### **Quo Vadis Cardiovascular Surgery:** The Role of Open and Endovascular Techniques in the future (21st Century)

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#### Proximal Aortic Surgery in 21<sup>st</sup> Century



### I'm here to "<u>Set Up</u>" this excellent Session!!



Proximal Aortic Surgery in 21<sup>st</sup> Century

### I'm <u>ALSO</u> here to tell you that we are at the beginning of a <u>Revolution</u>





#### Aortic Arch Surgery in 21<sup>st</sup> Century



 Recently, We (The Aorta Community) spent much energy and time trying to "Optimize" and answer the Question: What is the best <u>Circulation Management Technique</u> during Aortic Arch Reconstruction?

- Temperature

– HCA, RCP, ACP, Unilateral, Bilateral, etc.

The "Optimization" revolved around: What is the <u>KEY CONCEPT</u> 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.

#### Aortic Arch Surgery in 21<sup>st</sup> Century

General Consensus on Circulation Management

 Tepid Temperatures are reasonable with "good" ACP technique

 ACP thought to be best, RCP reasonable especially for Short Arch reconstructive times, <u>HCA Alone should be</u> <u>abandoned</u>.





#### On Chiculation Management. Celebrai



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#### Aortic Arch Surgery in 21<sup>st</sup> Century

 <u>Recently</u>, We spent much energy and time trying to "Optimize" and answer the Question: What is the best Circulation Management Technique during Aortic Arch Reconstruction?

• <u>But Now</u>: We are Changing Practices and Developing Reconstructive Operations ......

 Based on the Availability of New Devices. New Technology!!







#### Proximal Aortic Surgery in 21<sup>st</sup> Century

## Aneurysm







### **Proximal Aortic/Arch Aneurysm: Future**



CT Chest, Ascending Ao SAX



#### Aortic Arch Surgery in 21st Century: <u>Aneurysm</u>

- All open (proximal) operations will be performed with an "<u>Attitude</u>" looking towards <u>Distal TEVAR Solutions</u>.
- The Classic elephant trunk will be rare
- FET will be victorious
- All "<u>Conduct of Operation</u>" will be geared towards "Proximalization" into Zones 2,1,and 0

   The (New) Debranching concept







# The Arch in Acute Type A Dissection? What is State of the Art ...... Now/Future??



Original Video Courtesy of J. Bavaria Acute Type A Dissection: Design of an Operation (What is Missing?)

Cause of death

Acute CHF due to AI resuspension

Coronary malperfusio

Cerebral malperfusior

Free Ascending ruptur

tment

Aortic valve

oot repair

replacement

ic 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



### Distal re-operation rate after Type A Dissection Repaired "<u>Classically</u>"

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
- Griepp et al, (USA), 16% reoperation at 8 years
  - Included Debakey II
- Glauber and Murzi, 2010, 39% reoperation at 10 years (proximal and distal)



#### Freedom from Reoperation after Type A: Proximal and Distal



Glauber, Murzi, et al; 2010:



### Late Outcome after Debakey Type 1 Repair



## Late Complications: Aneurysmal Dilation of the Dissected Aorta (8.0 cm)

2007





53y.o male



#### 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.



#### 40 y.o male 1 year post Type A repair (6.4 cm)









#### 68y.o male 10 years post type A repair (7.3 cm)

#### Aortic Enlargement and Late Reoperation After Repair of Acute Type A Aortic Dissection

Andreas Zierer, MD, Rochus K. Voeller, MD, Karen E. Hill, BS, Nicholas T. Kouchoukos, MD, Ralph J. Damiano, Jr, MD, and Marc R. Moon, MD

#### <sup>Division</sup> Barnes. The fate of the distal aorta after repair of acute type A aortic dissection

after n pletely Meth David Spielvo went n 168 op tion or Late bl able fo

scans lumen

follow

to 170

patient

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(p = 0)tion. A Fate of the Residual Distal and Proximal Aorta After Acute Type A Dissection Repair Using

#### Evolution of Aortic Dissection After Surgical Repair

Rossella Fattori, MD, Letizia Bacchi-Reggiani, MSc, Paola Bertaccini, MD, Gabriella Napoli, MD, Francesca Fusco, MD, Massimo Longo, MD, Angelo Pierangeli, MD, and Giampaolo Gavelli, MD

Patients after aortic dissection repair still have long-term unfavorable prognosis and need careful monitoring. The purpose of this study was to analyze the evolution of aortic dissection after surgical repair in correlation to anatomic changes emerging from systematic magnetic resonance imaging (MRI) follow-up. Between January 1992 and June 1998, 70 patients underwent surgery for type A aortic dissection. Fifty-eight patients were discharged from the hospital (17% operative mortality) and were followed by serial MRI for 12 to 90 months after surgery. In all, 436 postoperative MRI examinations were analyzed. In 13 patients (22.5%) no residual intimal flap was identified, whereas 45 patients (77.5%) presented with distal dissection, with a partial thrombosis of the false lumen in 24. The yearly aortic growth rate

From the Departments of Cardiothoracic approximately tw

There were 4 sudden deaths, with documented aortic rupture in 2. Sixteen patients underwent reoperation for expanding aortic diameter. In all but 1 patient, a residual dissection was present (in 13 without any thrombosis of the false lumen). Close MRI follow-up in patients after dissection surgical repair can identify the progression of aortic pathology, providing effective prevention of aortic rupture and timely reoperation. Thrombosis of the false lumen appears to be a protective factor against aortic dilation. ©2000 by Excerpta Medica, Inc.

was maximum in the descending aortic segment (0.37  $\pm$ 

0.43 cm) and was significantly higher in the absence of

thrombus in the false lumen  $(0.56 \pm 0.57 \text{ cm})$  (p < 0.05).

(Am J Cardiol 2000;86:868-872)

Changes were analyzed separately in the thoracic and abdominal segments.

Results. In early CT, thoracic false lumen was patent in 85 patients (69.7%), and abdominal false lumen was patent in 111 patients (91.0%). Among these, the false lumen remained patent after a mean interval of 33.6 months in 69 patients (81.1%) and 105 patients (94.6%),

#### ic False Dissection

fD, Euisuk Chung, MD, MD, PhD Jundang Hospital, Bundang, Jedicine.

re. Dilatation occurred more freaorta and in patients with patent , larger aortic diameter, Marfan (ge, and male sex. Meanwhile, alse lumen occurred in 36 patients ge occurred in 23 of 24 patients bosed and narrow false lumens in

stoperative characteristics of false for predicting both dilation and how not only a high incidence of

descending aortic dilatation after repair of acute type I dissection, but also shrinkage of thoracic false lumen in some patients. These findings can be used as control data for determining the benefit of more extensive or new surgical approaches.

(Ann Thorac Surg 2009;87:103-8)

#### Do we have a

problem with the distal aorta after repair of acute type A dissection? ....

YES

Especially if we use a <u>**COMPOSITE**</u> function of <u>Index Operation Failure</u>: 1. Aortic Death; 2. Reoperation; 3. Aneurysm > 6.0 cm.





## What can we do?? What Options are available??

STS San Diego, Jan 2015

#### **STS/EACTS** Aortic Symposium:

Management of the Aortic Arch during Type A Dissection

Moderators: Joseph Bavaria (STS) Ruggero DePaulis (EACTS)







#### Not worry about it: The Hemi-Arch (+/-Root)



Aggressive Hemi-Arch with "felt Neo-Media" Reconstruction





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



Siena Graft

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

### "More Proximal" Aortic Arch Surgery <u>ENABLING</u> later TEVAR if anatomy Suitable



#### Acute Type A "Stented Elephant Trunk"

Pochettino, Szeto, and Bavaria; AnnThor Surg 2009



### However .....

#### Let's look at these



#### Aortic Arch Surgery in 21<sup>st</sup> Century

## •The Future Arch Treatment "Civil War" ....



#### Technical: Conventional Total Arch with <u>Frozen Elephant Trunk</u>: Standard Zone 3 Arch FET









#### So how should we handle the ARCH? Or ... ZONE 2 Arch with Sequential 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 larnygeal nerve injury
  - Not doing unnecessary distal procedure at Index operation
  - Griepp/Etz Collateral Network theory friendly!

Desai, Bavaria (First presented) STS 2015; AATS 2016 JTCVS 2017 (in press)



#### Zone 2 TBE (12 mm Portal) in "Residual" Type A Dissection (Downstream Aorta) 10 days



3 cm Dacron LZ previously constructed with Zone 2 Arch (10 days earlier)



Side branch sheath positioned in LSA Note nice horizontal access



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









The "Classic" Type A Operation is under Siege!! There are reasonable arguments to "extend" the operation BOTH distally and proximally.... However, The Arch and Distal

imperative is MORE IMPORTANT!!



<u>Conclusions</u> on Management of the Arch in Acute DeBakey I Dissection 21<sup>st</sup> Century

- There are Multiple Ways to manage the ARCH in an Acute Type A Dissection
- My Prediction on the future based on our data, our increased sophistication, and the available technology:
  - In Patients with < 10-15 years life expectancy (>65) ..... <u>Use Classic Hemi-Arch</u>
  - In Patients with an arch tear or distal Malperfusion ...... <u>FET</u>
  - In patients < 65 and stable ........ Zone 2 Arch with possible (60%)</li>
     <u>SEQUENTIAL Arch branch TEVAR</u>
- Coming to you SOON!







#### **<u>Rapid Supra-Aortic Arch Vessel Anastomosis</u>** Using the Gore "Hybrid" Prostheses (90 seconds and better!!)



Courtesy of Jim Williams, Peoria IL



MM. Levack , JE. Bavaria , RC. Gorman , JH. Gorman III , LP. Ryan. The Annals of Thoracic Surgery Volume 95, Issue 6 2013 e163 - e165.

## Endovascular Arch Repair ?



Gore Zone o TBE



## Endovascular Arch Repair ?



Gore Zone 0 TBE



What does an "Arch Endograft" really mean visà-vis Arch pathology???

- Isolated Arch Pathology?
- Arch Pathology WITH Ascending Pathology?
- Arch Pathology WITH Root/Valve Pathology?
- Arch Pathology as a Proximal extension of Descending pathology?



#### Aortic Arch Surgery in 21<sup>st</sup> Century

#### This anatomy only represents 1-3% of <u>ALL ARCH</u> cases



There is already a TOTAL TEVAR (Endo) Solution for this anatomy

#### **Bolton Relay:** Fenestrated Arch Grafts







**Courtesy of Bolton Medical** 

### Cook Branch Arch Prosthesis (Significant Wordwide experience)

b

Cook Branched Arch Graft Courtesy of Cherrie Abraham, MD, Montreal, Canada





What does an "Arch Endograft" really mean visà-vis pathology???

Isolated Arch Pathology?

Arch Pathology WITH Ascending Pathology?

Arch Pathology WITH Root/Valve Pathology?

Arch Pathology as a Proximal extension of Descending pathology?



### Zone o Landing: Achilles Heal??



Most "Arch TEVAR" will be Secondary or Sequential to PROXIMAL OPERATION DACRON



#### Aortic Arch Surgery in 21<sup>st</sup> Century

## There are Significant Proximal Landing Zone Issues



#### **Giant Fusiform Thoracic Aortic Aneurysm:** Isolated Arch Endograft?? Where's the LZ??



CT Chest, Ascending Ao SAX

Hypertensive Ascending Aneurysm with <u>partial</u> Proximal Arch Extension AND Distal Arch Aneurysm: Isolated Arch TEVAR??? ......<u>Where's the LZ??</u>



May Want to Replace Ascending Aorta?! In



## Bicuspid Valve Phenotype Aorta: Isolated Arch TEVAR?? ..... Where's the LZ??





### Water Hammer Pulse Al Aneurysm: Major LZ Issue!!

#### +3 AI BAV Aneurysm





#### Ascending Aorta Motion in multiple planes: Major Proximal LZ Issues?

Long Term TEVAR stability will possibly have issues





#### Aortic Arch Surgery in 21<sup>st</sup> Century

## •Despite all of That!!





#### The Future of Ascending TEVAR?: Repair of Ascending Aneurysm <u>Trans-Apically</u> with Stent Graft Szeto, Bavaria, et al; AnnThorSurg 2010





Pre



#### Medtronic Ascending Endograft FDA Physician IDE (Type A Dissection)

#### Valiant Captiva 46x46x80 mm



Courtesy of Khoynezhad/White; Cedars-Sinai /UCLA



#### Proximal Aortic Surgery in 21<sup>st</sup> Century



### The Audit Function

#### – Data and Outcomes



#### **Open and TEVAR Surgery**

### **Presentation of a Newly Designed Thoracic Aortic Surgery** Database: A Report from the STS Adult Cardiac **Surgery Database**





Nimesh D. Desai MD. PhD., E. Chen, M.D., J. Bavaria, MD on Behalf of the STS Aortic Surgery Task Force (First reported at the Jan. 2017 STS Annual Mtg, Houston, TX)



Proximal Aortic Surgery in 21<sup>st</sup> Century

## Conclusions





#### Proximal Aortic Surgery in 21<sup>st</sup> Century:

- Index Proximal operations will be <u>driven</u> and <u>concieved</u> by the <u>NEW</u> Availability of New Technology Endografts

   Zones 0,1, and 2 TEVAR Branched Arch grafts
- "Proximalization" of the Conduct of Operation" will continue (reduced Nerve injury and Collateral Network friendly)
- Supra-Aortic Vessel anastomosis will also improve with Technology ... Much faster and easier





#### Proximal Aortic Surgery in 21<sup>st</sup> Century:

- Index Operation "Tactics" will be driven to REDUCE Total CPB TIME (more important than Circ Arrest time)
- It's too early to have Guidelines on Aortic <u>ARCH</u> Surgery!!
   Very (Too) Dynamic at this Stage
  - The only thing we should do is "Outlaw" HCA alone
- Better Outcomes Data (Global)





## Questions?

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



