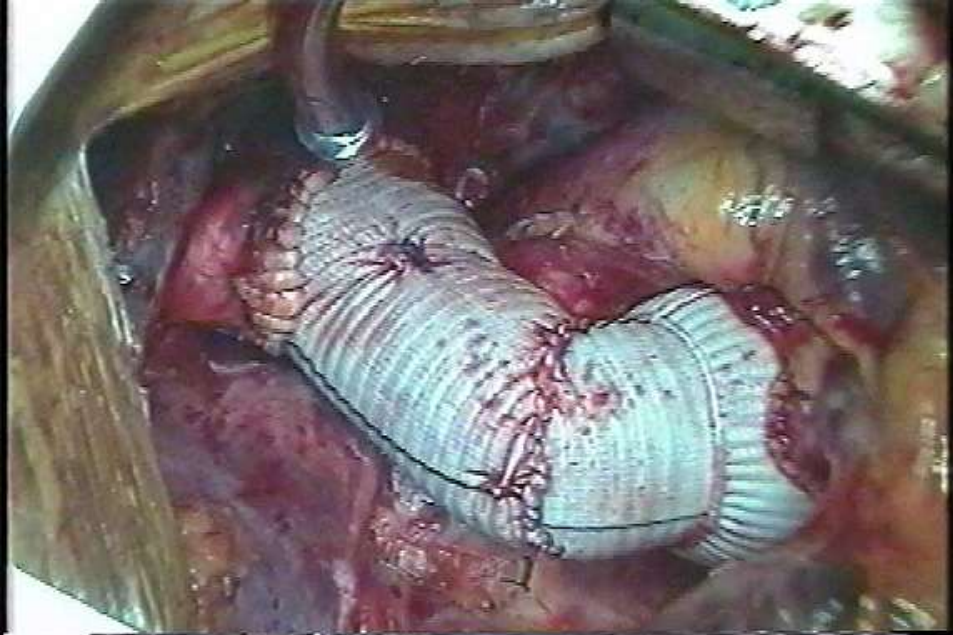
- **Marfan's** (Sinus Aneurysm; 10-15%)
- **Bicuspid** Valve or Primary Valve leaflet abnormality (10-15%)
- **Intimal Tear** (not dissection) into sinus segment (Could do a David V in this situation)  
(not simply a dissection down to the annulus)
- Other more rare indications



# Acute Type A Dissection: Freedom from Proximal Re-Operation using “Neo-Media” Resuspension and the Penn Aortic Root Decision algorithm



# Aortic Root Options for Type A Dissection Repair



# Survival after Surgery for Acute Type A Aortic Dissection in Bicuspid Aortic Valve Patients

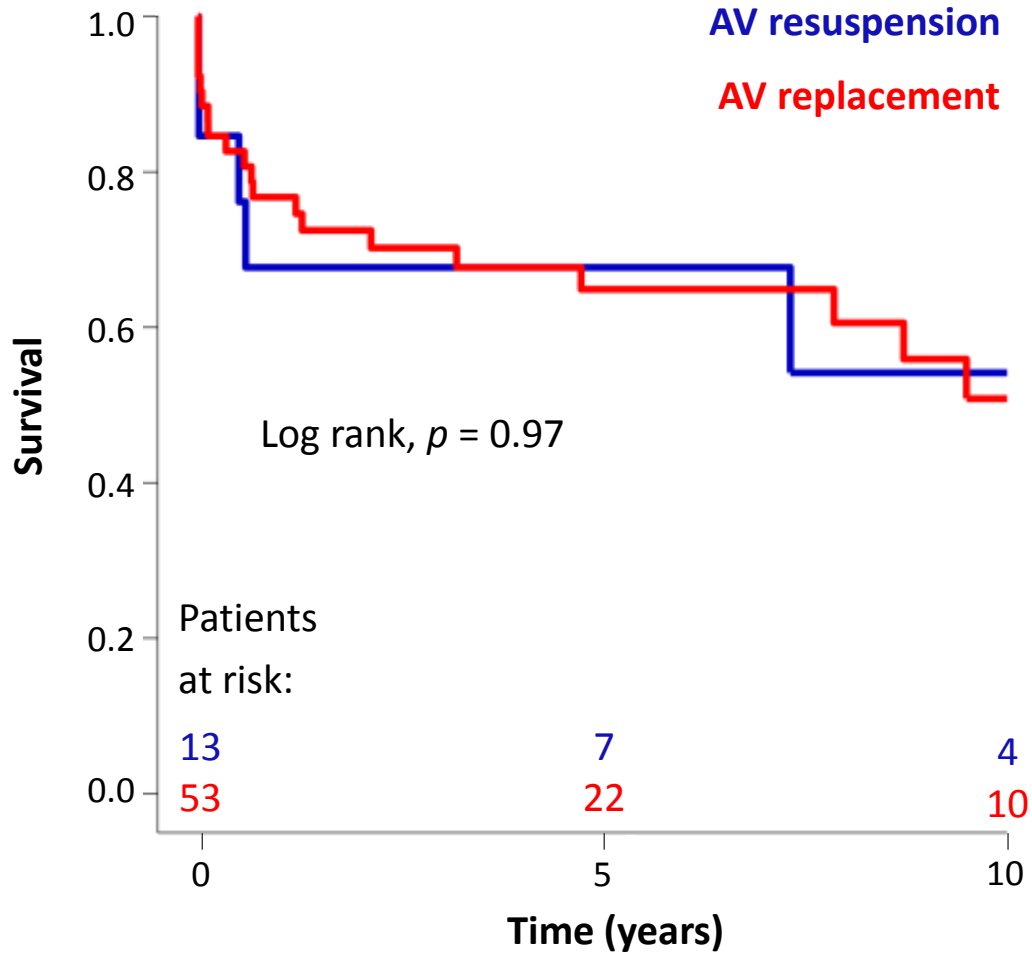


Figure 1

# Understanding the Role of Malperfusion

and where it fits into Management



# Malperfusion Syndrome in Acute Type A Dissection: Incidence

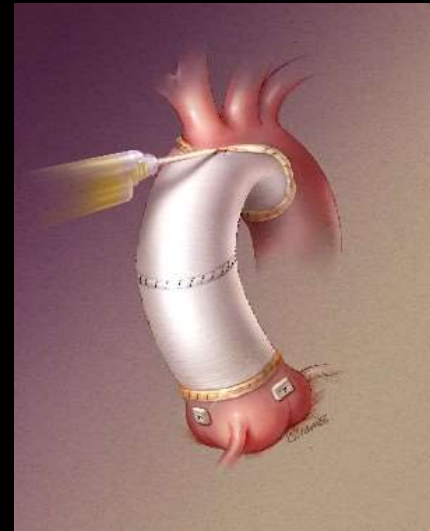
- Overall Malperfusion Incidence of any Major Vascular bed is 21-33%
- Distal Malperfusion Rates are 20-31% (Spinal, Mesenteric, Renal, Iliofemoral)
- Coronary Malperfusion Incidence is 6-12%
- Cerebral Malperfusion Incidence is 7-13%
- Multiple (>1) Malperfusion Vascular beds: **5.6% - 9%**
  - Avg = 1.4/pt

Girardi LN, ATS 2004; Fann JL, Miller DC, Ann Surg 1990; Geirsson, Bavaria, EJCTS 2007; Neri E, JTCVS, 2001; Kawahito K, ATS 2003; Pacini, DiBartolomeo, 2011; Girdauskas E, JTCVS 2009; Immer FF, ICVTS 2006



# Type A Dissection with Valve Resuspension and Ascending & Hemi-Arch (+/- Bioglue):

So What Happens to These Malperfusion Cases with a “Standard” Operation ??

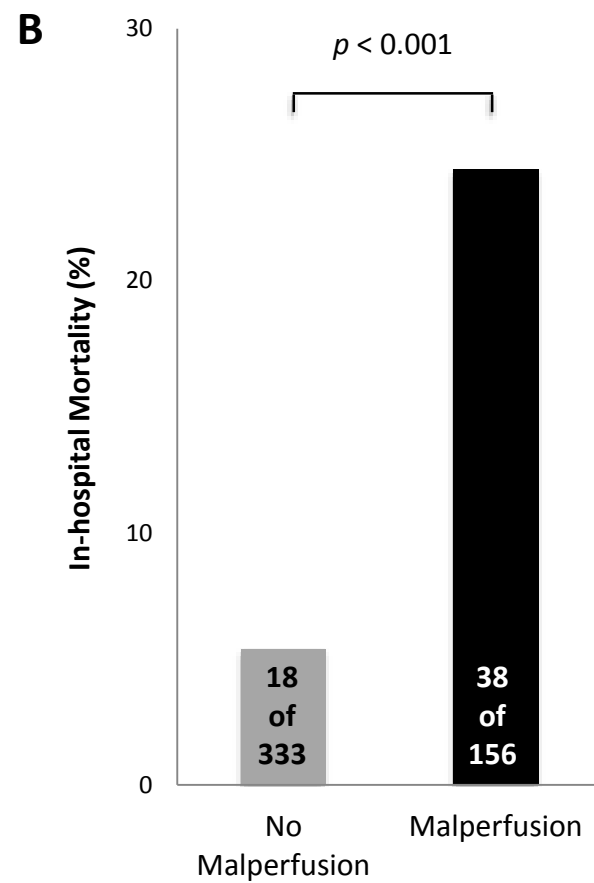
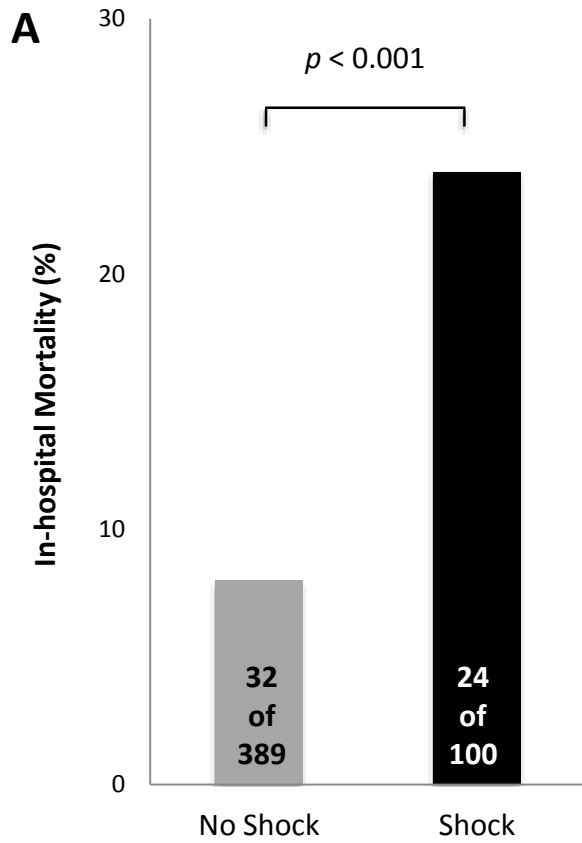


# Malperfusion Syndrome in Acute Type A Dissection: Results

- Overall Results are **SIGNIFICANTLY** and Negatively impacted by the presence of Malperfusion.
- Pacini, Gabbieri, Zussa, Pignini, Contini, and DeBartolomeo for the Emilia-Romagna AAD Registry (2011) **N=502**
  - **43.7%** mortality with Malperfusion vs **15%** without ( $p < .001$ )
- Geirsson, Szeto, Pochettino, Bavaria (2007) **N=244**
  - **30.5%** mortality with Malperfusion vs **6.2%** without ( $p < .001$ )







**Figure 3**

# Operative Outcome (The 70% Rule): Rationale for EXPEDITIOUS Restoration of Majority True Lumen Flow

- Technical success defined as coverage of primary tear site 97.1% (34/35 patients)
- No conversion to open repair
- Left SCA-carotid bypass in 1 patient
  - \*On POD # 6 for left arm ischemia
- Distal adjunctive procedures performed in 12 patients (34.3%)



# Integrated Approach: Methods

- Routine Rapid Admission to OR via PENNSTAR helicopter (Level I Trauma model)
- Routine TEE/Neuro-Cerebral Monitoring /NIRS: OR as Diagnostic and Therapeutic suite
- Aprotinin .... Now Cryo first, High dose Amicar
- Routine Open Arch repair (HCA/RCP/ACP) using Femoral/Axillary/ Direct Aorta cannulation
- Clamp Ascending Aorta with Fibrillation (or earlier if AI too severe)



# Integrated Approach: Methods

- When Flatline EEG, Proceed with Open Arch reconstruction (90% Hemi;10% Total)...Variable
- Antegrade graft perfusion **(ALWAYS)**
- Complete Proximal Aortic Procedure during rewarming
  - 70% Resuspensions
  - 15% Mechanical Composite Root
  - 10% BioRoots
  - 5% Re-implantation
- Graft to Graft proximal Aortic Reconstruction



# Results of this “Protocol-Driven” Institutional Approach

1. Geirsson, Bavaria, and Pochettino; STS 2007; AnnThorSurg 2007
2. Geirsson and Bavaria; Eur JTCVS 2007



# So, if you do all this: Major Mortality/Morbidity

## Penn Data (N= 457 from 1993 -2011)

- 30 day Mortality 12.1%
  - Intra-op mortality 2.3%
- NEW Stroke rate 5.5%

This is **Consecutive** All Comers with **Immediate** transfer to OR protocol



# Key Pre and Intra-op Risk Factors for Death in Type A Dissection: Multivariate H/Ratios

■ Factor	Odds/Ratio	P-value
■ Age/yr	1.04	.002
■ Pre-op CVA	7.1	.004
■ Dialysis	5.1	.009
■ CPB time/min	1.008	.01
■ Cerebral malperfusion	2.9	.04

Malperfusion Syndromes Rule!



# Acute Type A Dissection: Design of an Operation

## Cause of death

Acute CHF due to AI

Coronary malperfusion

Cerebral malperfusion

Free Ascending rupture

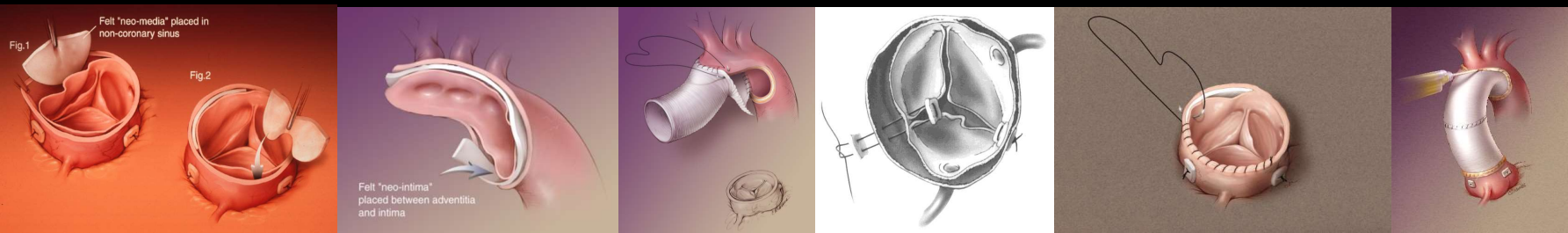
## Treatment

Aortic valve resuspension

Aortic root repair

Arch replacement

Asc aortic replacement





# Acute Type A Dissection: Design of an Operation: (What is Missing?!)

## Cause of death

Acute CHF due to AI

Coronary malperfusion

Cerebral malperfusion

Free Ascending rupture

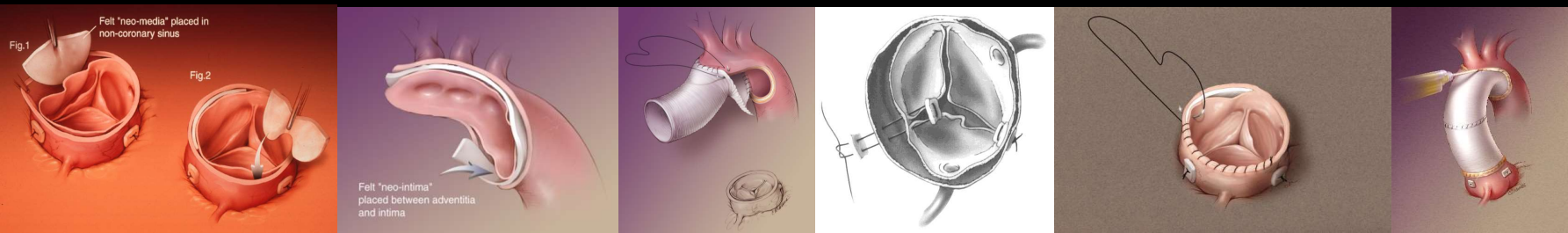
## Treatment

Aortic valve resuspension

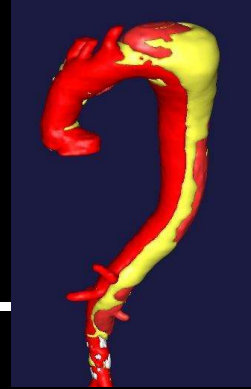
Aortic root repair

Arch replacement

Asc aortic replacement



# Acute Type A Dissection: Design of an Operation (What is Missing?)



## Cause of death

Acute CHF due to AI

Coronary malperfusion

Cerebral malperfusion

Free Ascending rupture



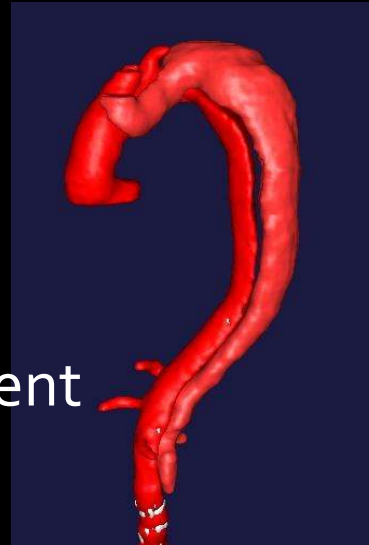
## Options

Distal aortic valve resuspension

Distal aortic root repair

Distal aortic replacement

Distal aortic replacement



# Fate of Distal Descending Aorta!



# Do we have a problem with the downstream aorta ?



- R. Fattori et al. : Evolution of Aortic Dissection after Surgical Repair; Am J Cardiol 2000.
  - Follow-up 12 to 90 month (58 pat.): 77,5% patent false lumen
  - Year aortic growth rate: 0,56 cm PDFL vs. 0,11 cm TFL
  - During 7 year period: 27,5 % re-op due to increasing diameter
- Barron DJ et al.: Twenty year follow-up of acute type A dissection: the incidence and extend of distal aortic disease using MRI. J Card Surg 1997.
  - Follow-up 60 month (87 pat.): 72 % patent false lumen
  - Most common cause for late death: related to distal aortic disease



# CT scans after "Successful" Type A Dissection surgery: No Reasonable distal Aortic Remodelling

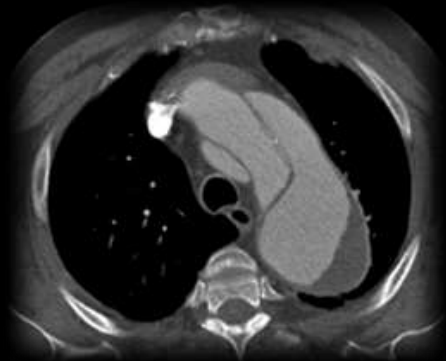
M. Grabenwoger, Vienna



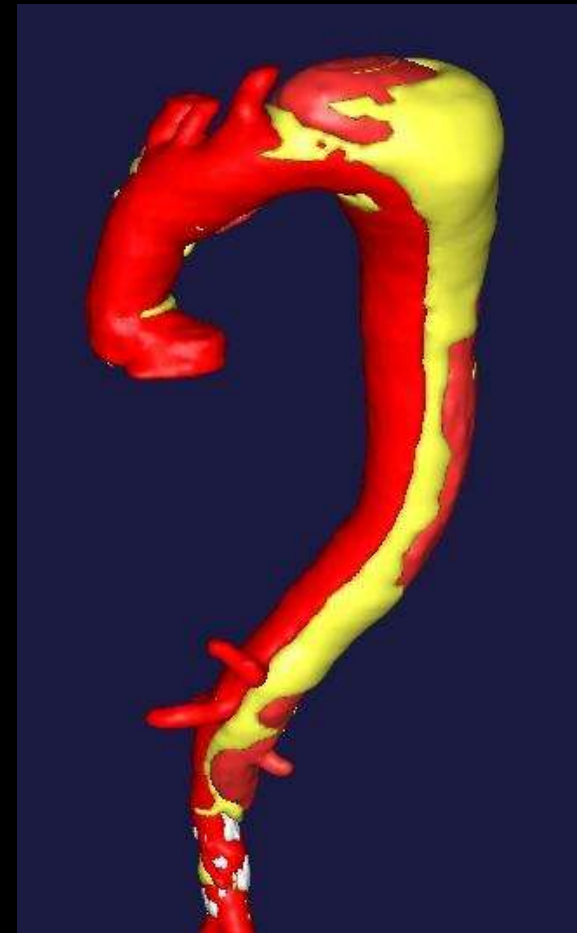
Mal-Perfusion



Chronic Distal  
Dissecting  
aneurysm



Chronic Complex  
Arch Dissecting  
aneurysm



Residual 6.8 cm  
Dissecting Aneurysm after  
Type A Repair with Arch  
involvement



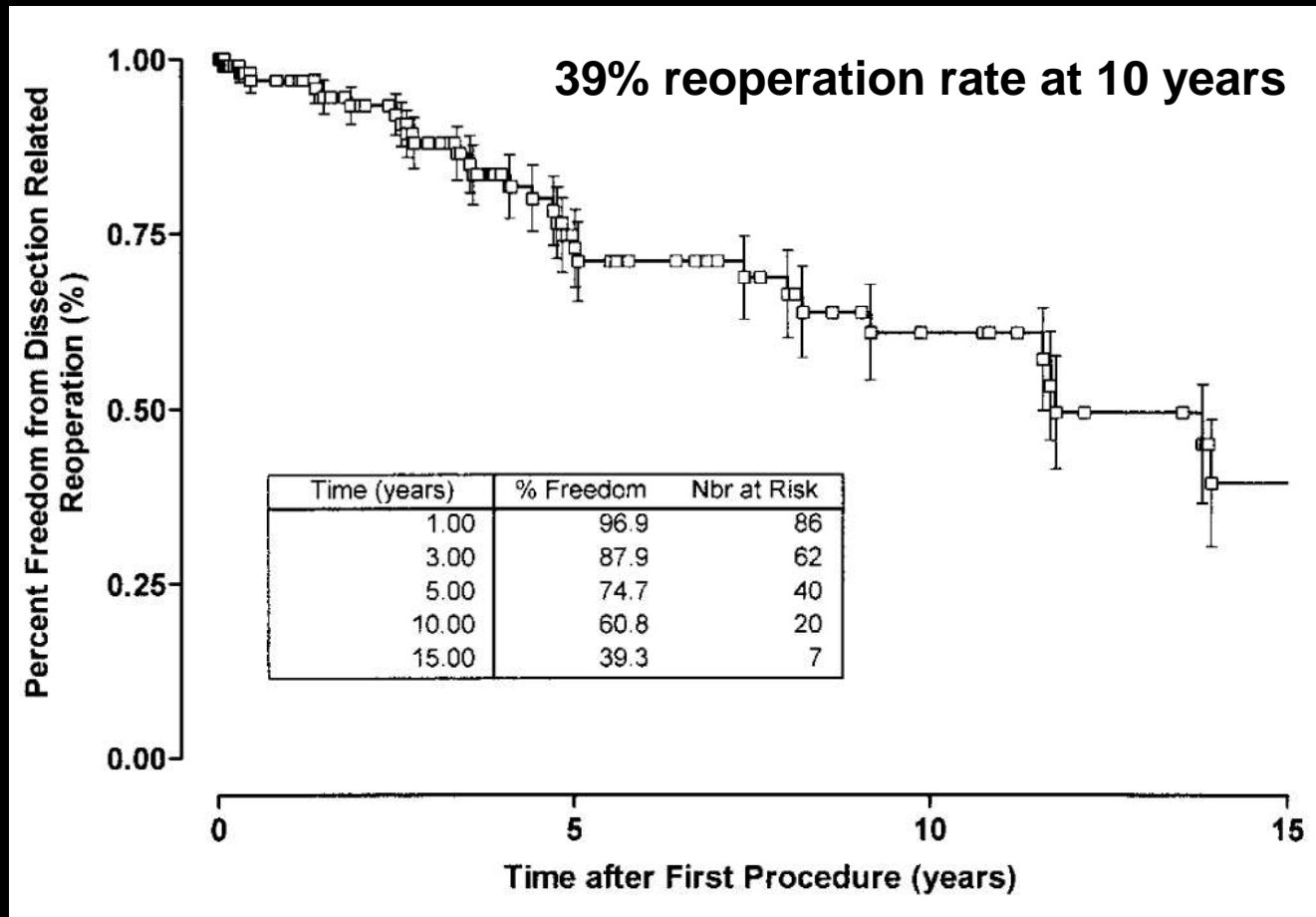
# Distal re-operation rate after Type A Dissection Repaired “classically”

## Senior Surgeon Series

- Bavaria et al, 2007 (USA), 26% **Reoperation** at 12 years
  - Included DeBakey II
- Ishihara et al, 2009 (Japan), 27% **Aortic Events** at 5 years
- DeBartolomeo et al, 2001 (Italy), 27% **Reoperation** at 7 years
- Griep et al, (USA), 16% **reoperation** at 8 years
  - Included DeBakey II



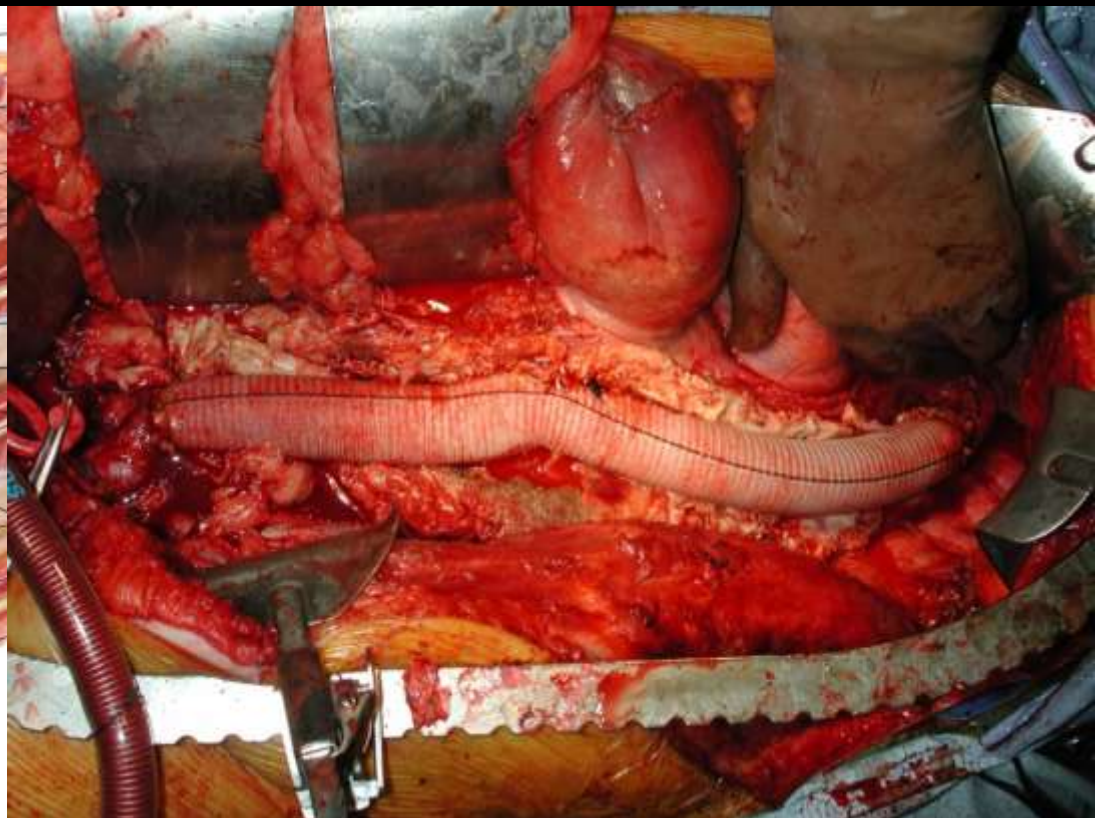
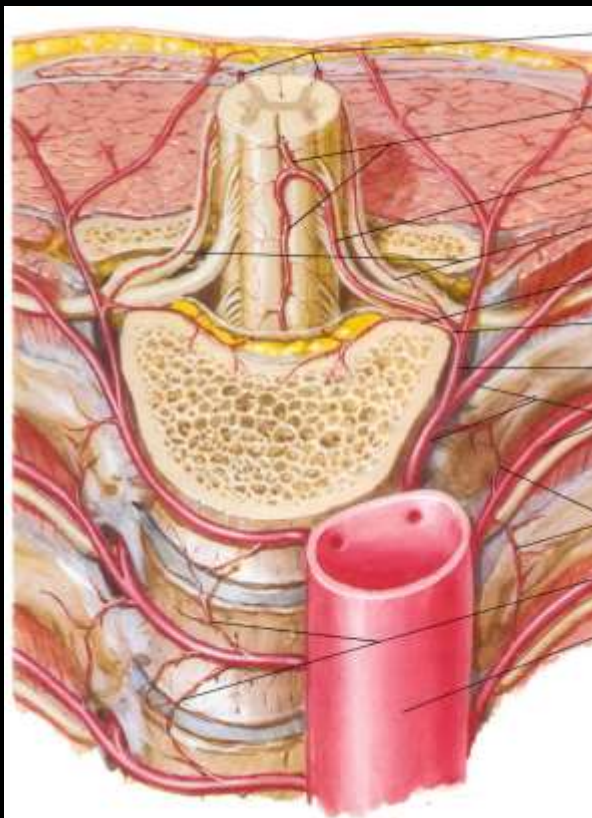
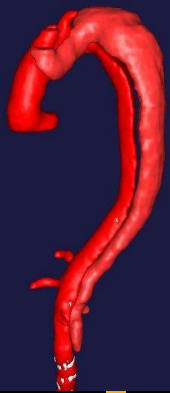
# Freedom from Reoperation after Type A: Proximal and Distal



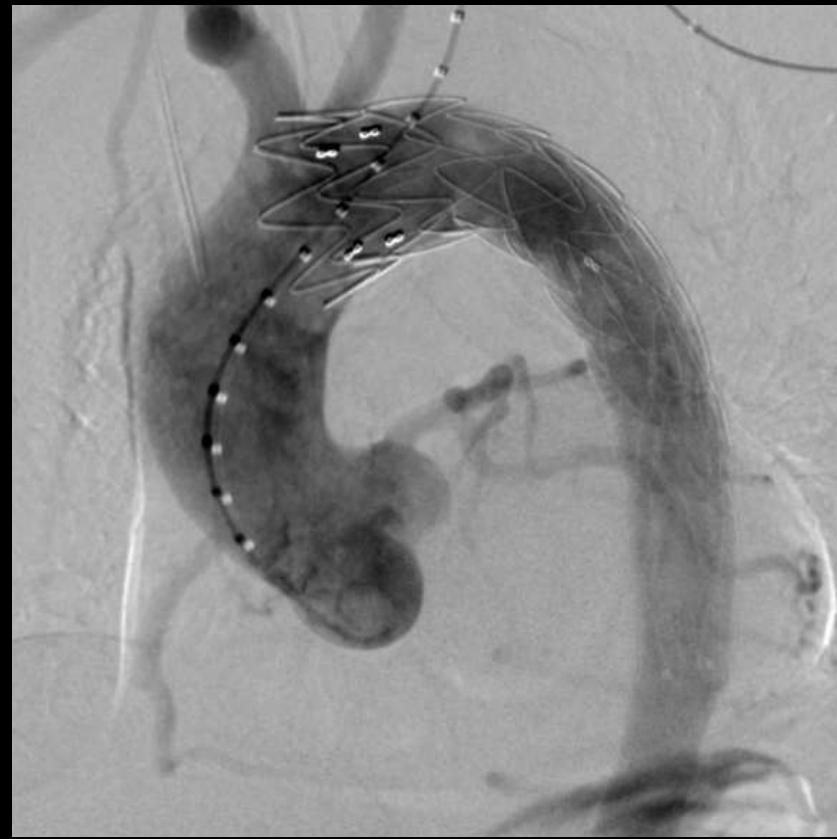
Do We Have a Problem with the Downstream Aorta?

**Yes, Absolutely**

Results in Complex distal arch + Thoracoabdominal Aneurysm Repair ..... Nice operation! (5-10% Paraplegia)



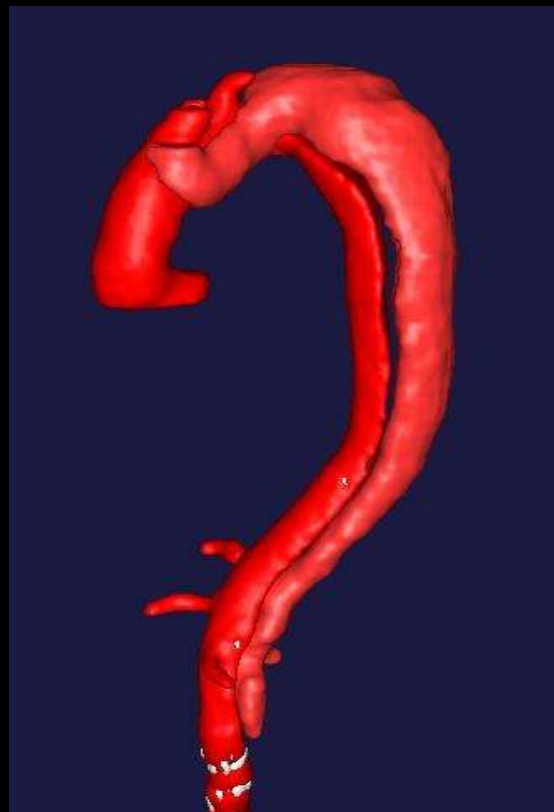
# Acute Type B “High Risk Un-Complicated” with Distal Aortic Remodeling: Can we make an Analogy?





So, ..... When I Proposed that we look at a **TEVAR ADJUNCT** regarding the **Downstream Aorta** in Type A Dissections to my Division colleagues, The Response

.....



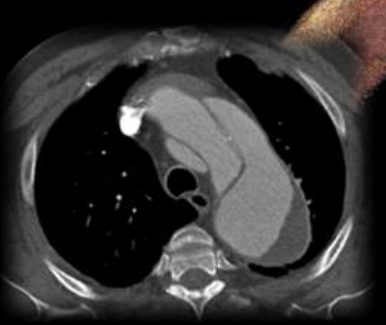
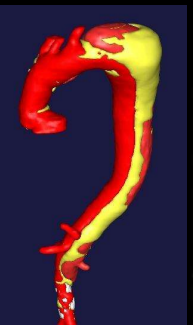
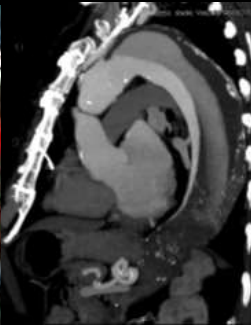


STS San Diego, Jan 2015

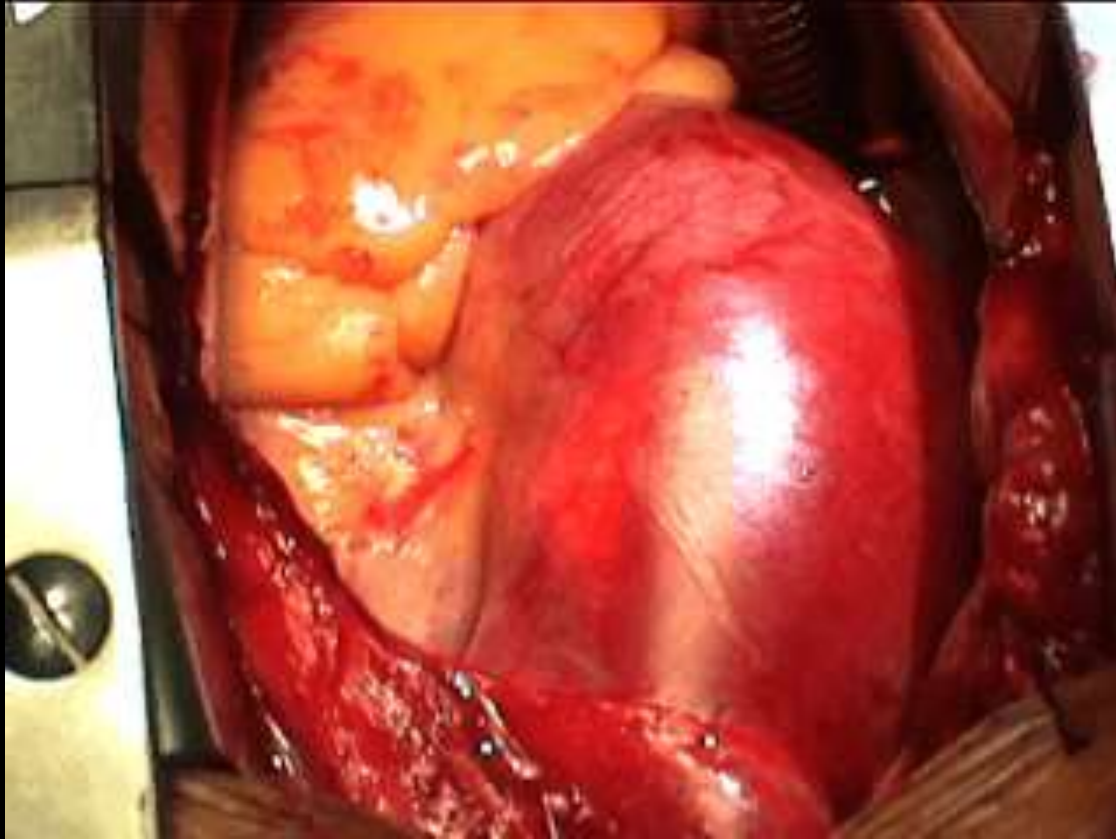
# STS/EACTS Symposium:

## Management of the Aortic Arch during Type A Dissection

**Joseph E. Bavaria (STS)**  
**Ruggero DePaulis (EACTS)**



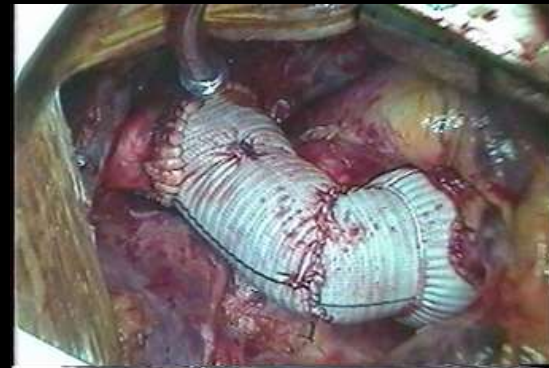
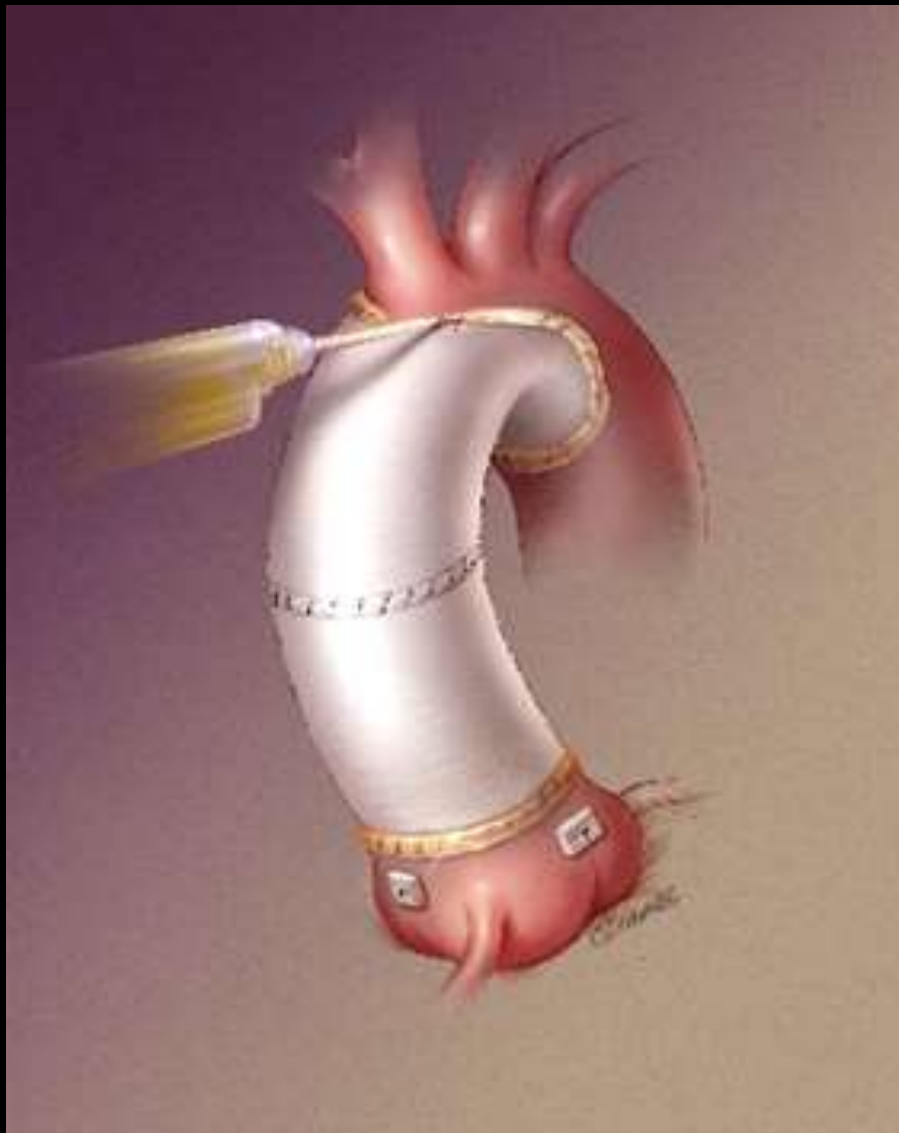
# Acute DeBakey Type I Dissection



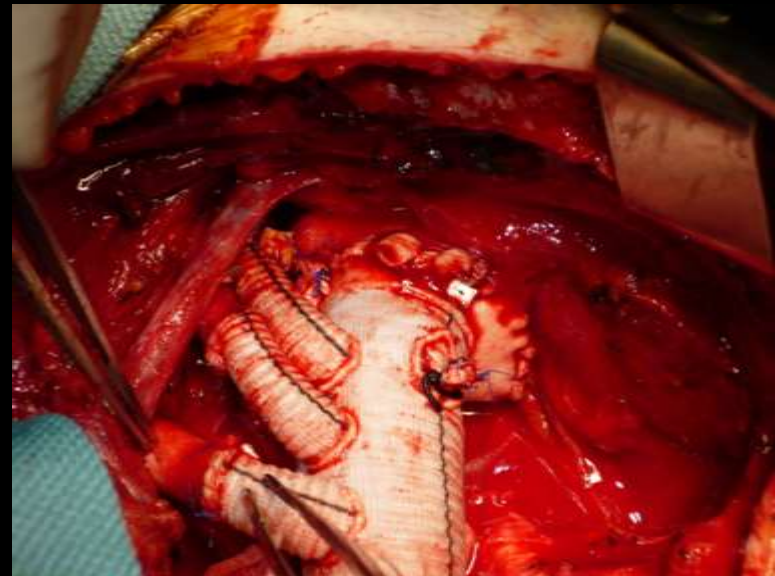
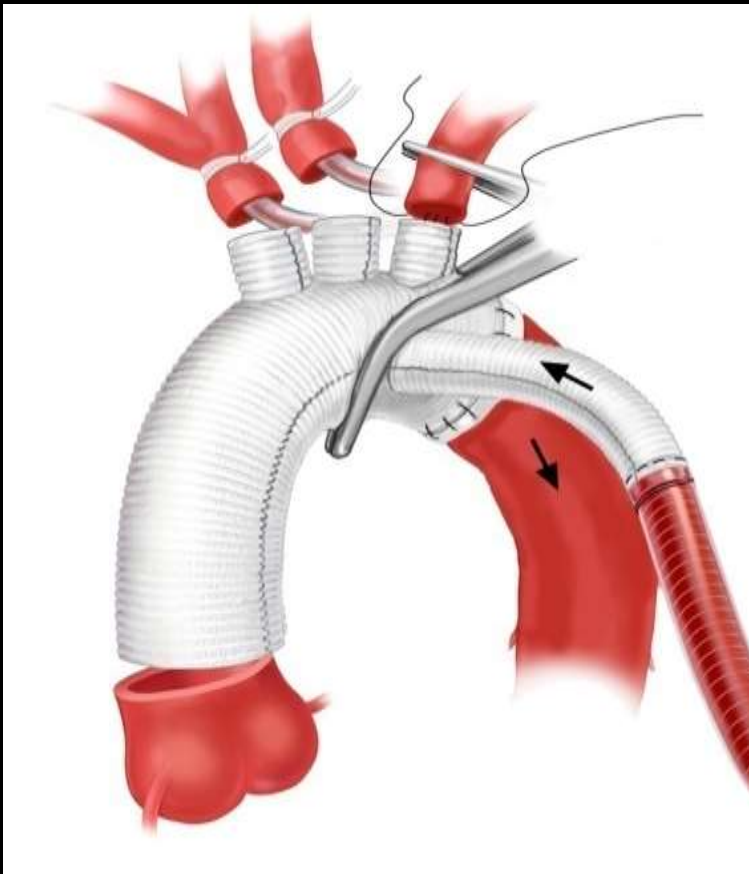
**There are Many Concepts  
and Options for  
Reconstruction of the  
Aortic Arch presently  
used in the World ....  
Which one is best???**



# The Hemi-Arch (+/- Root)

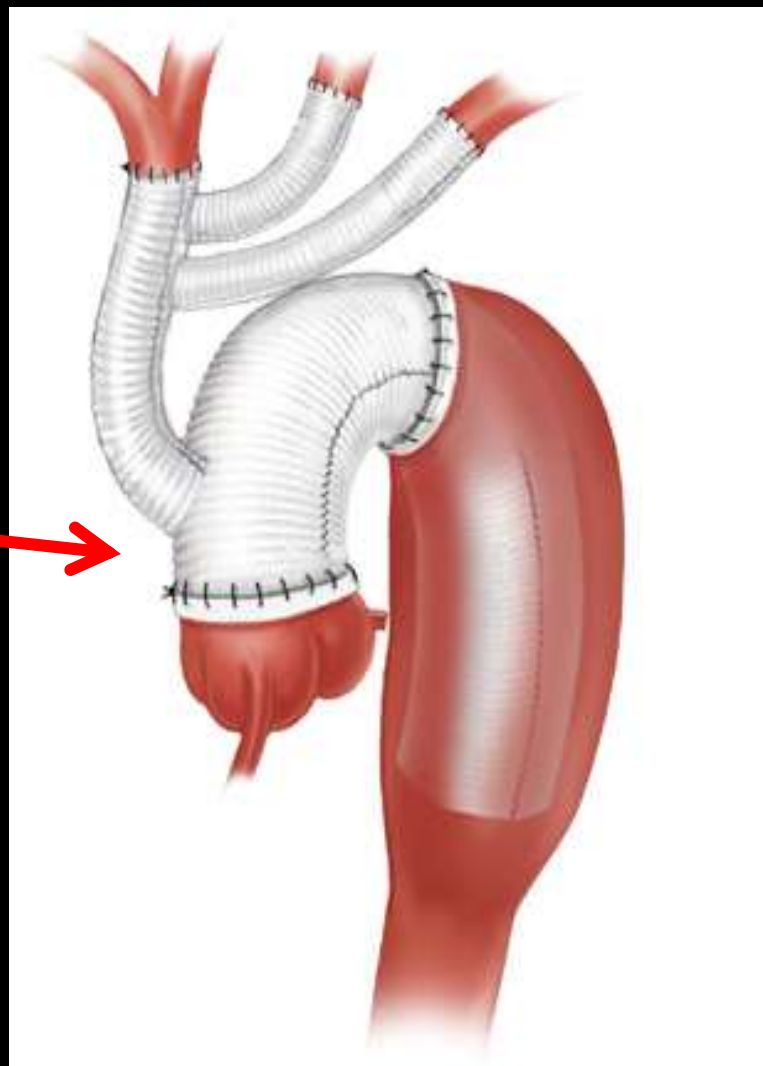
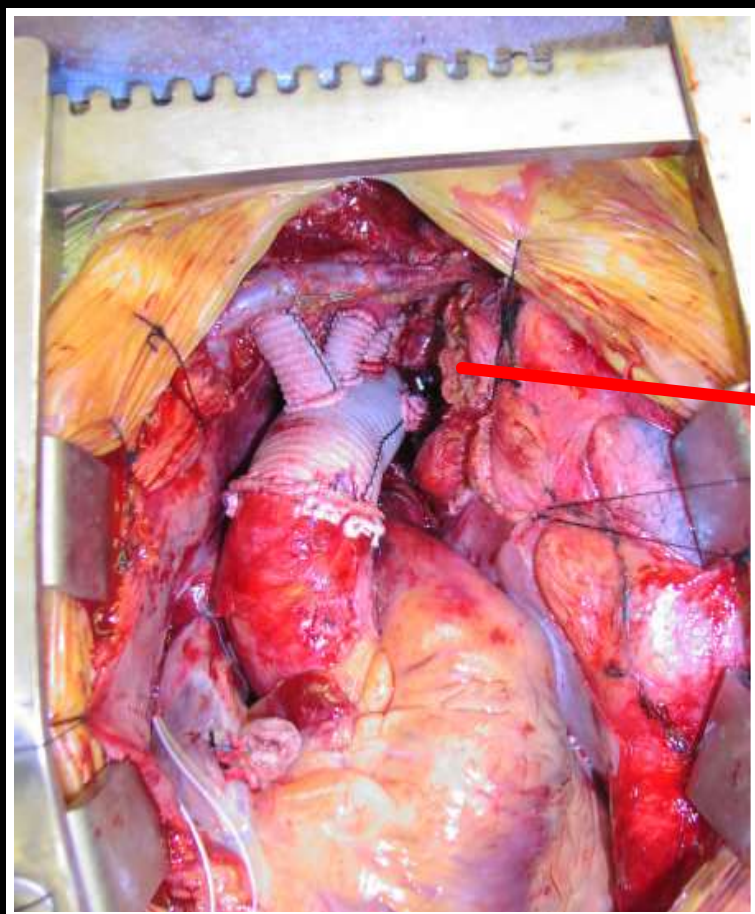


# Technical: Conventional Total Arch for with "deep" Distal anastomosis +/- Elephant Trunk: Standard Zone 3 Arch



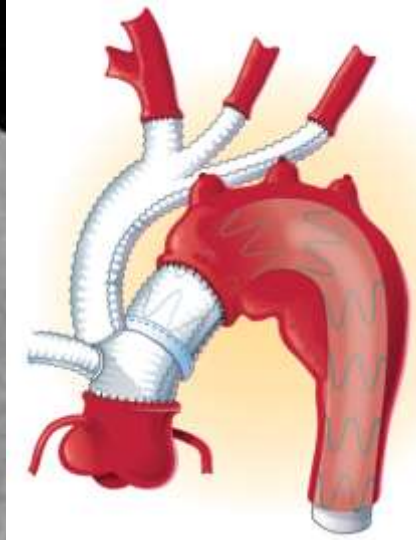
Total Arch +/- Elephant Trunk with 4-branch graft  
Selective ACP

# “More Proximal” Aortic Arch Surgery ENABLING later TEVAR if anatomy Suitable



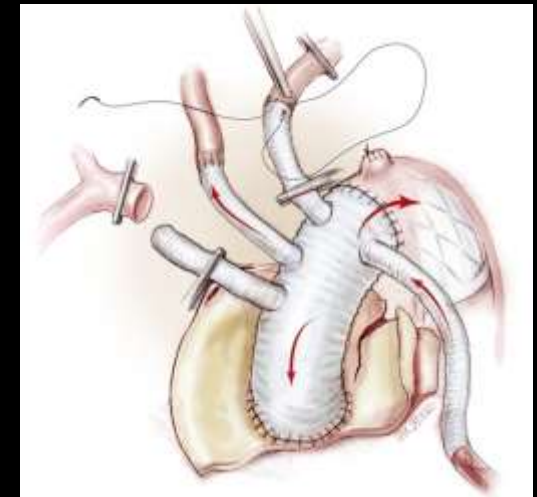


Calgary, Alberta, Canada



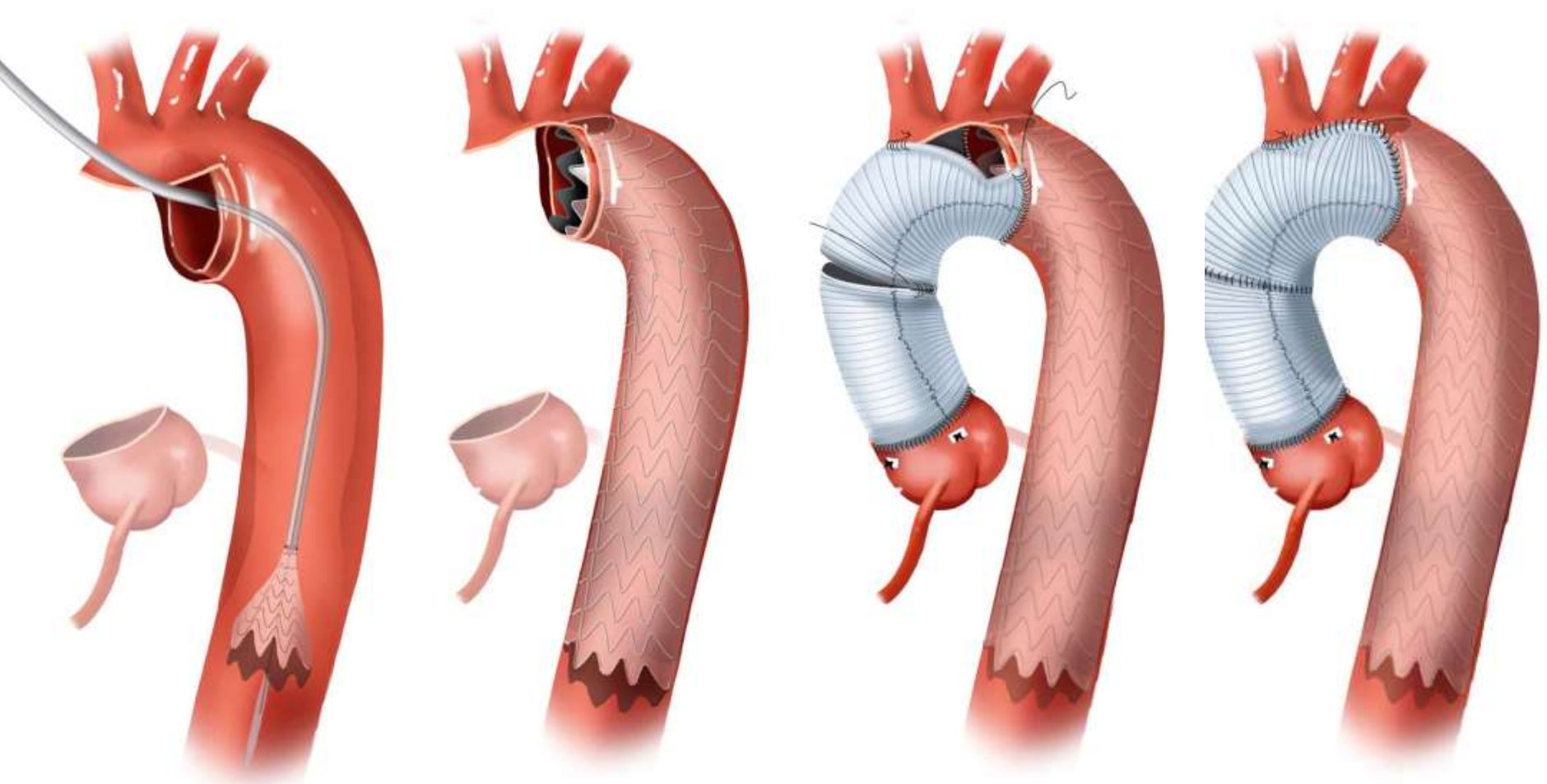
Debranching Acute Type A  
(DeBakey I) Dissection Repair  
with Type II Hybrid Technique

# Technical: Conventional Total Arch with Frozen Elephant Trunk: Standard Zone 3 Arch FET



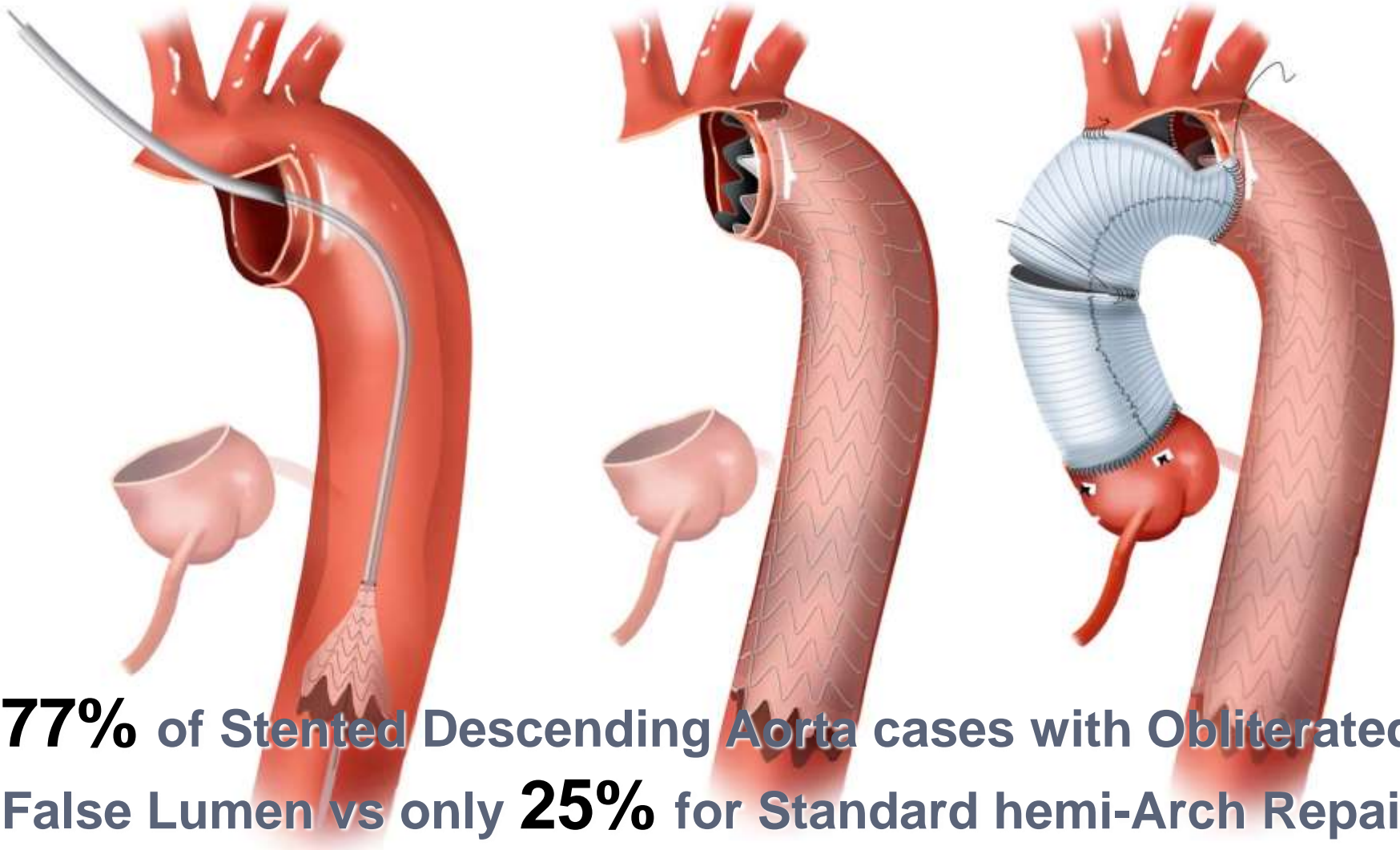
# Antegrade TEVAR during Open Hemi-Arch: Technical Methods

Pochettino, Szeto, and Bavaria; AnnThor Surg 2009



# Acute Type A "Stented Elephant Trunk"

Pochettino, Szeto, and Bavaria; AnnThor Surg 2009



**77%** of Stented Descending Aorta cases with Obliterated False Lumen vs only **25%** for Standard hemi-Arch Repair

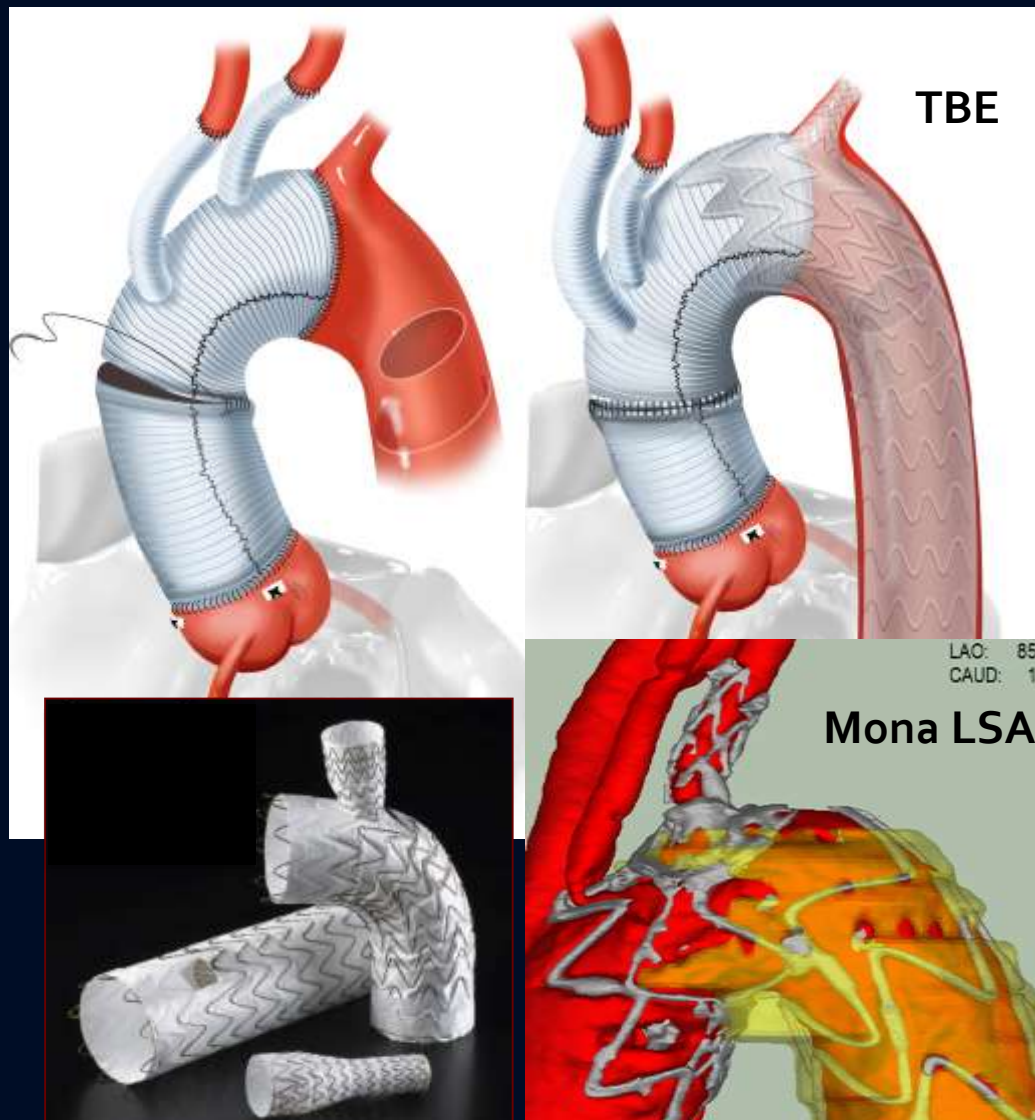


# So how should we handle the ARCH?

## Or ... ZONE 2 Arch with Branched TEVAR completion

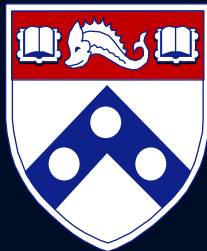
### ■ Advantages

- Simpler Distal Anastomosis
- Can address most complex arch tears and eliminate flap in proximal head vessels
- Shorter ACP times
- Definitive TEVAR options
- Less risk of Recurrent laryngeal nerve injury



# Type A Repair with Zone 2 Arch:

## Zone 2 Arch with 14 day Branched TEVAR Completion: 1<sup>st</sup> in MAN



# Hybrid OR-The Future

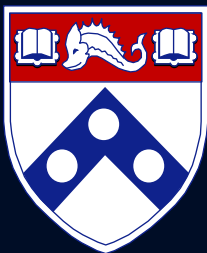


**THE FUTURE (???) ....**



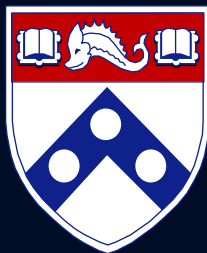


# Water Hammer Pulse At Aneurysm



# Ascending Aorta Motion in multiple planes

- Long Term TEVAR stability will possibly have issues



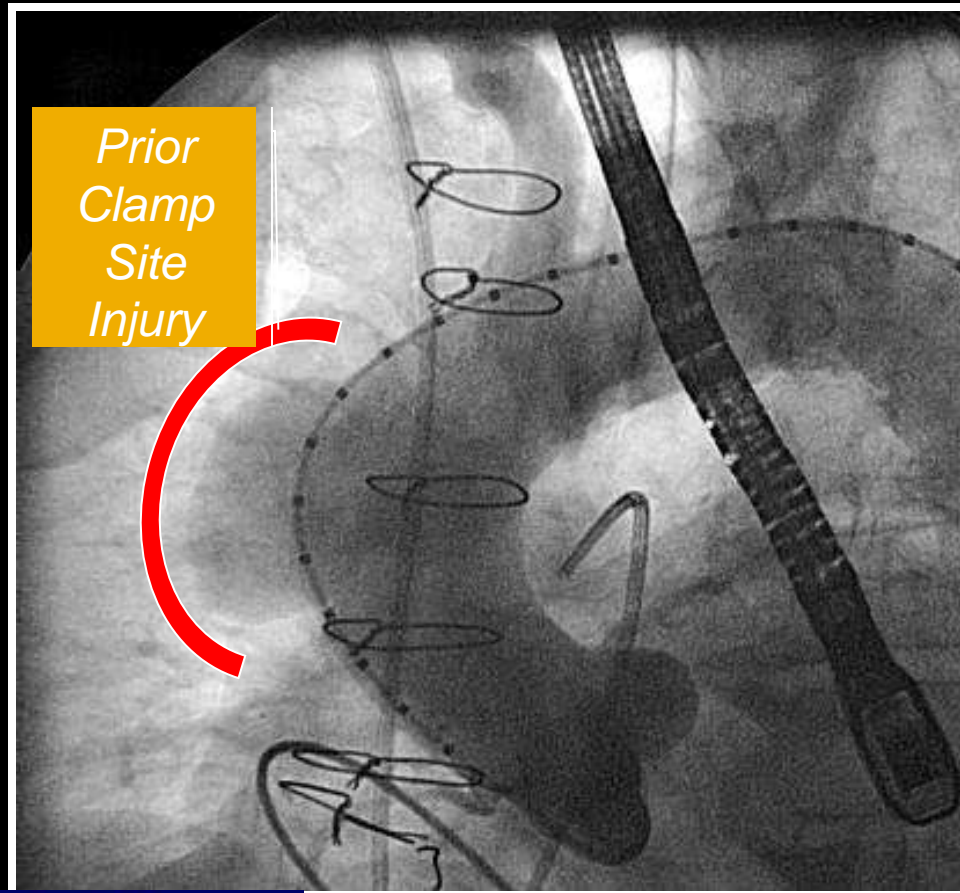
**However (???) ....**

**Never fear Failure!**

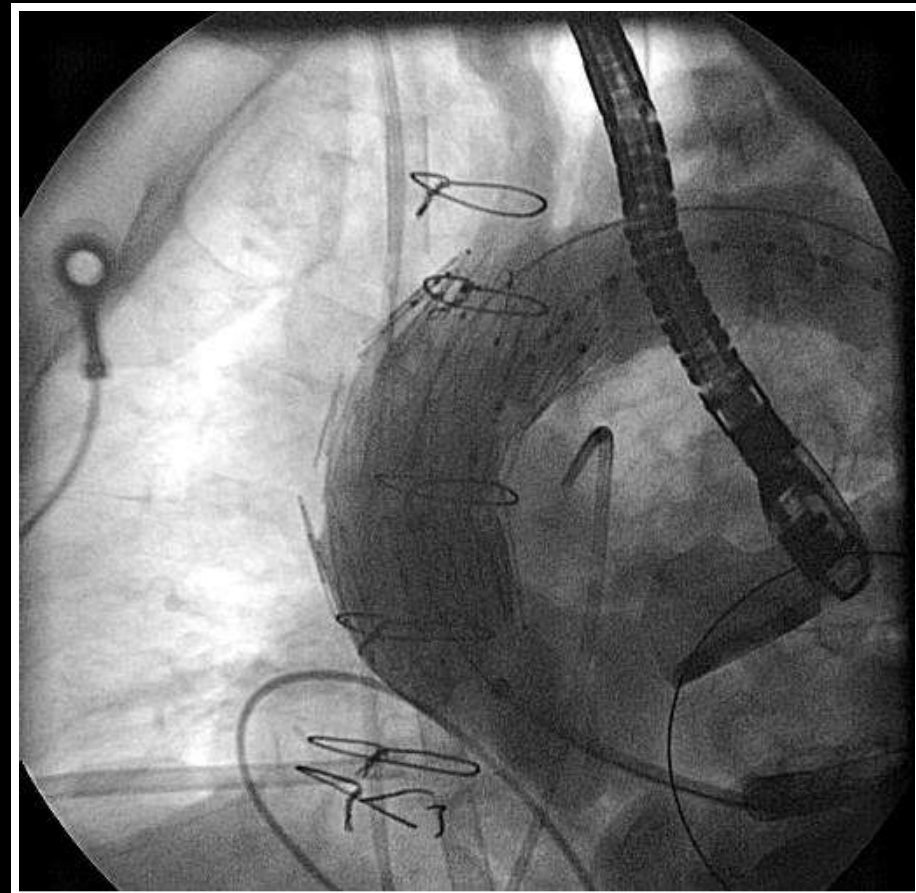


# The Future of Ascending TEVAR?: Repair of Ascending Aortic Aneurysm **Trans-Apically** with Stent Graft

(Szeto , Bavaria et al, ATS 2010)



Pre



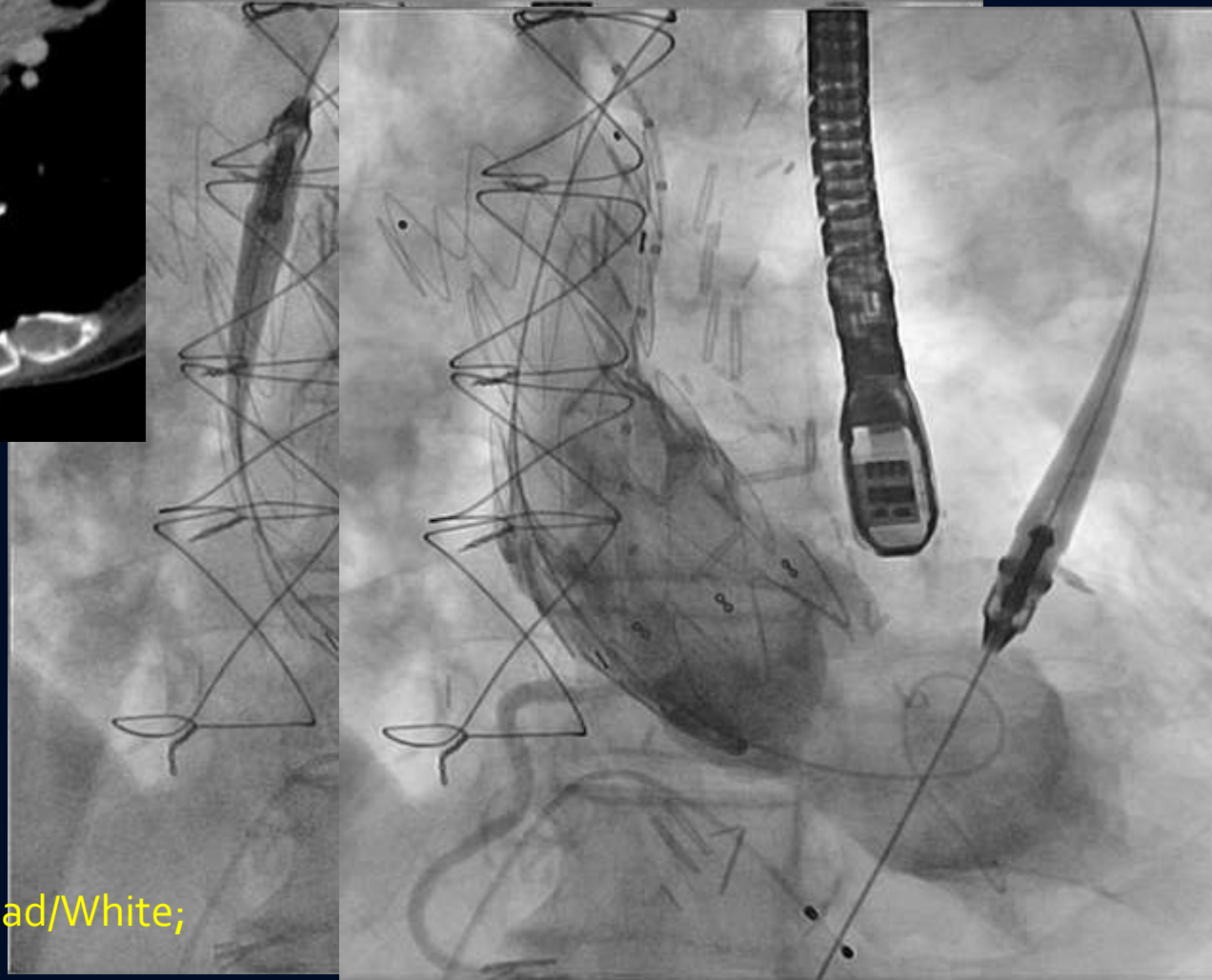
Post

# Medtronic Ascending Endograft

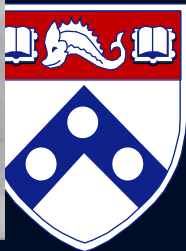
FDA Physician IDE (Type A Dissection)

Valiant Captiva

46x46x80 mm

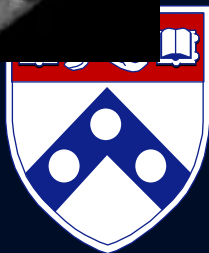
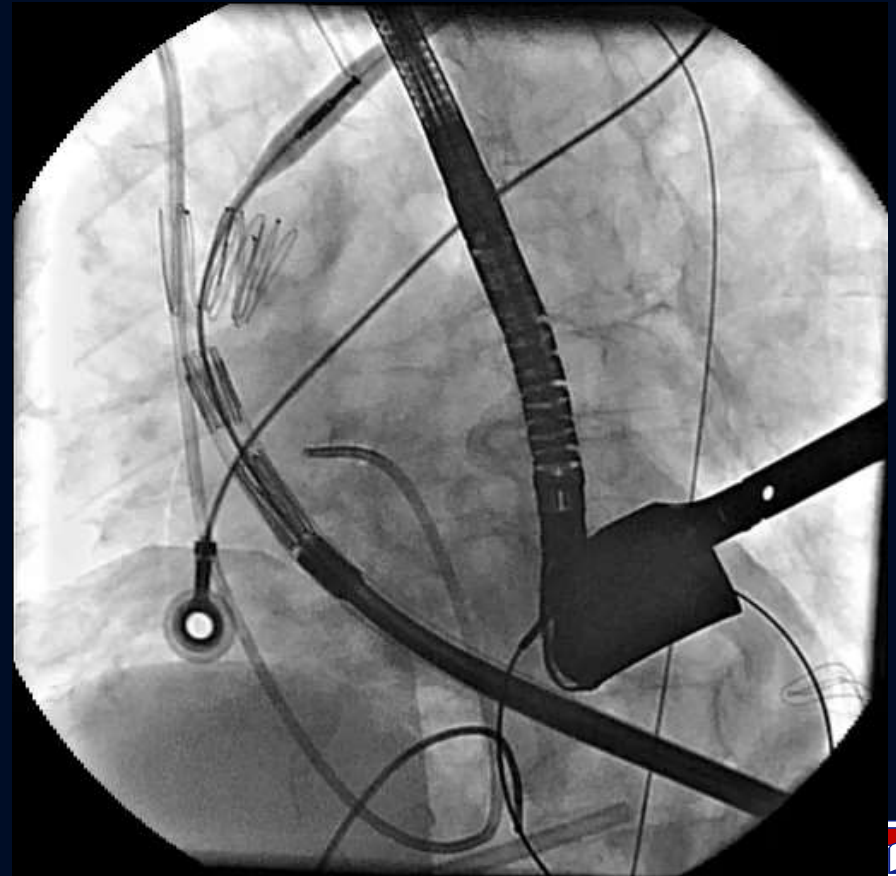
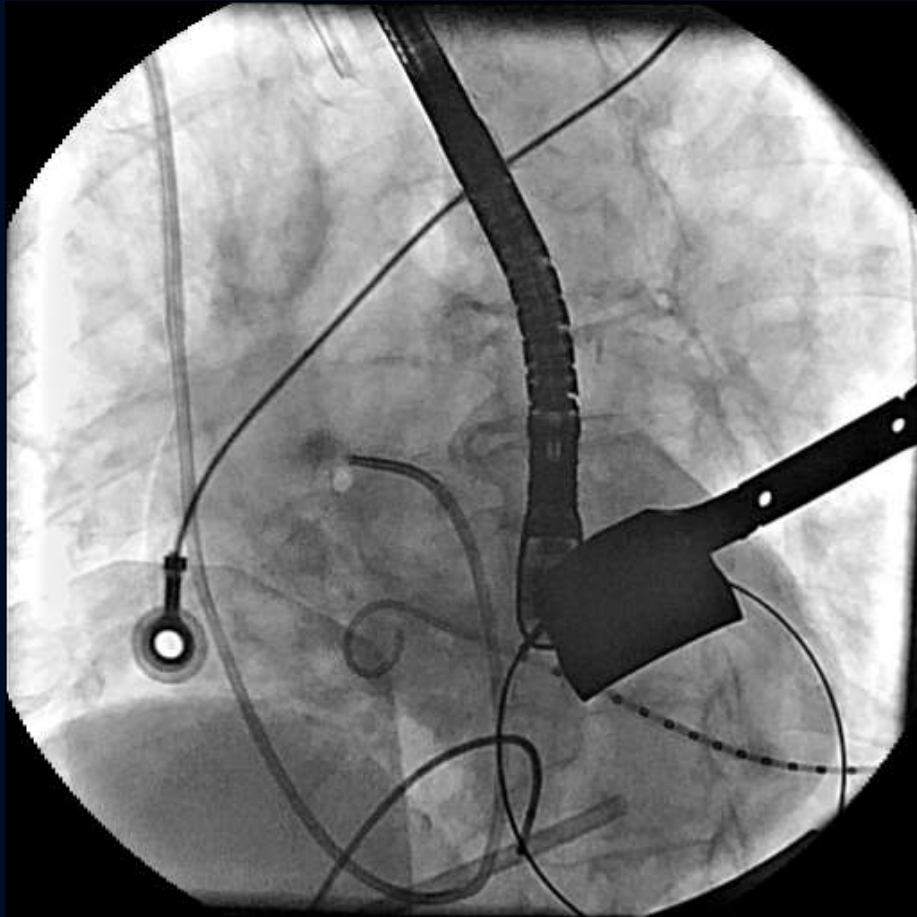


Courtesy of Khoynezhad/White;  
Cedars-Sinai /UCLA



# Transapical TEVAR for Type A Aortic Dissection

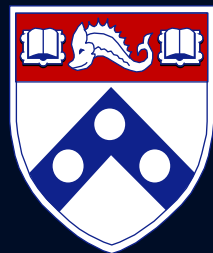
Desai, Szeto, Bavaria, et al



# Transapical TEVAR for Type A



- Acute type A aortic dissection
  - contained rupture and pericardial effusion
- Chronic Hep B
  - Compensated cirrhosis
  - MELD 10
  - Hepatocellular carcinoma
- Transapical TEVAR with Cook Tx2 Proximal Extension (40mm)



# Key Concepts and Debate regarding Type A Dissection: Summary

- **Cannulation:** No Consensus
  - Axillary, Direct Aortic, Femoral ... Rational approach?
- **Arch & Circulation Management:** Consensus  
ACP (minority RCP), Temp < 25, Axillary, Innominate, Bilateral direct cannulation
  - New Stuff: frozen elephant trunk more common, “proximalization” of the procedure, “**thinking**” about distal phase at initial operation
    - Lupae, Calgary, Evita/Thoroflex, Sun, hemi arch with antegrade TEVAR, etc





# Key Concepts and Debate regarding Type A Dissection: Summary

- **Timing of surgery for Malperfusion:** Debate Early vs Later ..... No consensus yet.
- **The Aortic Root:** Bachet!! ..... Data suggesting that "Robust" root repair and/or Reimplantation is best for otherwise normal anatomic aortic valves
- **Octogenarians/Age considerations:** >85 be careful, 80-85 without major malperfusion and stable then good results.



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

Great Progress in 10 years!

Thank You



**Thank You**

