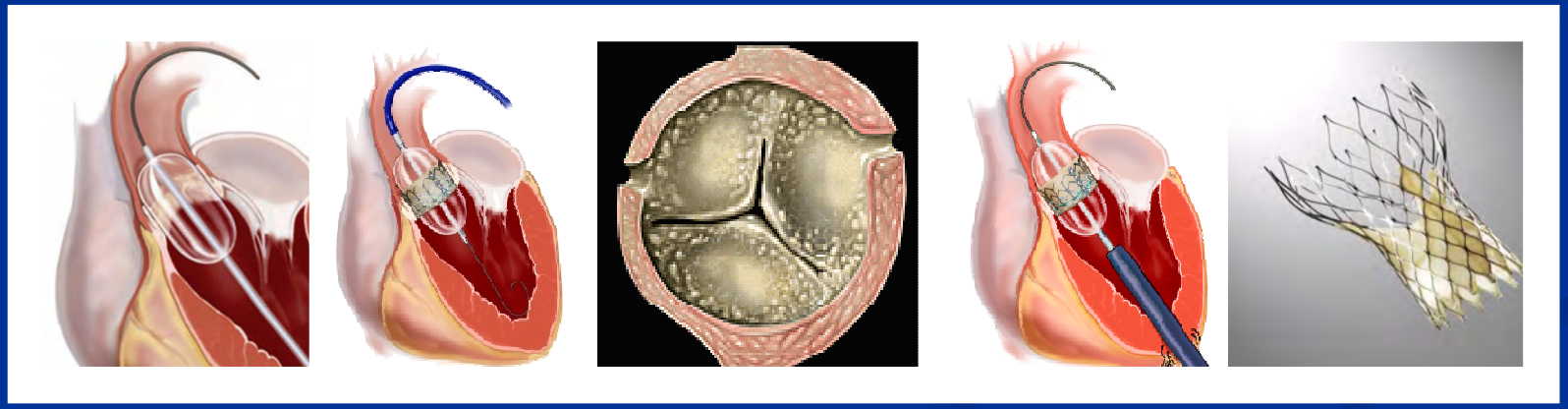
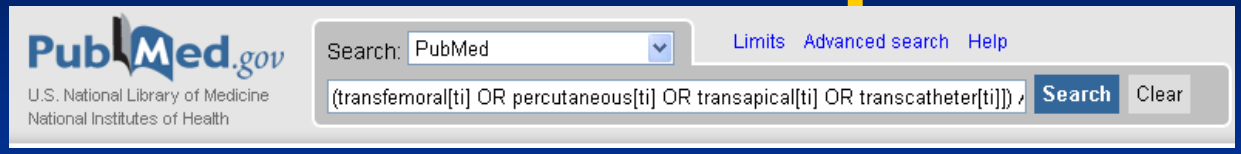
Transcatheter Aortic-Valve Procedures

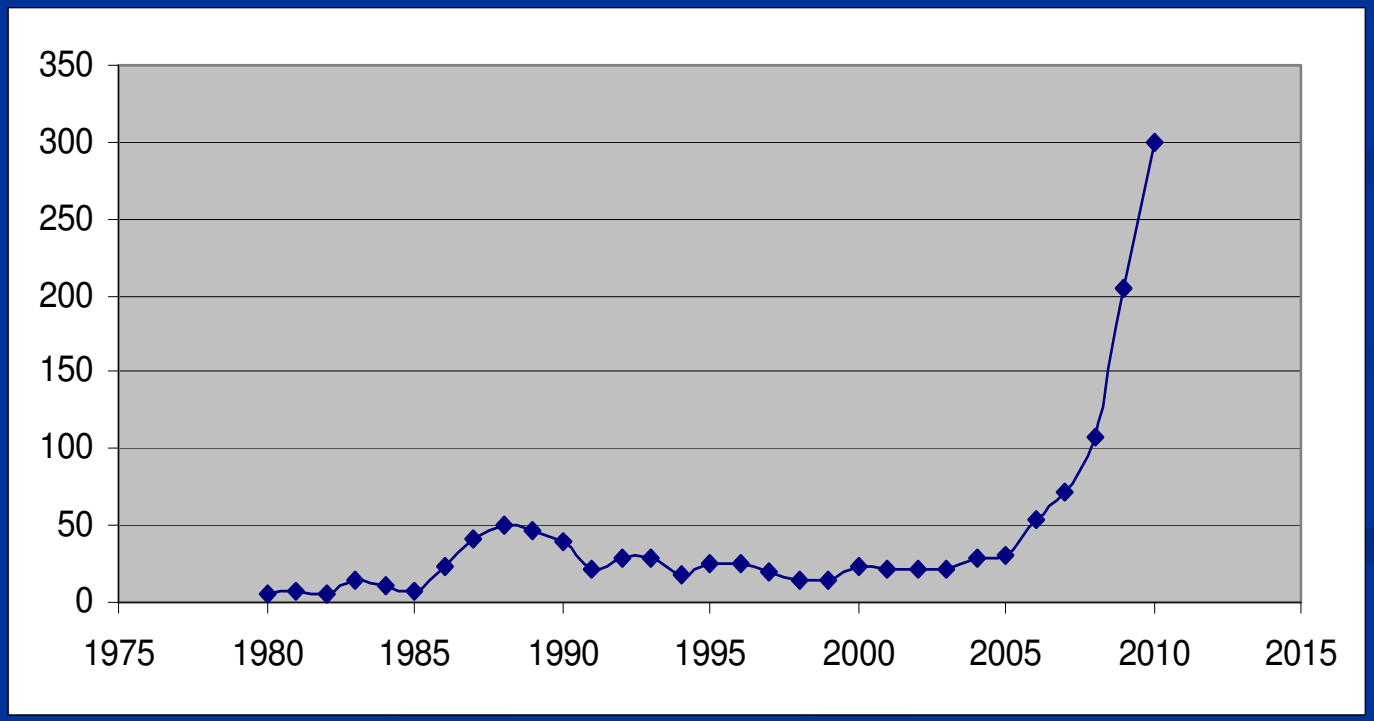


Danny Dvir, MD, Cardiology Department
Rabin Medical Center, Petach Tikva, Israel
27/7/2010

Annual publications of Transcatheter AV procedures



In the title: "transcatheter" OR "percutaneous" OR "transfemoral" OR "transapical"
AND
In the title: "aortic"



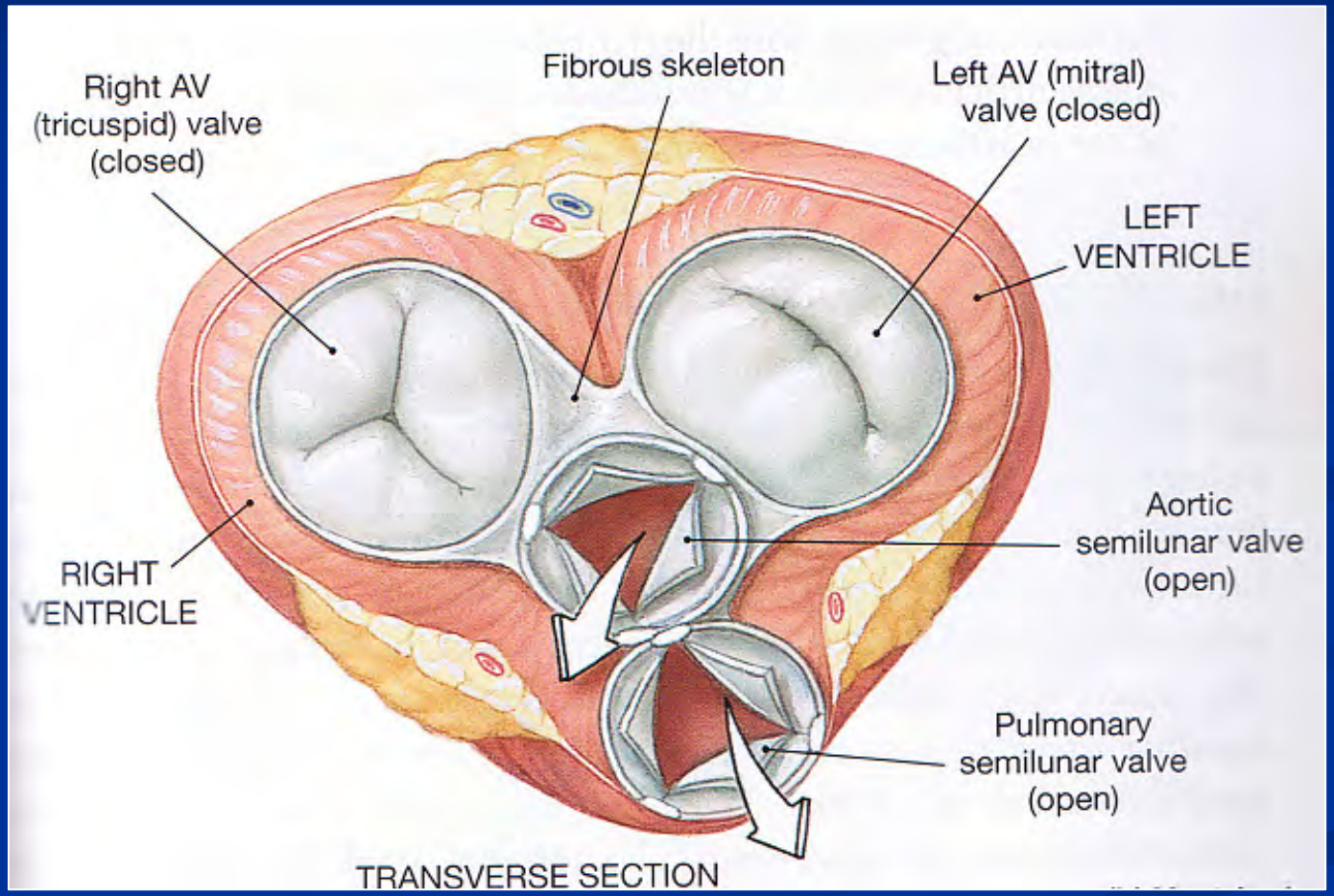
Presentation Sections

- Aortic Stenosis
- Aortic valve replacement
- Transcatheter AV implantation (TAVI)
- Screening patients for TAVI
- The Israeli TAVI experience
- Rabin Medical Center TAVI experience

Aortic-Valve stenosis

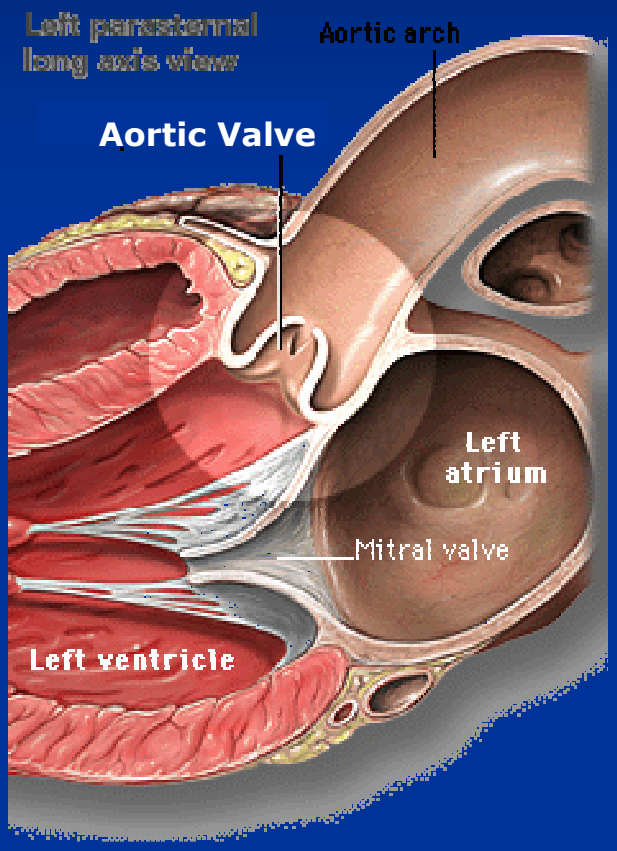
Anatomy

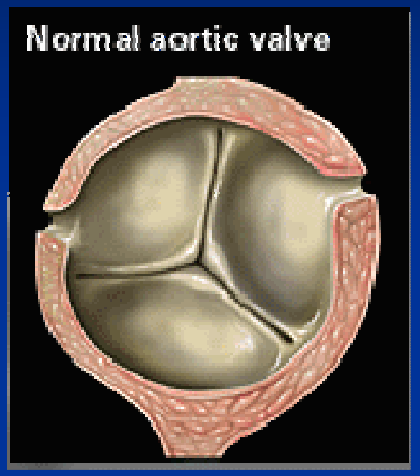
Anatomy

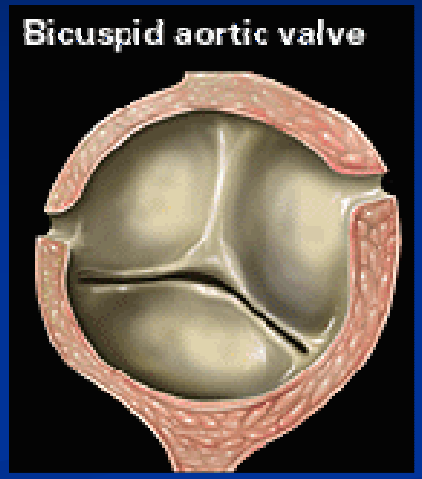


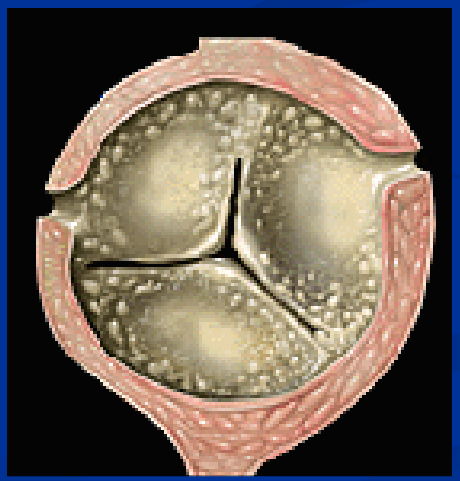
Anatomy of the Aortic Valvar Complex and Its Implications for Transcatheter Implantation of the Aortic Valve.
Piazza N et al. *Circ Cardiovasc Intervent* 2008;1;74-81

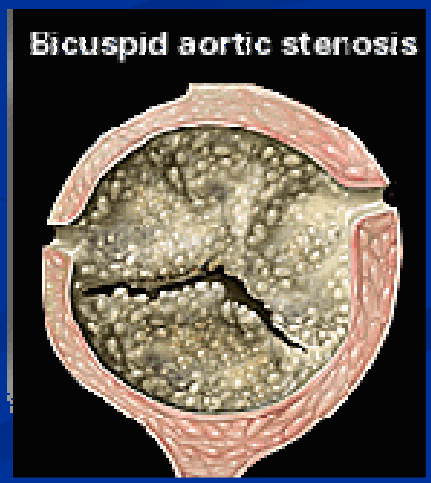
Aortic Stenosis Pathology



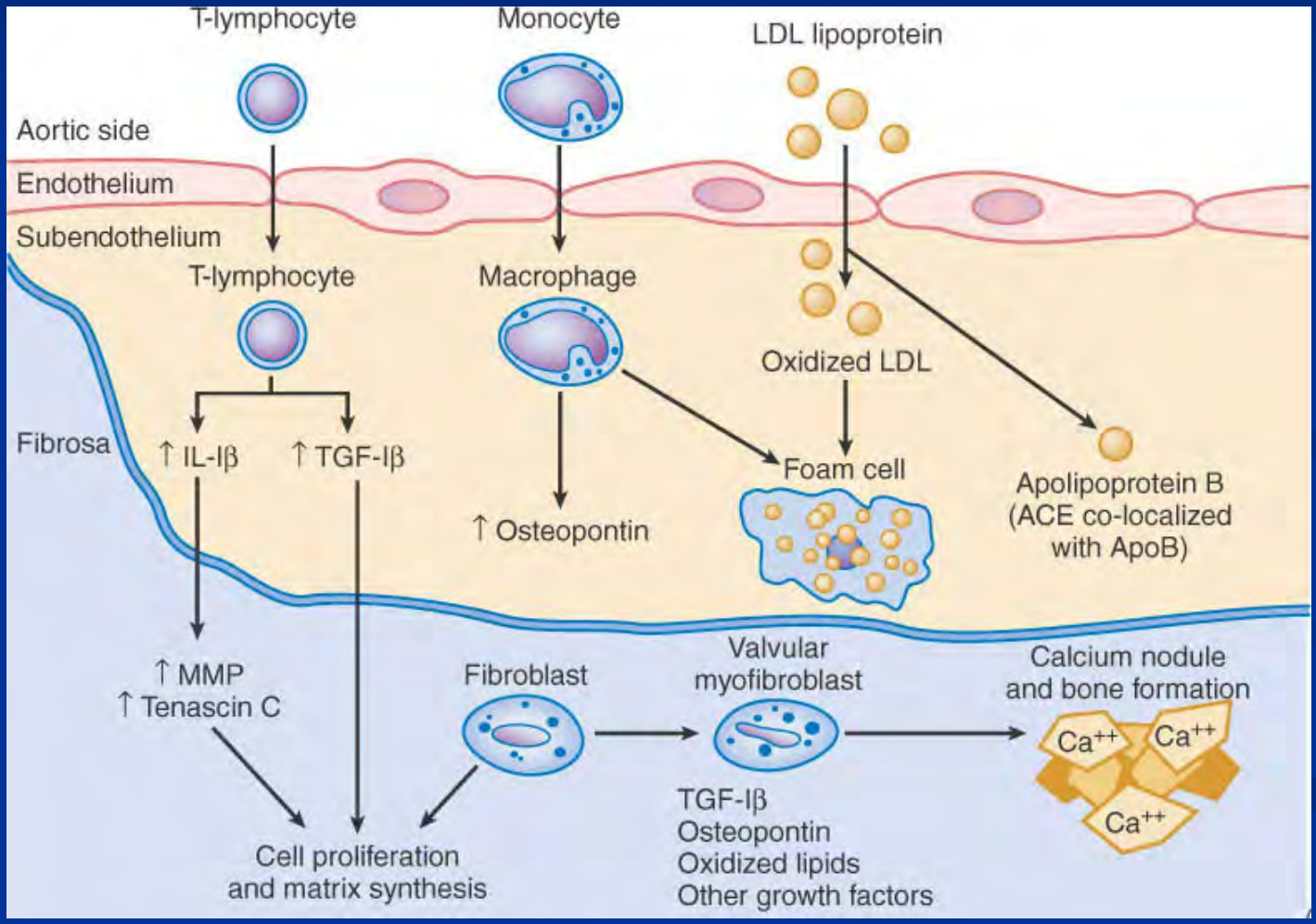




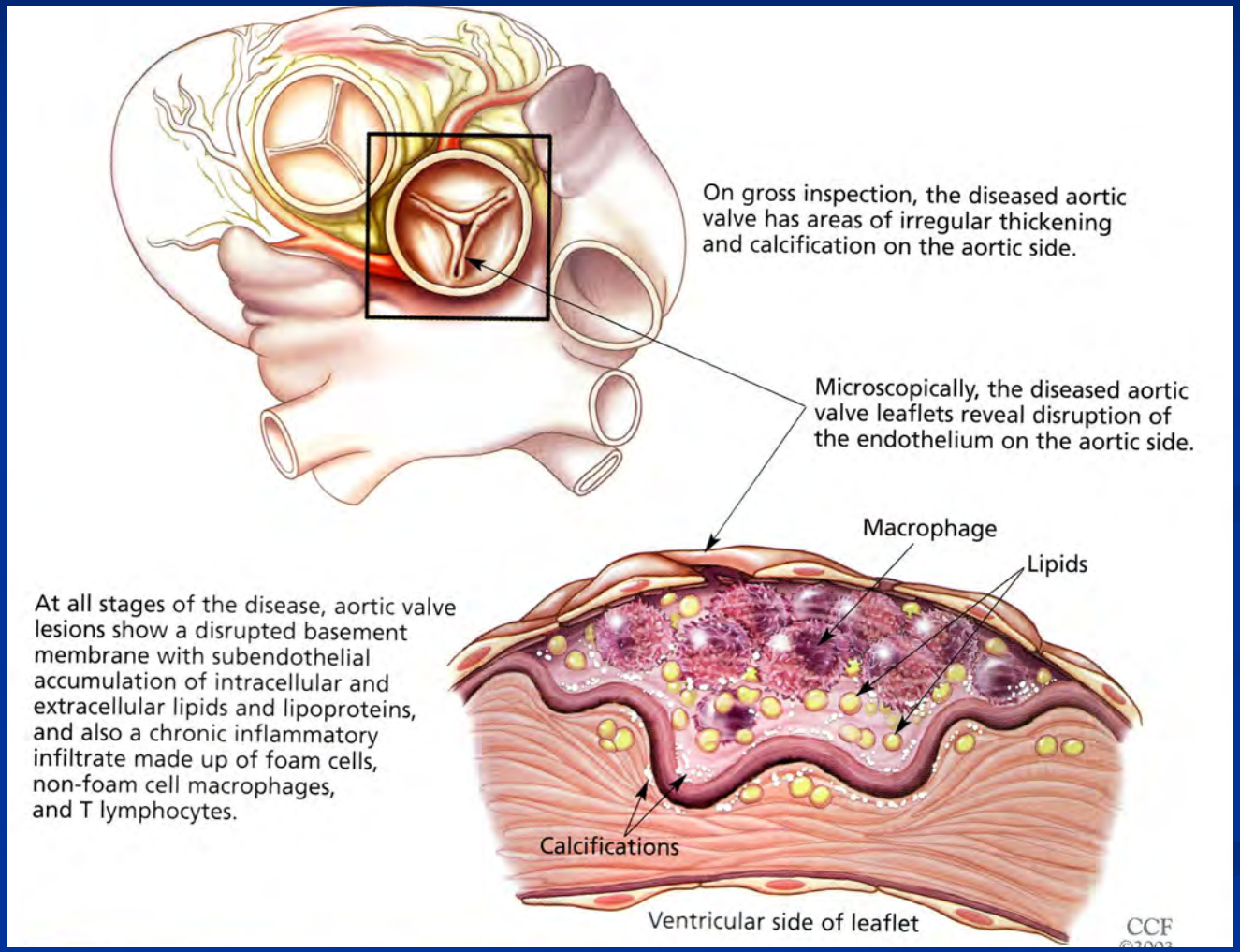




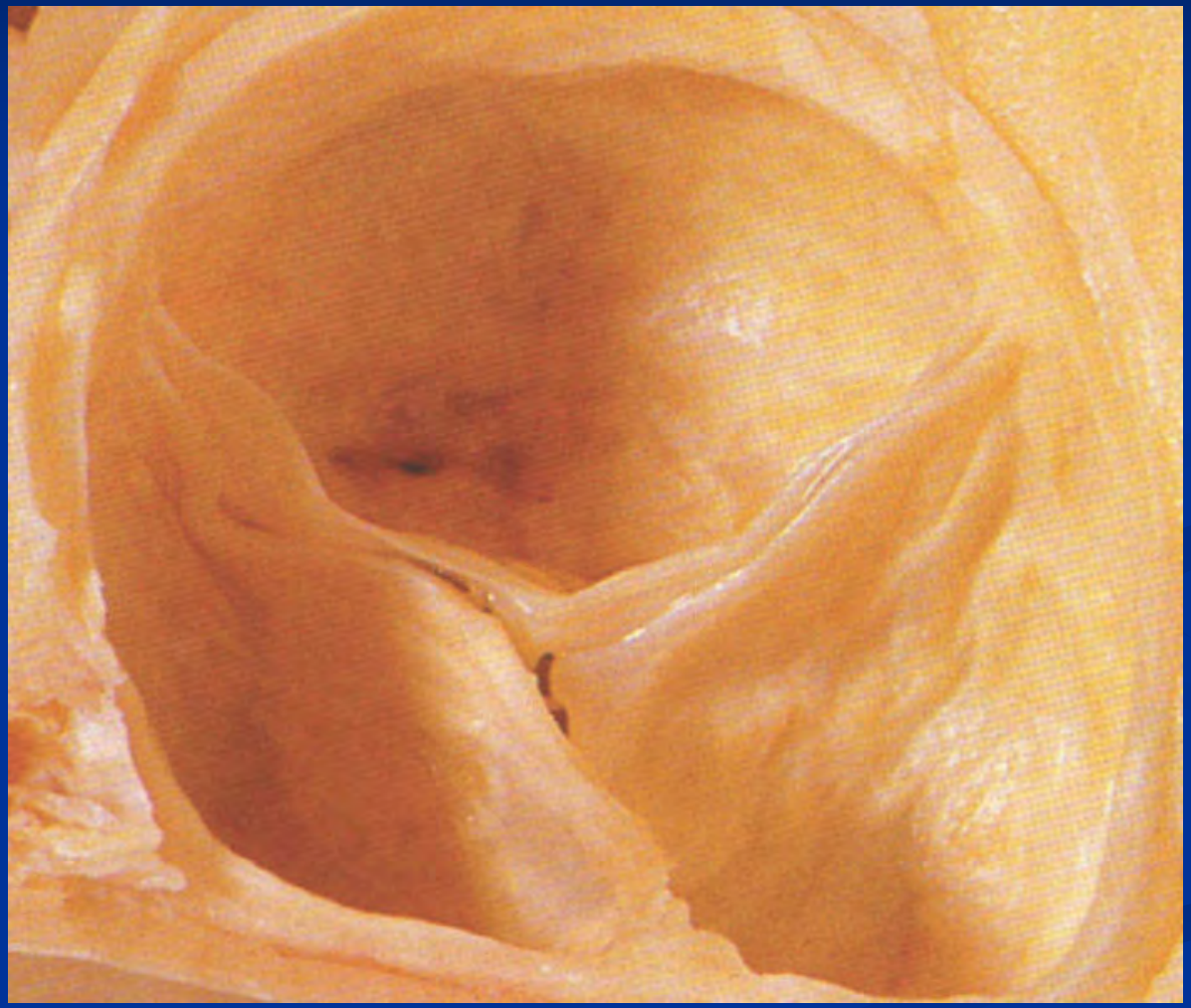
Potential pathway depicting calcific aortic valve disease



Aortic Stenosis Pathology



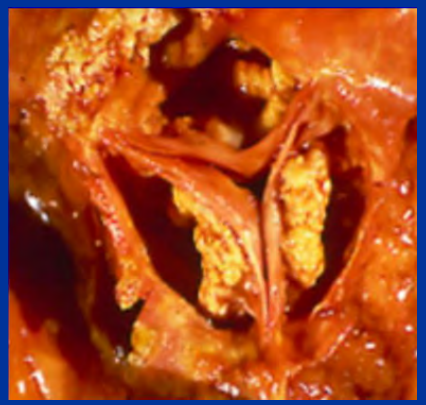
Normal Aortic Valve

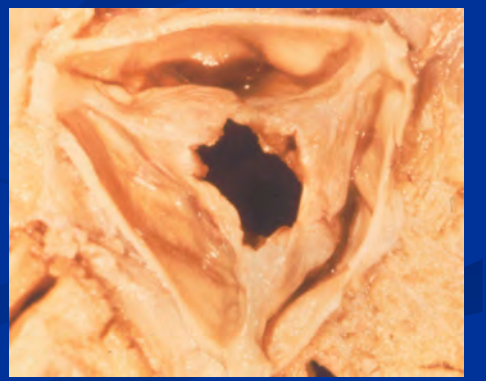


Aortic Stenosis Pathology





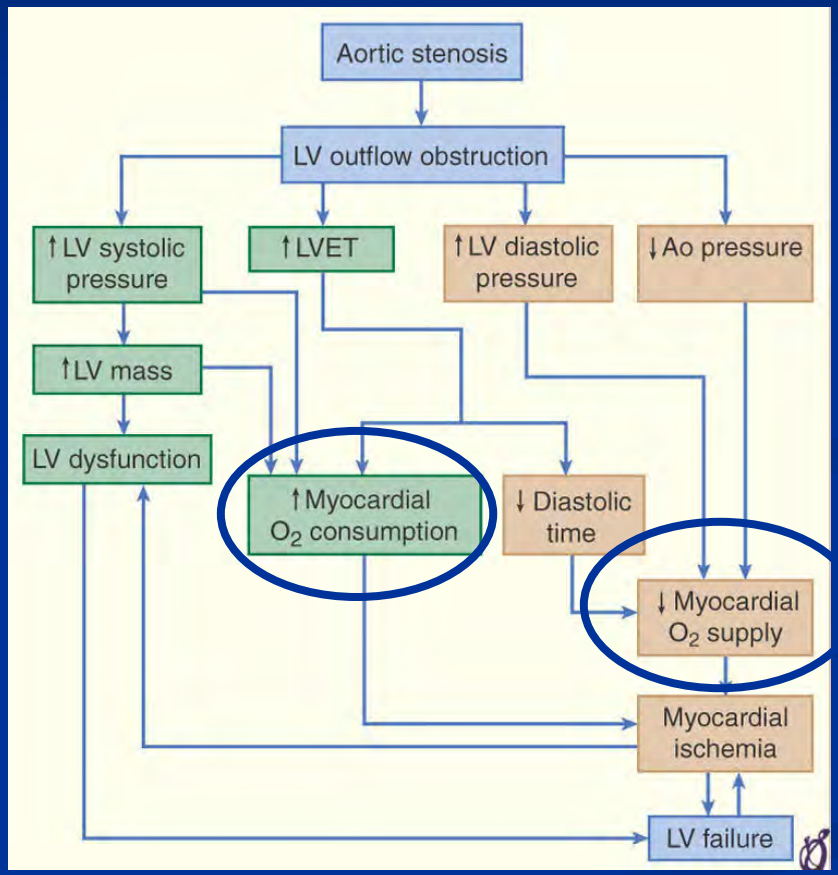


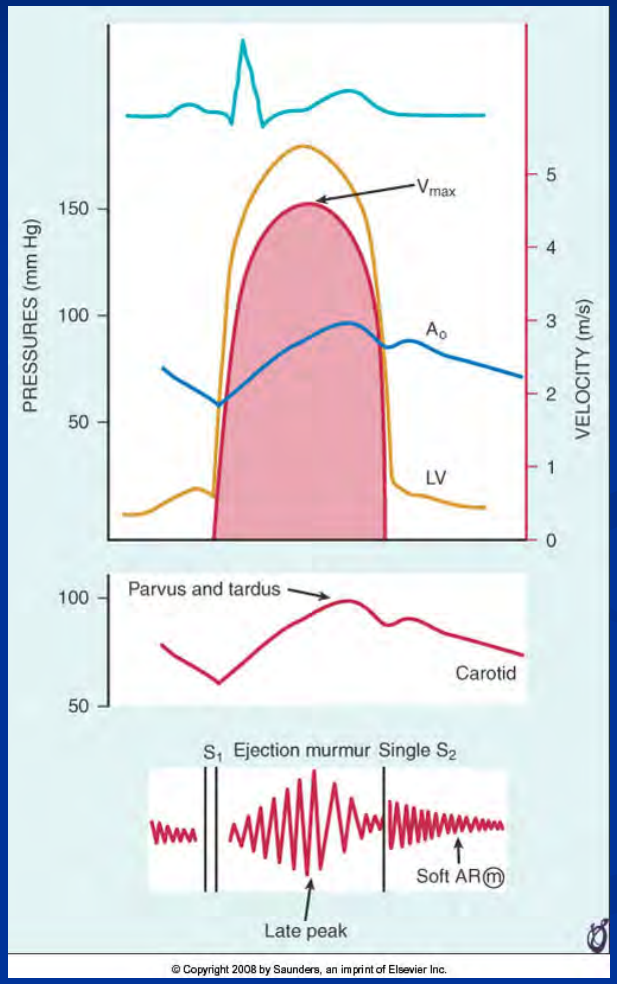
" When it is considered how narrow the opening is….it is difficult to conceive how such an organic derangement can continue for years…if such an obstacle to the circulation were suddenly introduced into a healthy subject, death would immediately follow…but as these obstacles are slowly formed, the circulation is gradually impeded and nature seems to be habituated to such a perversion of her laws…"

J. N. Corvisart 1803
French Cardiologist to Napoleon
A pioneer of cardiac auscultation

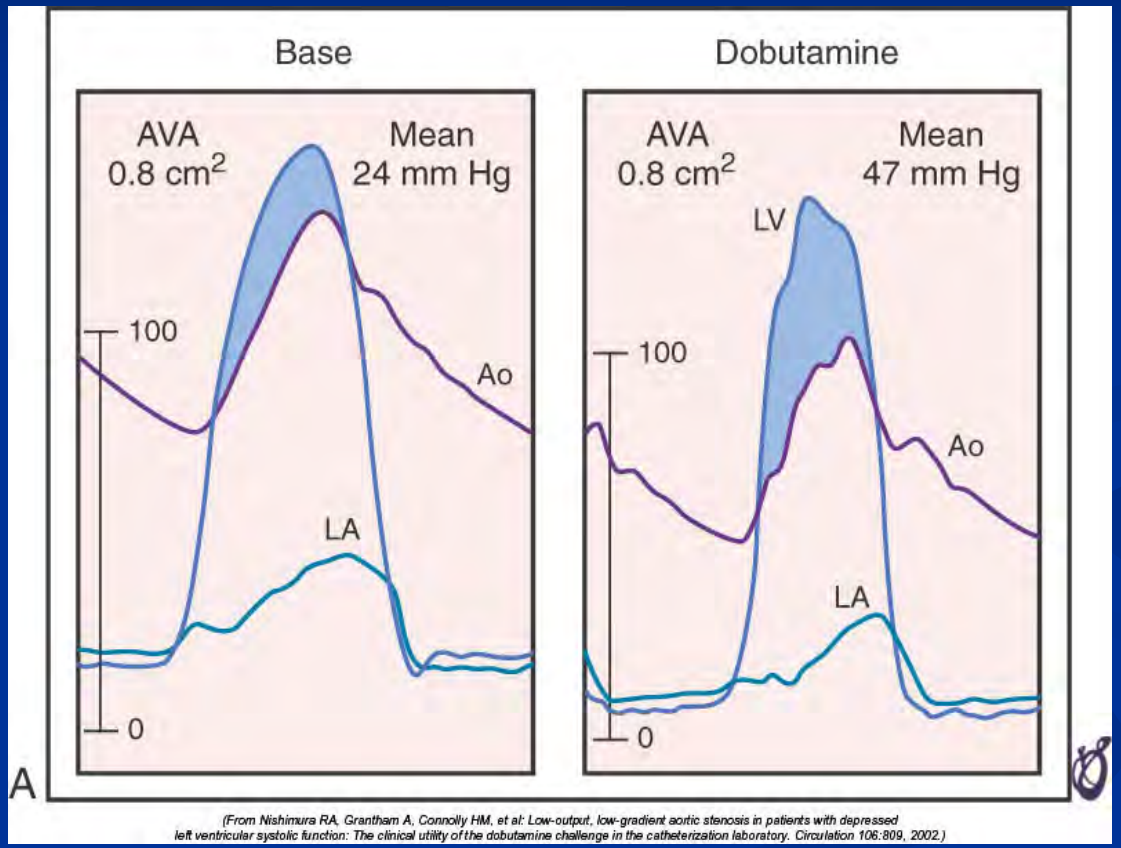
Pathophysiology of aortic stenosis



Pathophysiology of aortic stenosis



Pathophysiology of aortic stenosis



(From Nishimura RA, Grantham A, Connolly HM, et al: Low-output, low-gradient aortic stenosis in patients with depressed left ventricular systolic function: The clinical utility of the dobutamine challenge in the catheterization laboratory. Circulation 106:809, 2002.)

Definition of Severe Aortic-Stenosis

- Valve area < 1.0 cm^2 (Normal-2-3 cm^2)
- Valve area index < 0.6 cm^2/m^2

- Jet velocity > 4.0 m/sec
- Mean valve gradient > 40 mmHg

ACC/AHA 2006 guidelines

Prevalence of significant Aortic-Valve Disease

- **AS is the most frequent significant heart valve disease in Western countries.**
- Significant AS in ~2% of US population >65 years.

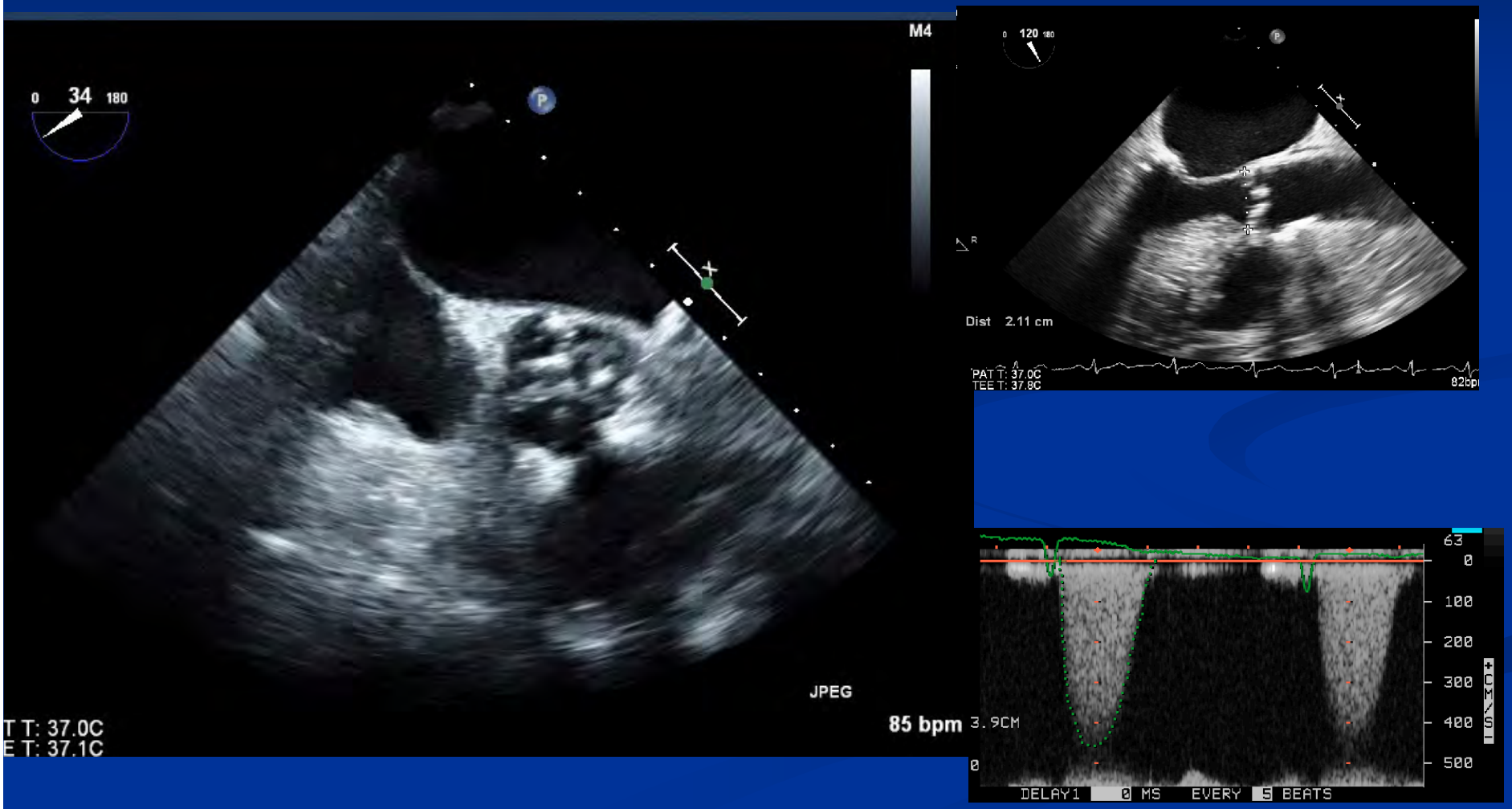
Freeman et al. Circulation. 2005;111(24):3316-26.

- Bicuspid AV- 0.5-2% of the population (men>women)

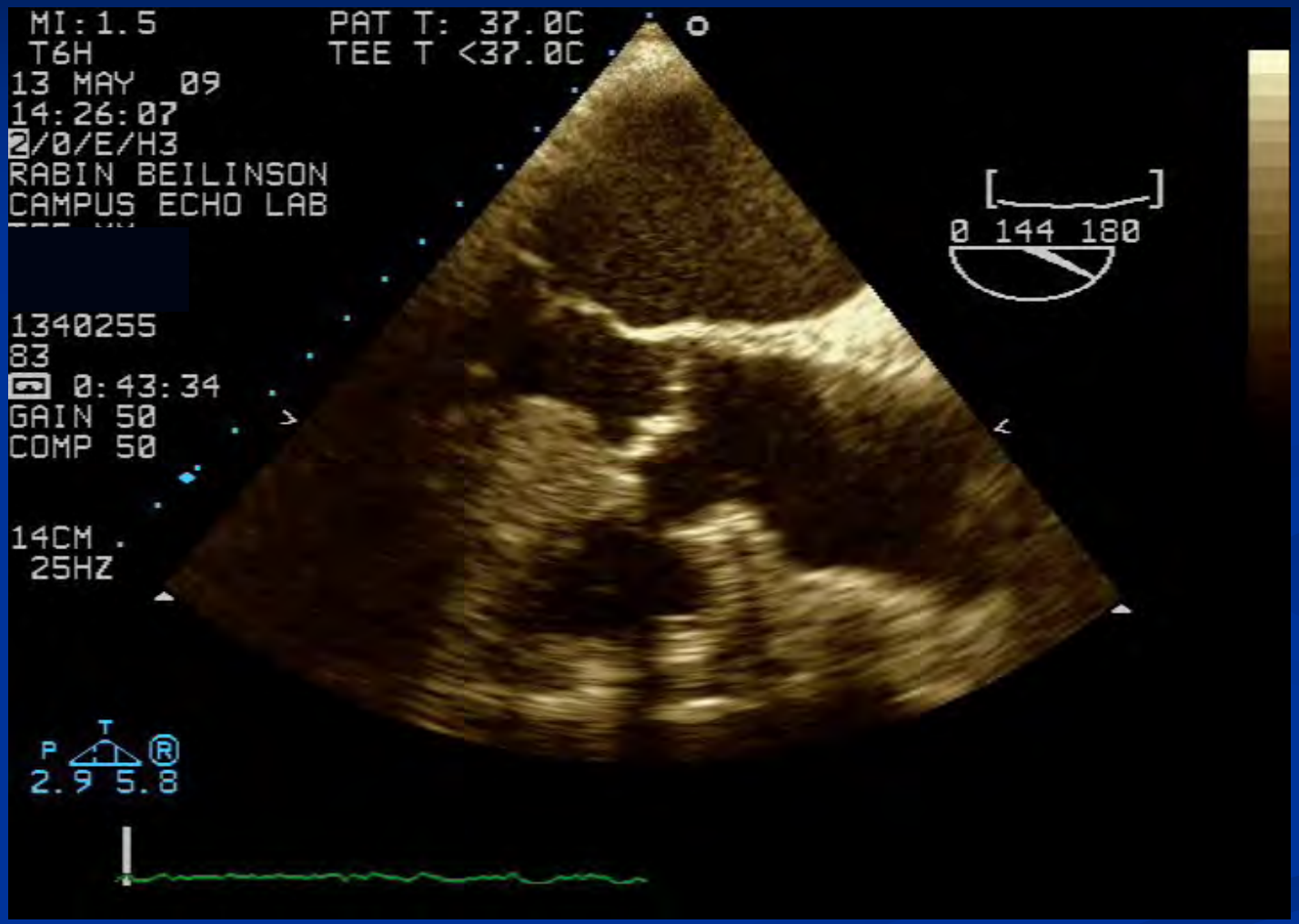
Basso et al. Am J Cardiol. 2004;93(5):661-3.

- 68% of all heart valve operations!
- In Israel: until recently ~1,000 AVR per year.

Echocardiography



Echocardiography



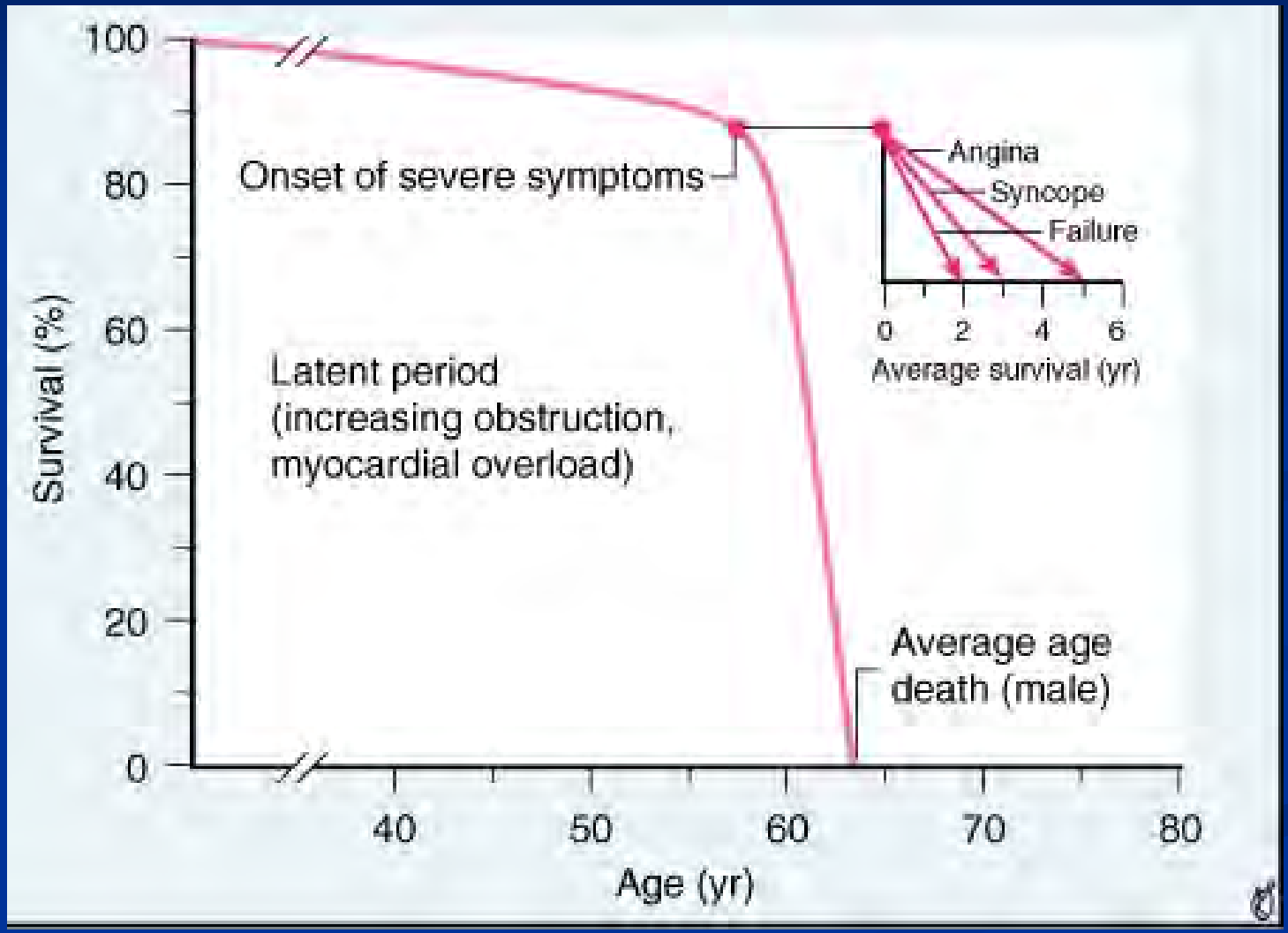
normal AV-echo.flv

Aortic Stenosis: Clinical Manifestation

- Asymptomatic

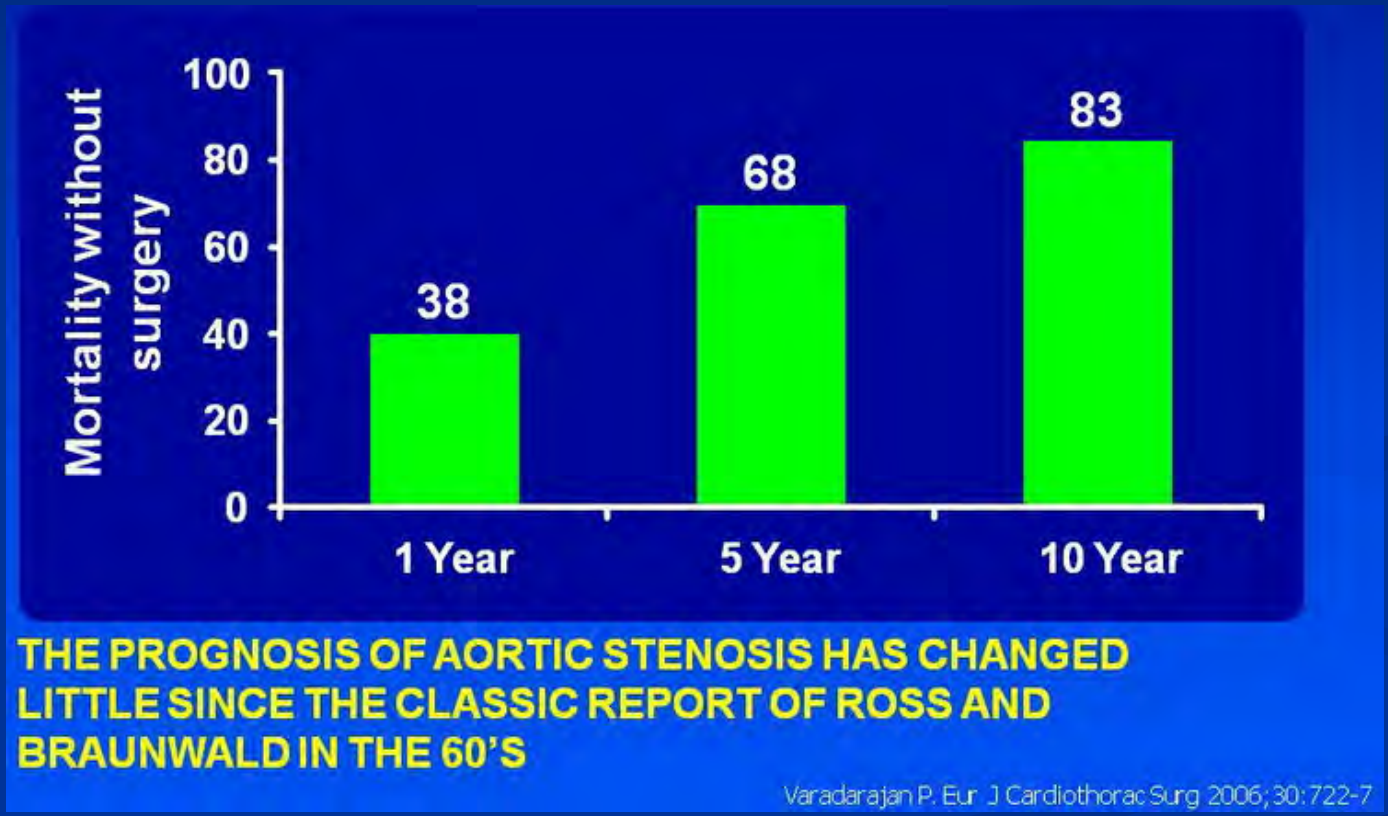
- Effort dyspnea
- Angina
- Weakness
- Pulmonary edema
- Syncope
- Sudden cardiac death

Natural History of Patients with Aortic-Stenosis



Ross J, Jr., Braunwald E. Circulation 1968; 38 (S1):61-7

Natural History of Patients with Aortic-Stenosis

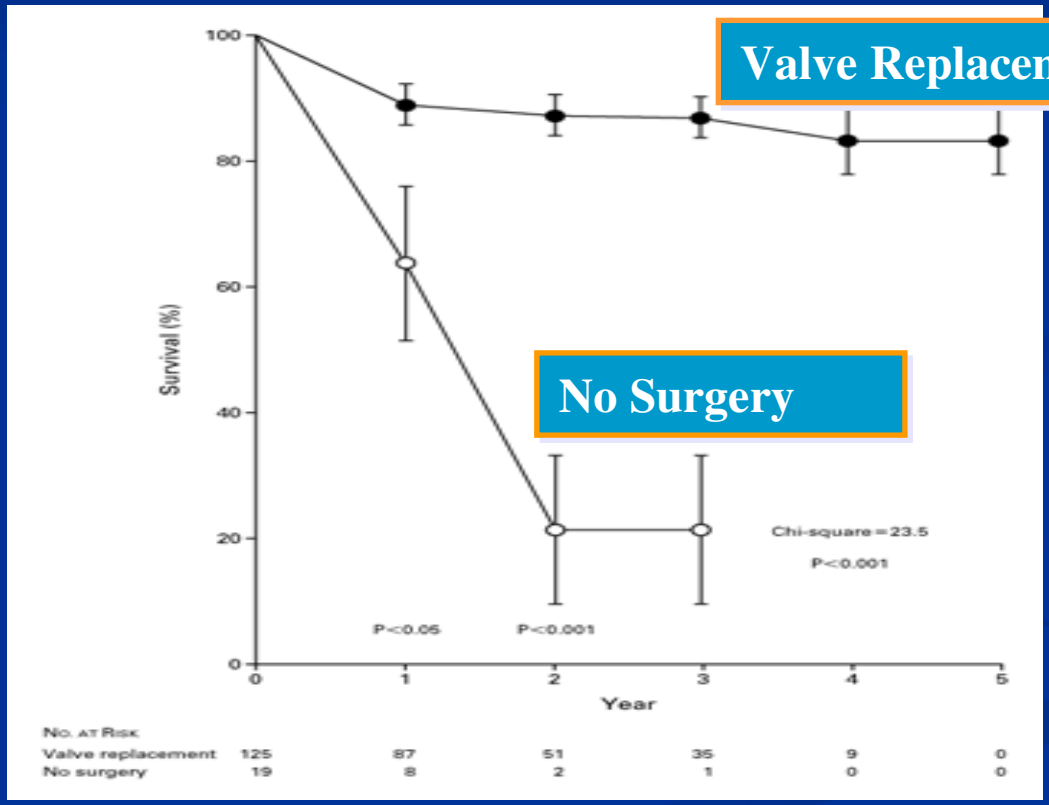


THE PROGNOSIS OF AORTIC STENOSIS HAS CHANGED LITTLE SINCE THE CLASSIC REPORT OF ROSS AND BRAUNWALD IN THE 60'S

Varadarajan P. Eur J Cardiothorac Surg 2006;30:722-7

Surgical Aortic-Valve Replacement

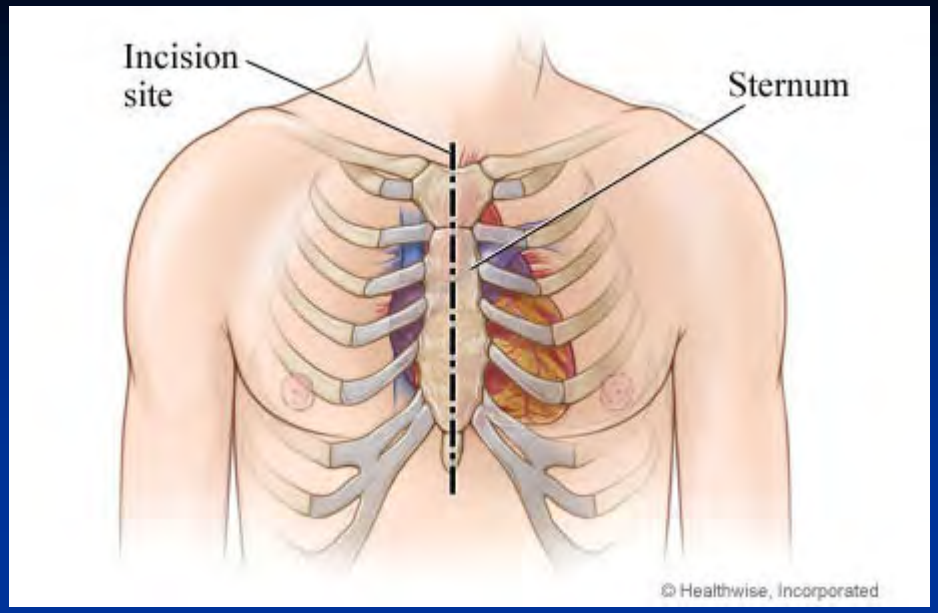
AVR should be performed in symptomatic severe AS patients

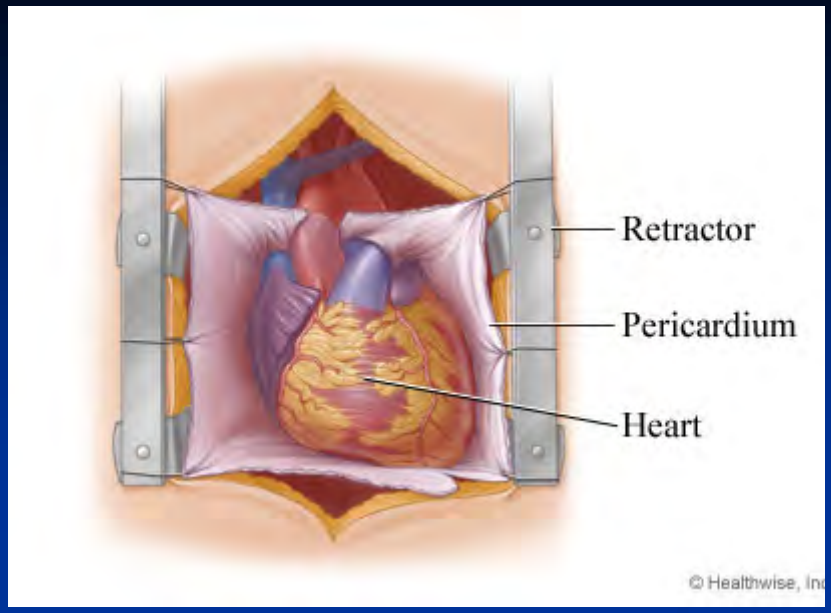


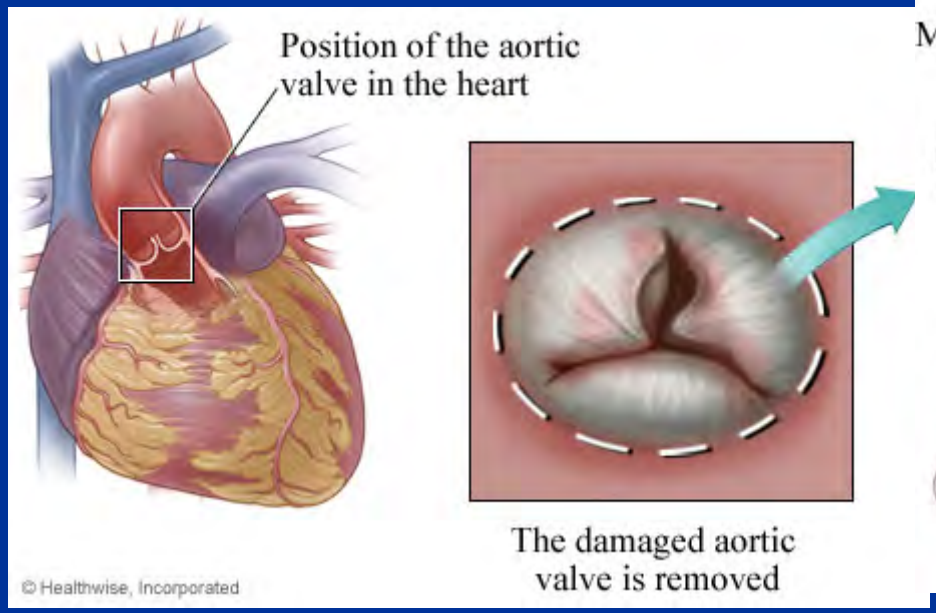
Carabello et al. NEJM 2002;346 (9)

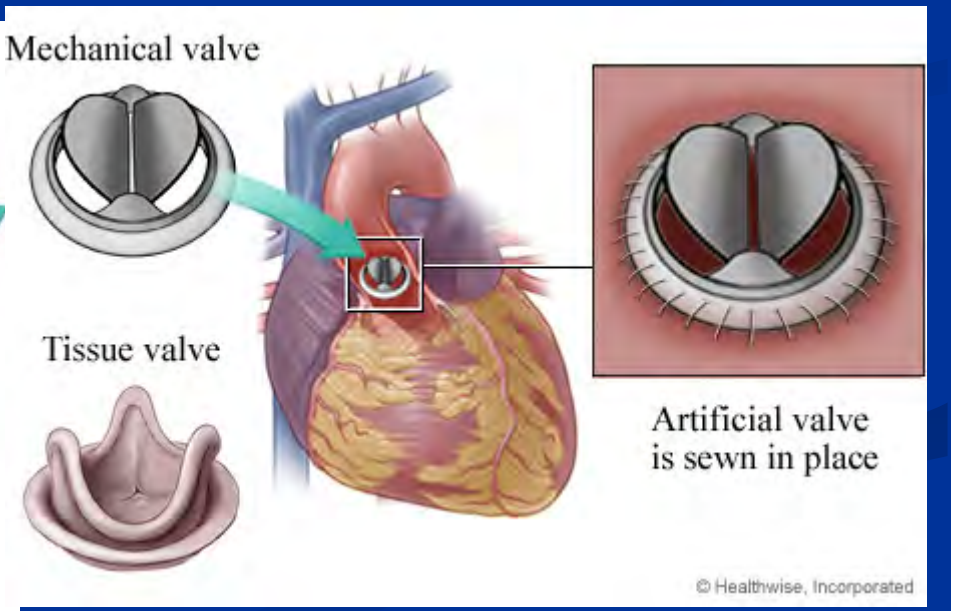
Surgical Aortic Valve Replacement

- Surgical AVR is the standard treatment for adults with symptomatic severe AS!
- Perioperative mortality rates are based on large databases: 2-3% in young pts with elective cases.
- Patient's lifespan returns to near that of general population.


Incision site
Sternum
© Healthwise, Incorporated


Retractor
Pericardium
Heart
© Healthwise, Inc

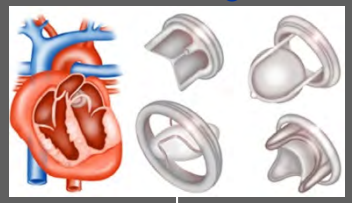

Position of the aortic valve in the heart
The damaged aortic valve is removed
© Healthwise, Incorporated


Mechanical valve
Tissue valve
Artificial valve is sewn in place
© Healthwise, Incorporated

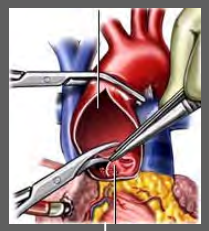
Surgical Aortic Valve Replacement

AORTIC VALVE REPLACEMENT TECHNOLOGY

Valve Design



Implantation Technology



Mechanical

Bi-leaflet

Ball and cage

Single disk

Tissue

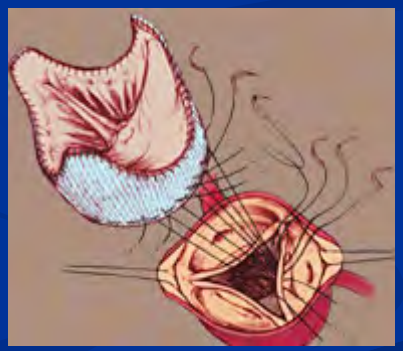
Stentless porcine

Stented Porcine

Stented bovine pericardial

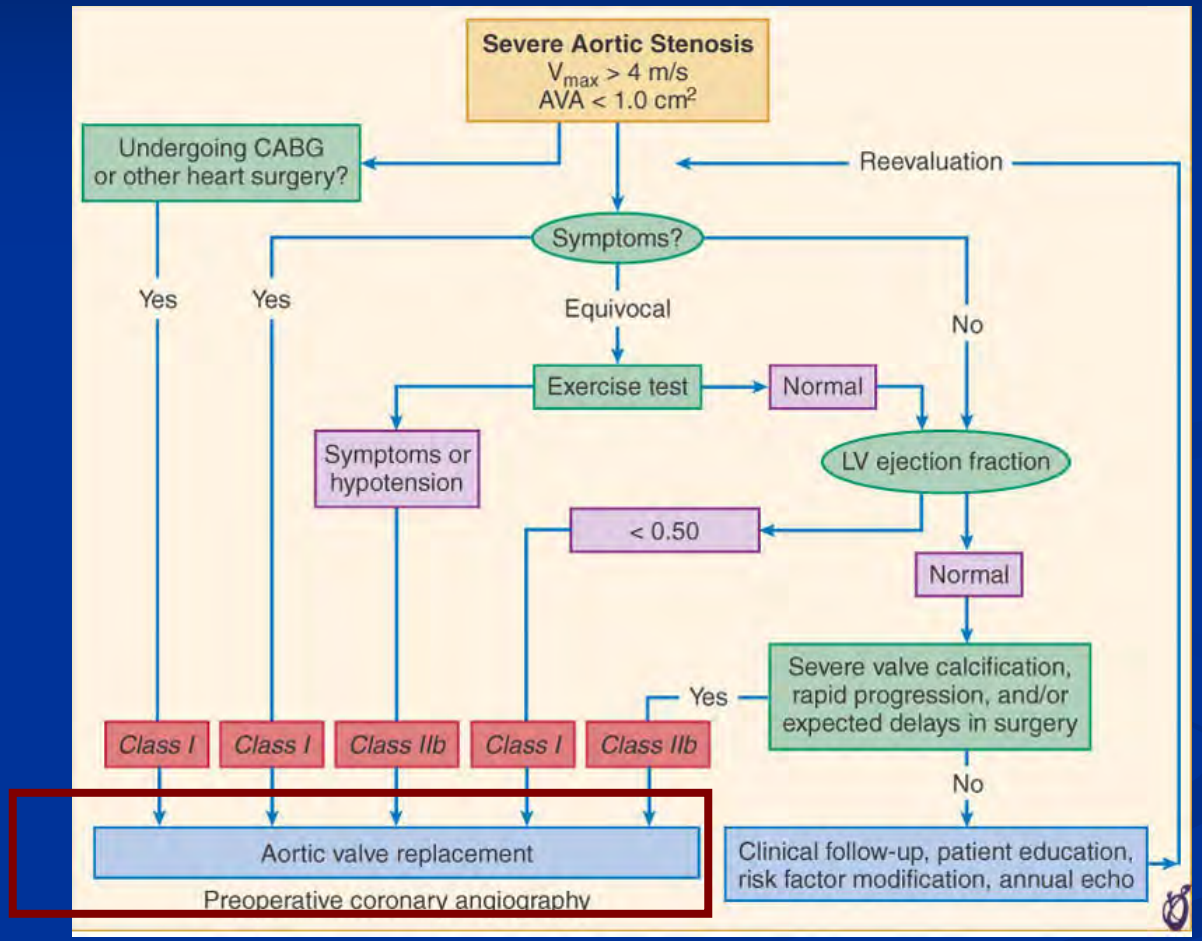
Cadaver (homograft)

Surgical



Repair

Management strategy for patients with severe aortic stenosis.



ACC/AHA 2006 guidelines

Mechanical valves

Caged Ball

Starr-Edwards

Albert Starr 1960

Tilting Disk

Bjork-Shiley

V. Bjork 1969

Bi-Leaflet

St Jude

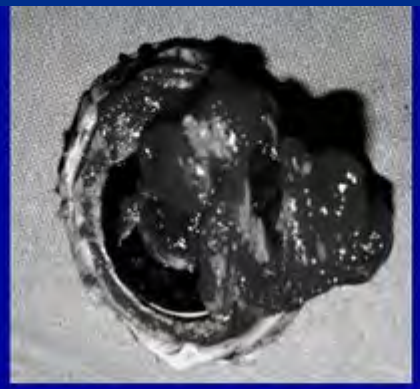
D. Nicoloff 1977

Multiple generations and brands of each design type

Mechanical valves

Panus

Obstruction



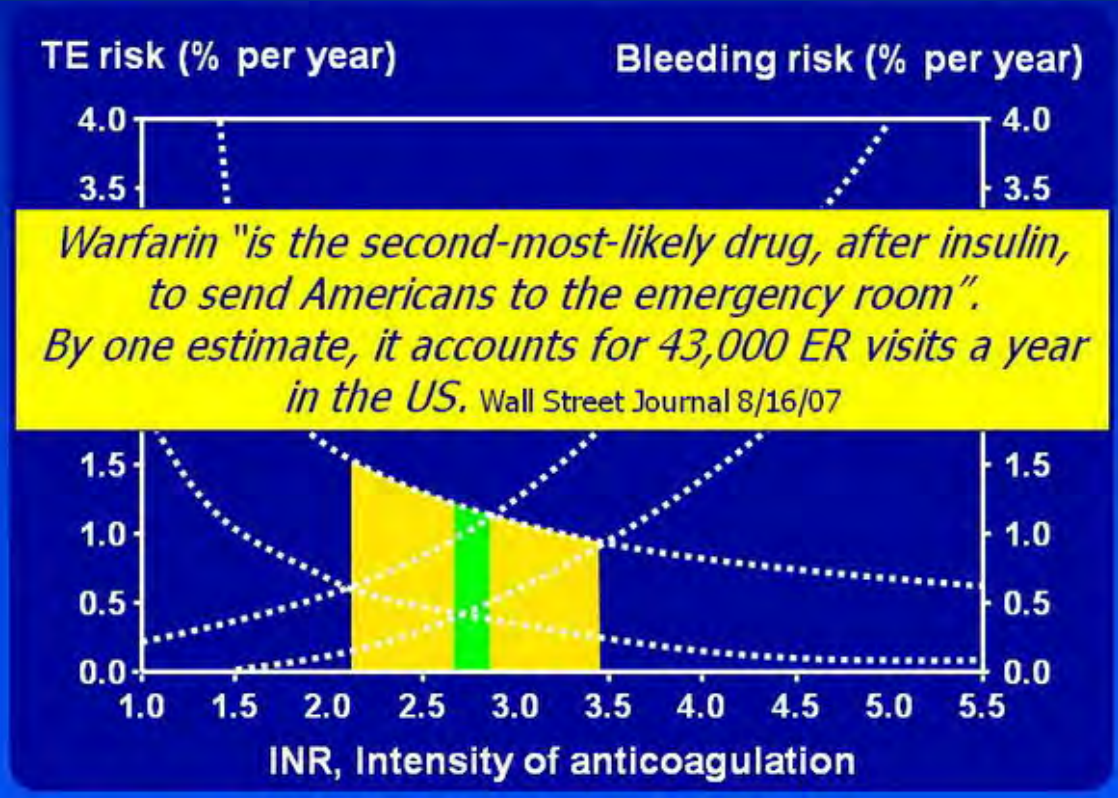
Thrombosis

Thrombo-
Embolism

Wearing

Malfunction

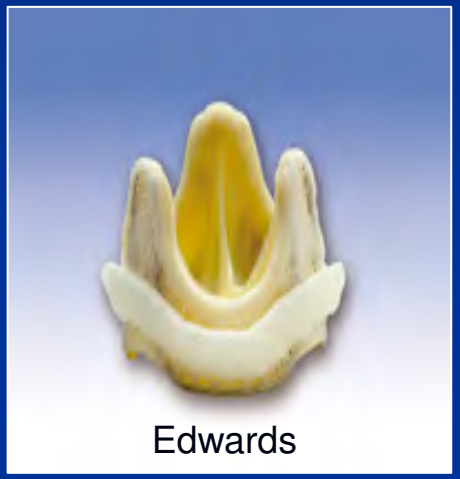
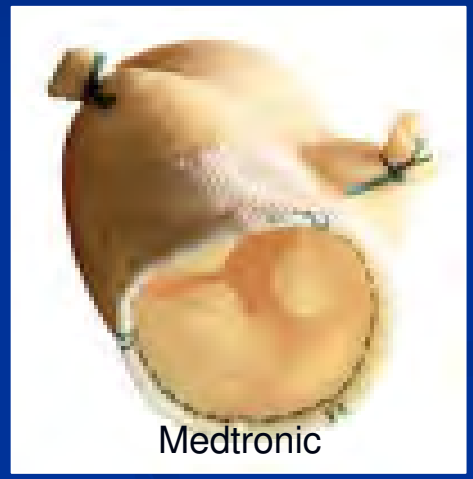
Mechanical valves: the need for anticoagulation



INR was only introduced in the 80's

Horstkotte D. JTCVS 1994;107:1136-45

Tissue Valves

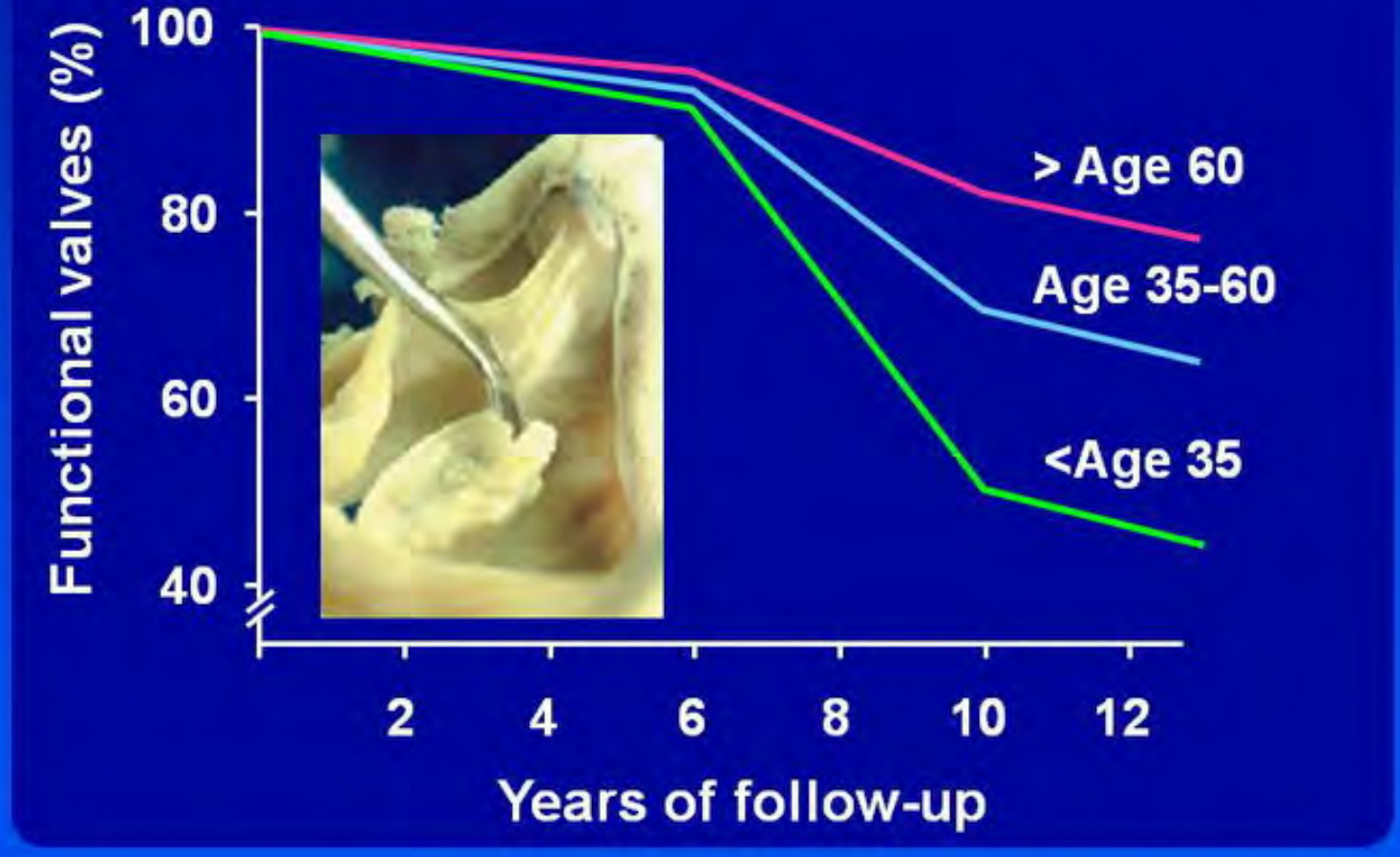
Porcine Heterograft	Pericardial Xenograft	Stentless Heterograft	Homograft
			
Edwards	Edwards	Medtronic	Cryolife

Multiple generations and brands of each design type

Tissue Valves

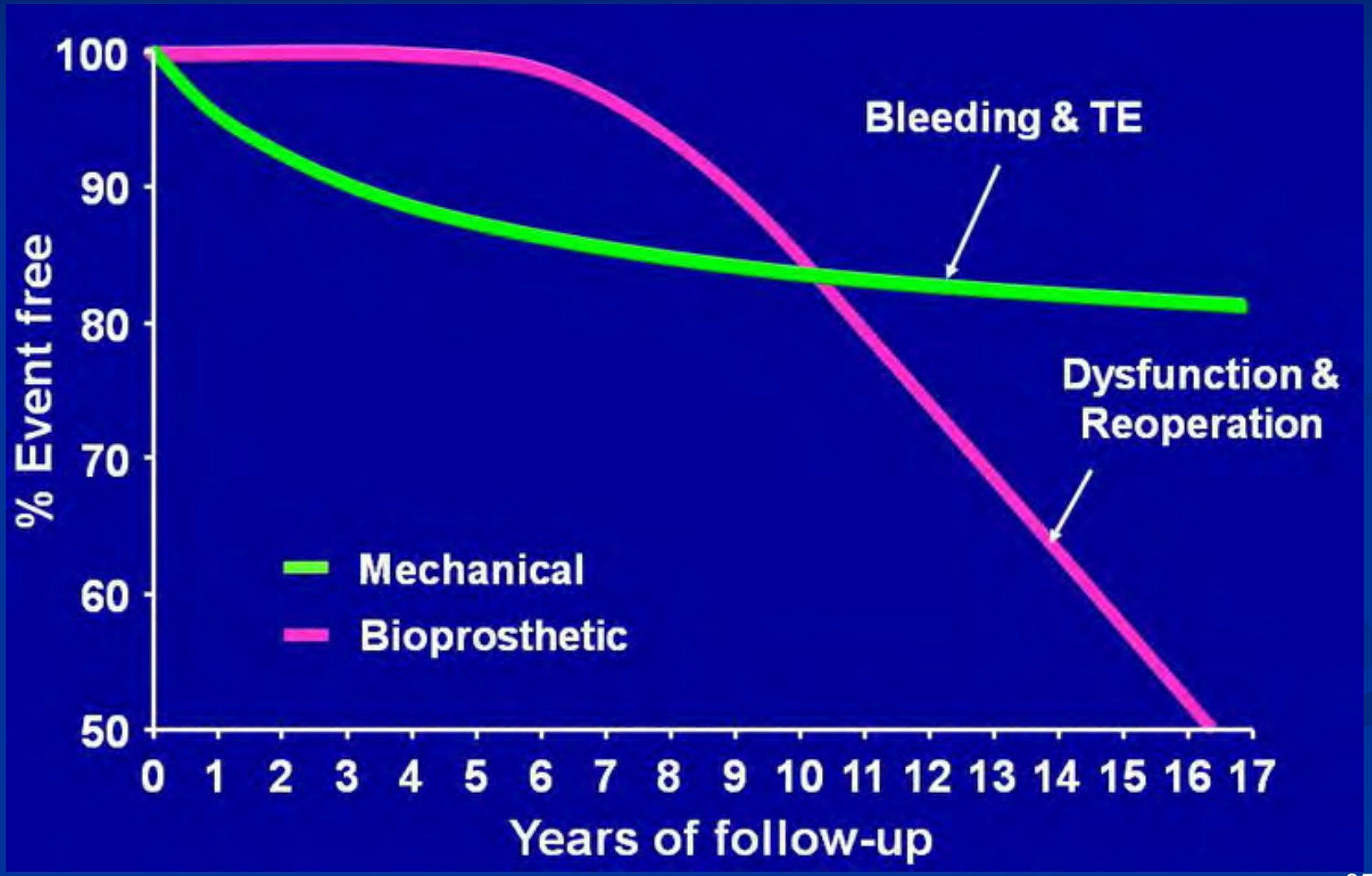
- **Early 60's:** limited success with allograft and autograft replacements (D. Ross)
- **1968:** A. Carpentier showed that glutaraldehyde preservation improved stability of porcine tissue & prevented valve degeneration
- **1970's:** development of 1st Bioprosthesis namely the Carpentier porcine valve with elgiloy stent
- **1980's:** development of Perimount bovine pericardial valve and Stentless tissue valve (T. David)
- **1990's:** anti-calcification treatment

Tissue Valves



Carpentier A. Nature Medicine 2007;13:10

Bioprosthesis valves vs. Mechanical valves

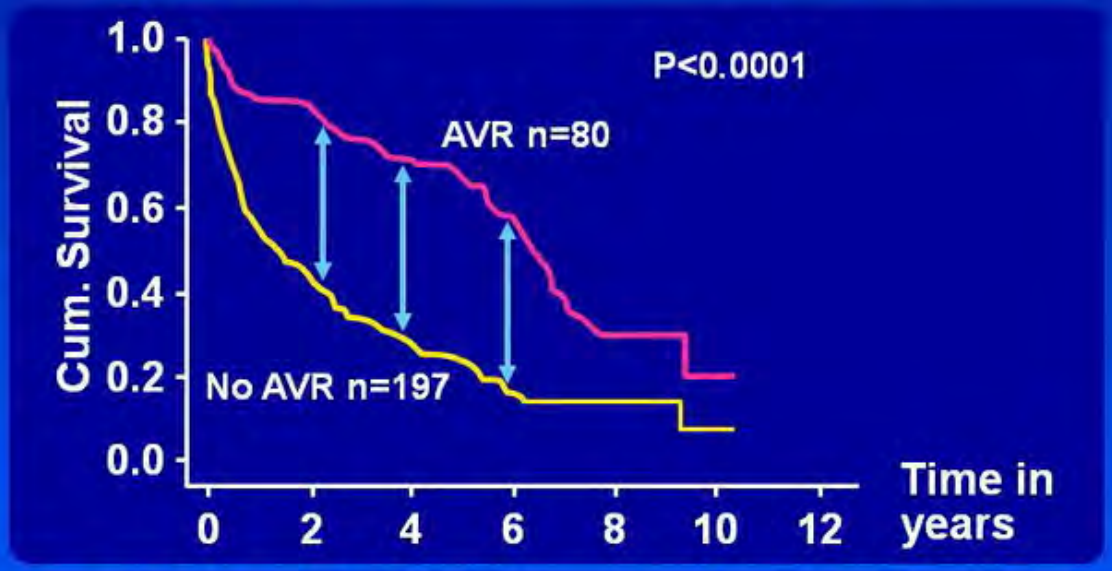


Risk factors for Impaired Prognosis after AVR

- Advanced age (> 80 yrs)
- Impaired LV function
- Prior heart surgery
- Renal insufficiency
- Previous stroke
- Lung disease
- Emergency operation

Survival of Octogenarians after surgical AVR

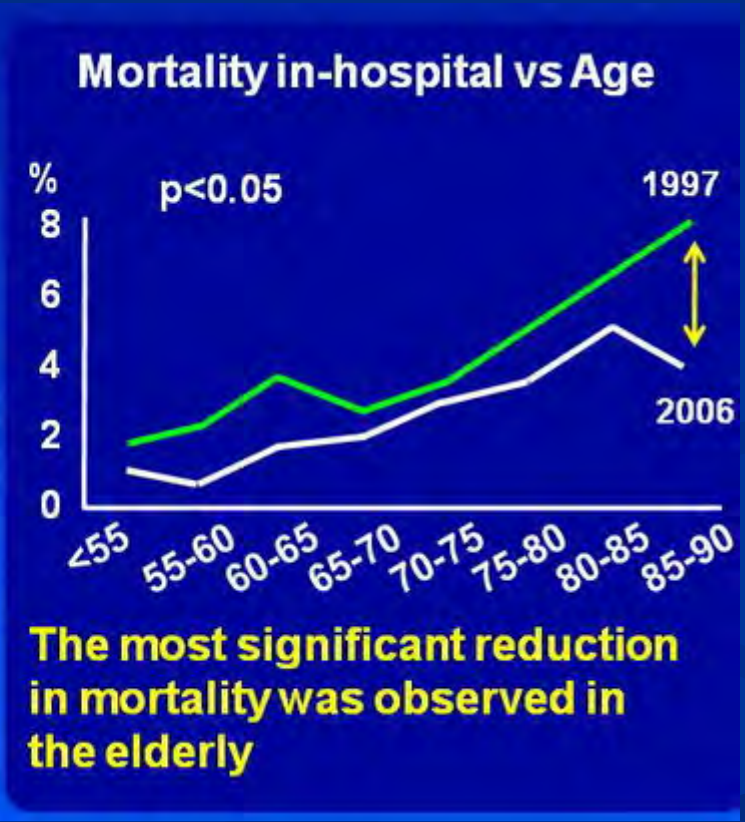
740 Octogenarians, 277 (37%) had Aortic Stenosis, 89 (29%) were operated



Patients suitable for SAVR had a significant survival benefit at 2-, 4- and 6-years follow-up . . . this was true even after a propensity score matched analysis

Varadarajan P. Eur J Cardiothorac Surg 2006;30:722-

Outcome of 108,687 patients after isolated AVR



Change in population undergoing isolated AVR

Relative changes in frequency of baseline characteristics of 108,687 patients selected for sAVR between 1997 & 2006

Age ≥ 70 years	+ 10 %	< 0.001
Renal failure	+ 36 %	< 0.001
BMI ≥ 30kg/m^2	+ 38 %	< 0.001
Cerebrovascular disease	+ 64 %	< 0.001
Any diabetes	+ 65 %	< 0.001
COPD	+ 218 %	< 0.001
Bioprosthesis	**+ 80 %**	**< 0.001**

Brown , STS Database. J Thorac Cardiovasc Surg 2009;137:82-90

European Heart Journal (2003) 24, 1231–1243

ELSEVIER

EUROPEAN SOCIETY OF CARDIOLOGY

A prospective survey of patients with valvular heart disease in Europe: The Euro Heart Survey on Valvular Heart Disease

Bernard Iung[a*], Gabriel Baron[b], Eric G. Butchart[c], François Delahaye[d], Christa Gohlke-Bärwolf[e], Olaf W. Levang[f], Pilar Tornos[g], Jean-Louis Vanoverschelde[h], Frank Vermeer[i], Eric Boersma[j], Philippe Ravaud[b], Alec Vahanian[a]

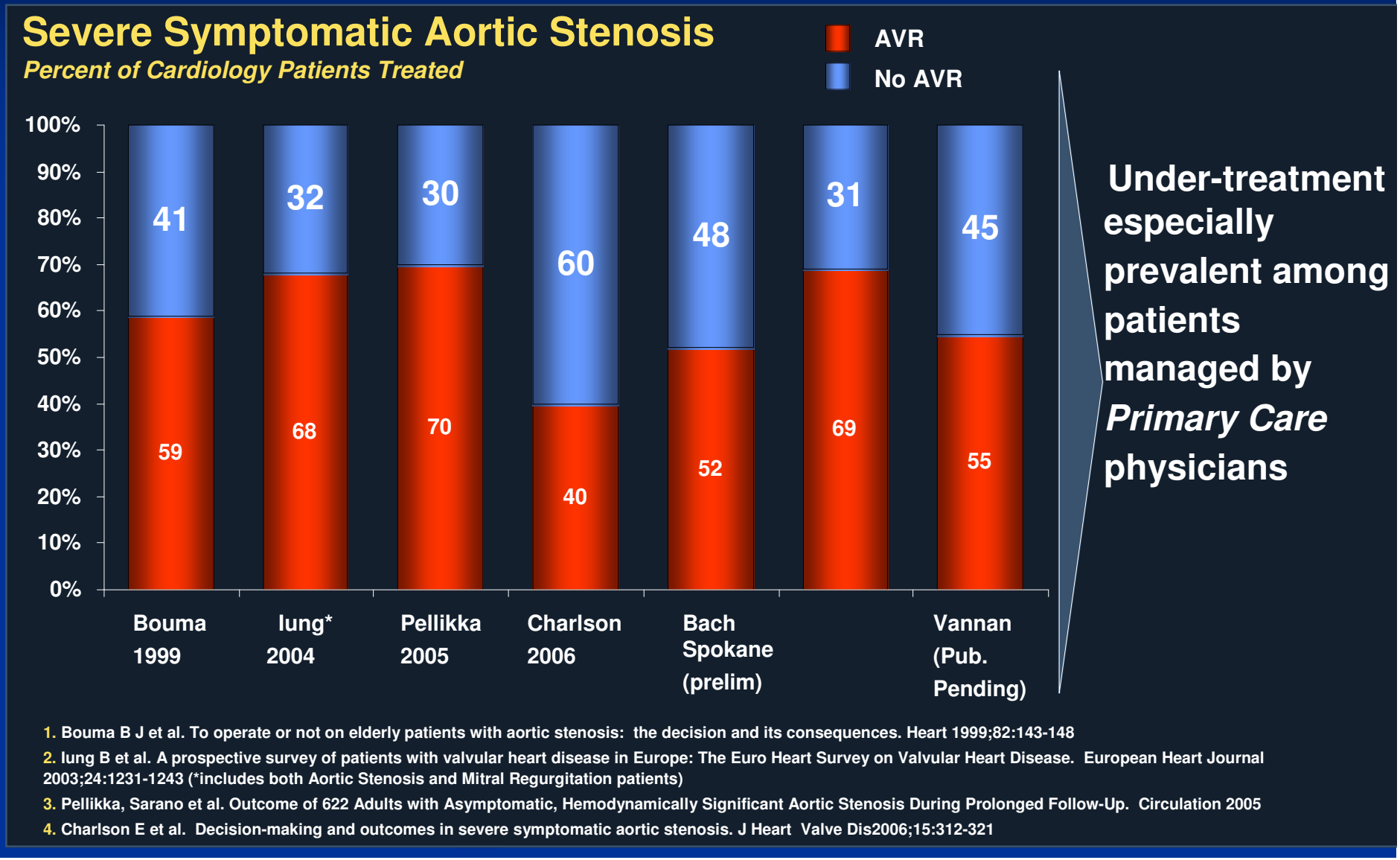
Aims To identify the characteristics, treatment, and outcomes of contemporary patients with valvular heart disease (VHD) in Europe, and to examine adherence to guidelines.

Methods and results The Euro Heart Survey on VHD was conducted from April to July 2001 in 92 centres from 25 countries; it included prospectively 5001 adults with moderate to severe native VHD, infective endocarditis, or previous valve intervention. VHD was native in 71.9% of patients and 28.1% had had a previous intervention. Mean age was 64±14 years. Degenerative aetiologies were the most frequent in aortic VHD and mitral regurgitation while most cases of mitral stenosis were of rheumatic origin.

Coronary angiography was used in 85.2% of patients before intervention. Of the 1269 patients who underwent intervention, prosthetic replacement was performed in 99.0% of aortic VHD, percutaneous dilatation in 33.9% of mitral stenosis, and valve repair in 46.5% of mitral regurgitation; 31.7% of patients had ≥1 associated procedure. Of patients with severe, symptomatic, single VHD, 31.8% did not undergo intervention, most frequently because of comorbidities. In asymptomatic patients, accordance with guidelines ranged between 66.0 and 78.5%. Operative mortality was <5% for single VHD.

Conclusions This survey provides unique contemporary data on characteristics and management of patients with VHD. Adherence to guidelines is globally satisfying as regards investigations and interventions.

~30-40% of Patients with Severe Symptomatic AS are "Untreated"!



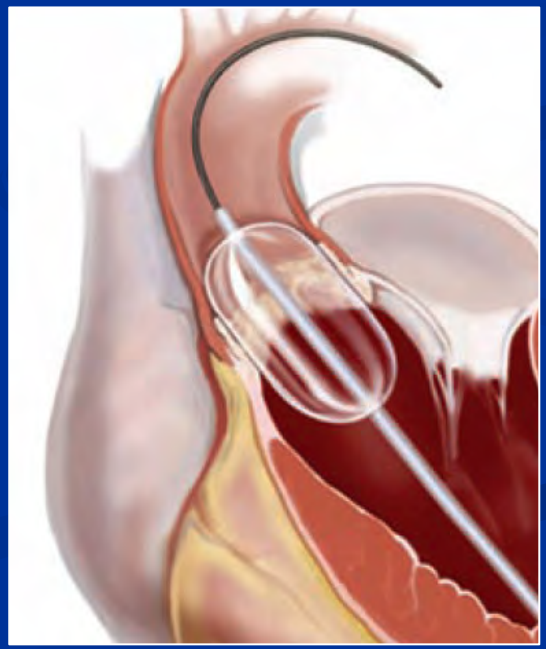
1. Bouma B J et al. To operate or not on elderly patients with aortic stenosis: the decision and its consequences. Heart 1999;82:143-148
2. Iung B et al. A prospective survey of patients with valvular heart disease in Europe: The Euro Heart Survey on Valvular Heart Disease. European Heart Journal 2003;24:1231-1243 (*includes both Aortic Stenosis and Mitral Regurgitation patients)
3. Pellikka, Sarano et al. Outcome of 622 Adults with Asymptomatic, Hemodynamically Significant Aortic Stenosis During Prolonged Follow-Up. Circulation 2005
4. Charlson E et al. Decision-making and outcomes in severe symptomatic aortic stenosis. J Heart Valve Dis2006;15:312-321

Introduction to Transcatheter Aortic-Valve Implantation

Balloon Aortic Valvuloplasty

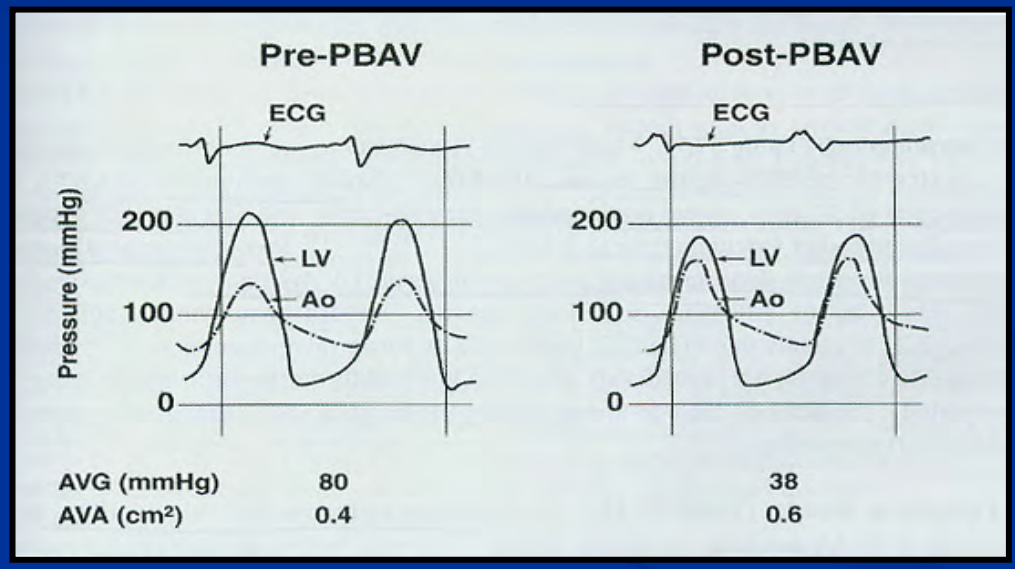
- Rapid ventricular pacing.
- First preformed in children with congenital AS.
- 1st adult palliative case in 1985.

Cribier A. et al. Lancet 1986;63-7.

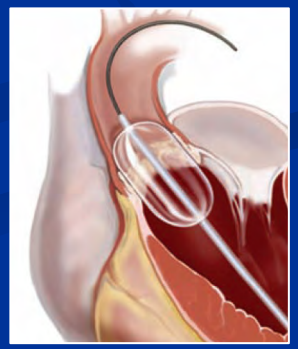


Balloon Aortic Valvuloplasty

- Results in 50-70% decrease in gradients and a 40-60% increase in AVA .

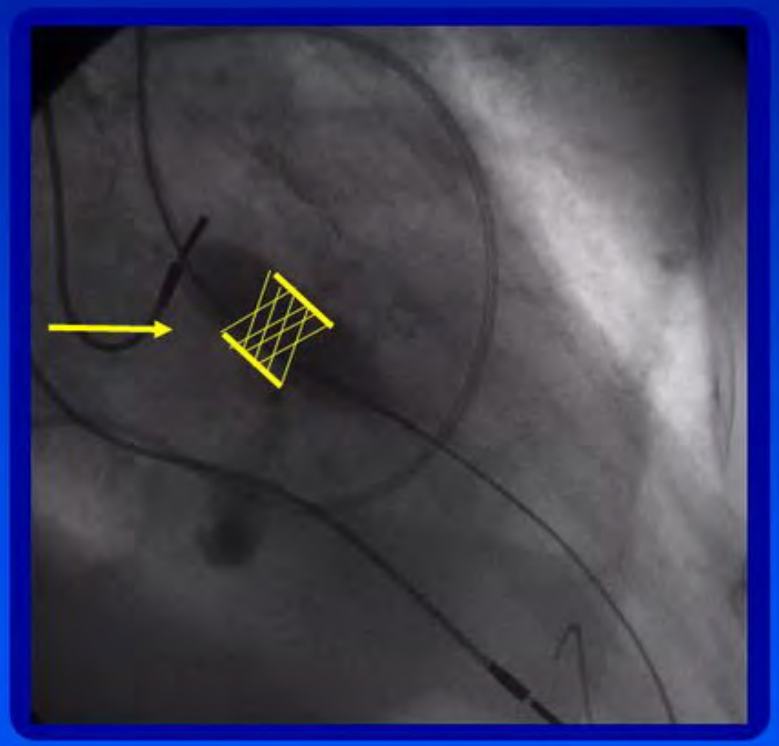


- **Problems**
  - Complications (vascular,…)
  - Sub-optimal results
  - Early restenosis ~50%

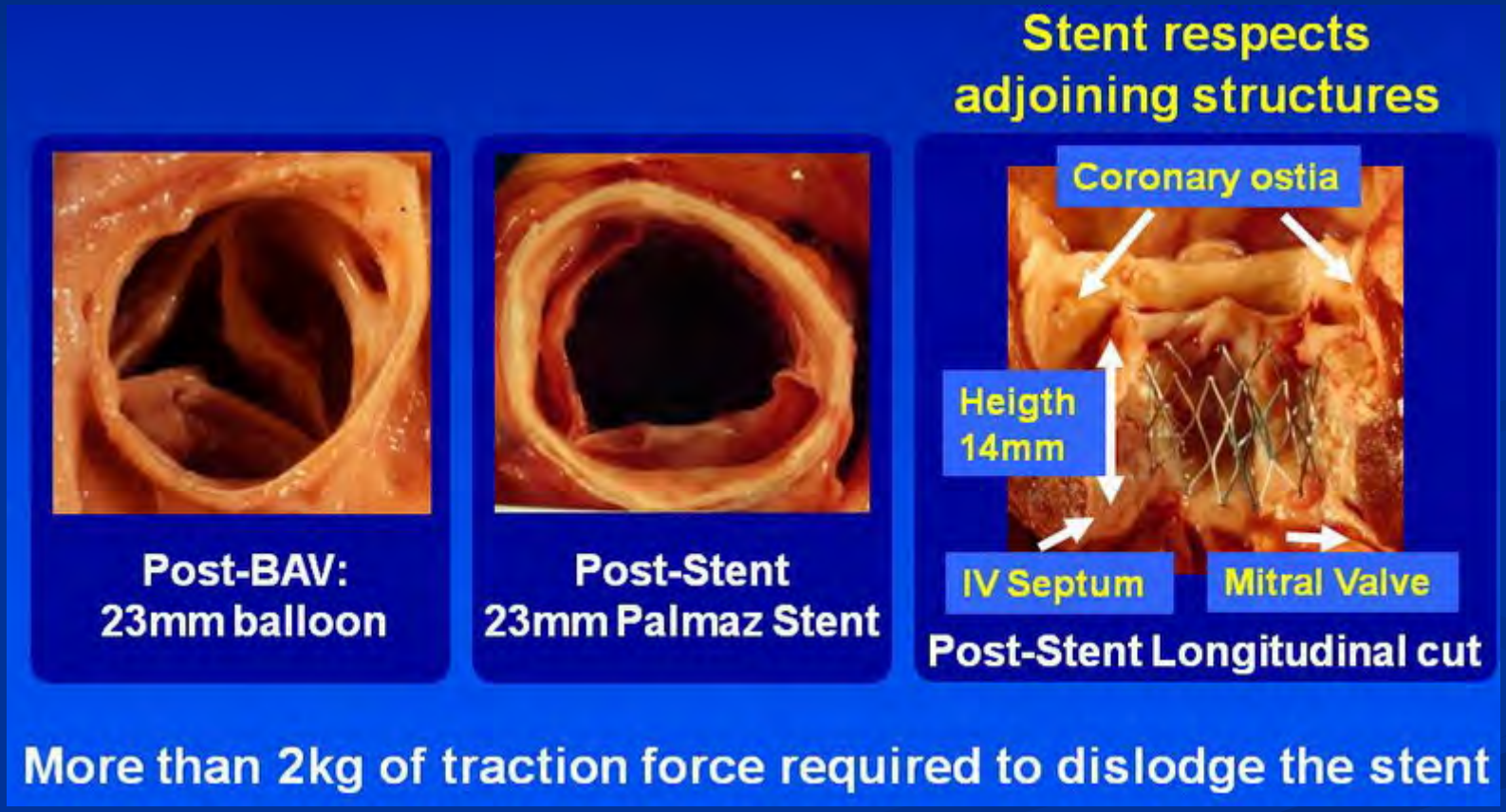


NHLBI Balloon Valvuloplasty Registry Participants. Circulation 1991;84:2383-2397

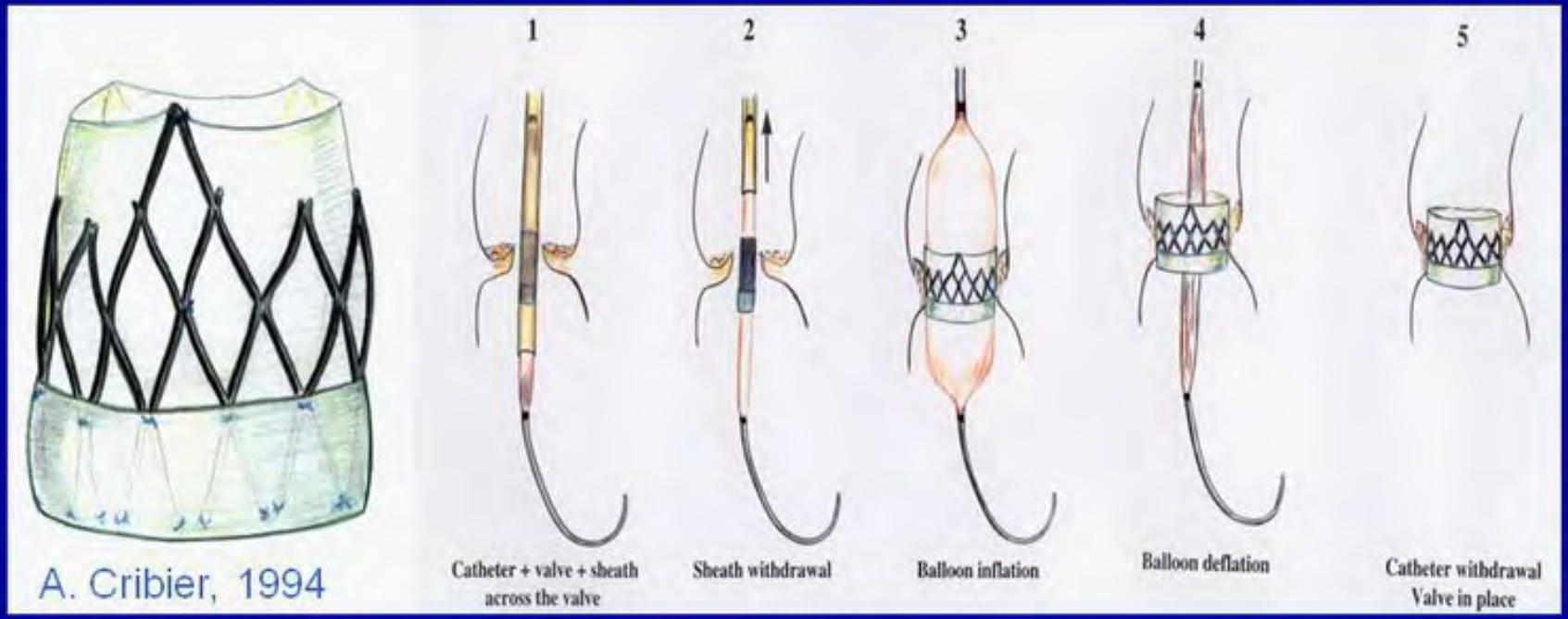
To avoid restenosis: Why not place a stent within the valve?



1993-1994: Post-Mortem implantations of AV stent



1st original drawings: The concept of stented valve



1994-1999: Trying to convince investors to create a biomedical copmpany

Negative comments and skepticism of experts, surgeons but also cardiologists

"Totally unrealistic, major technical issues"

"Definitely impossible to stent a calcific aortic valve"

"Occlusion of coronary arteries in 100% of cases"

"Would never be approved by FDA"

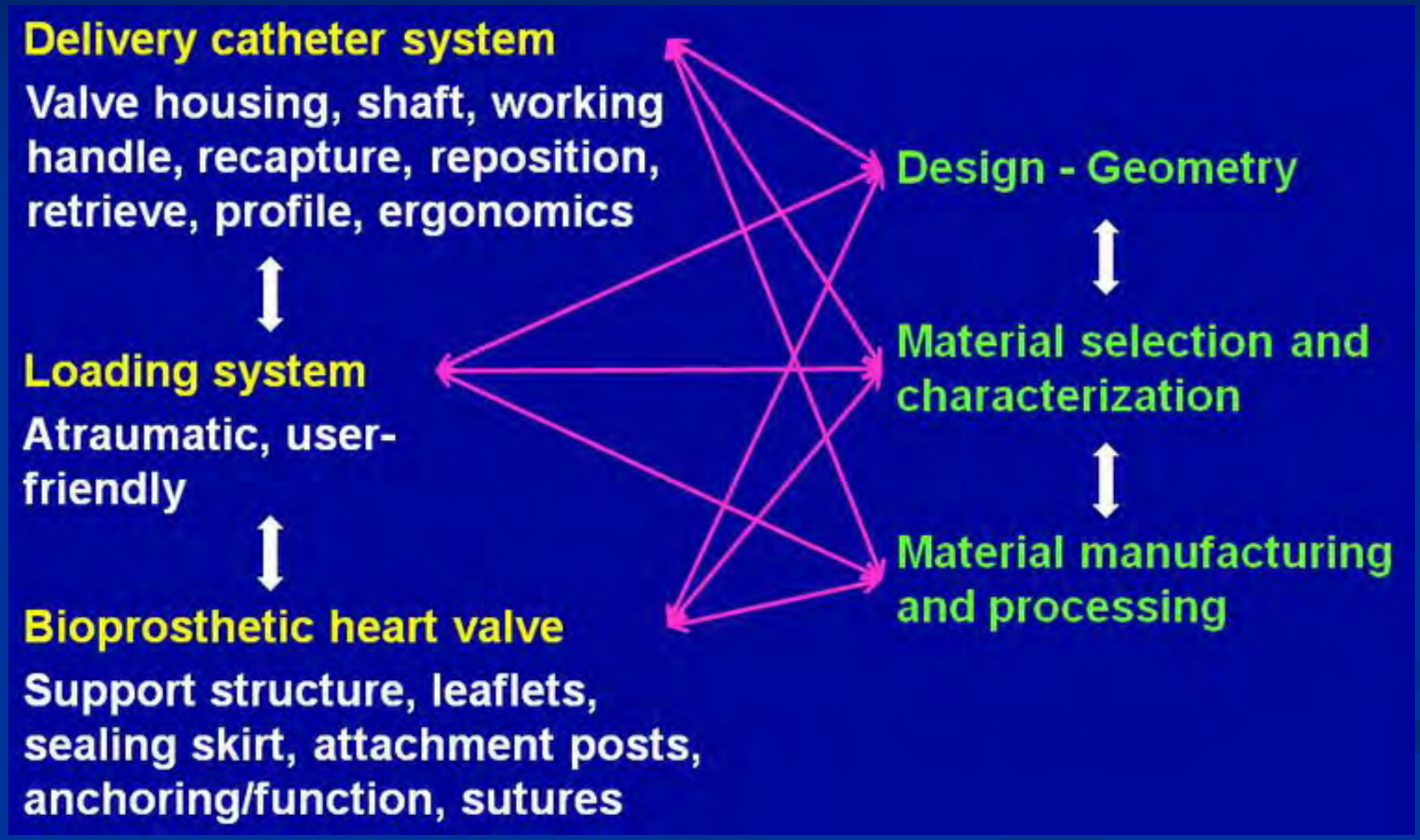
"Surgery covers 100% of the need. No indication"

"Most stupid project ever heard …"

1999: Percutaneous Valve Technologies (PVT) was eventually created

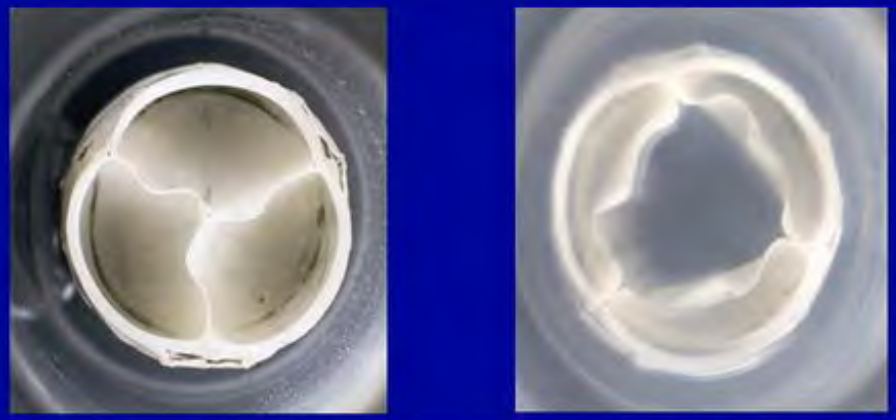
Founders of PVT

Device System and Engineers

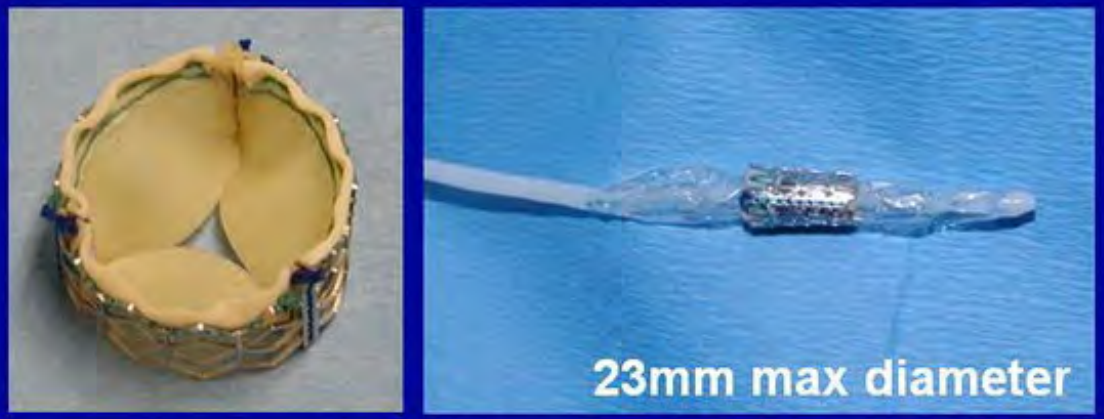


1st prototypes of stented valves

Polyuréthane valve

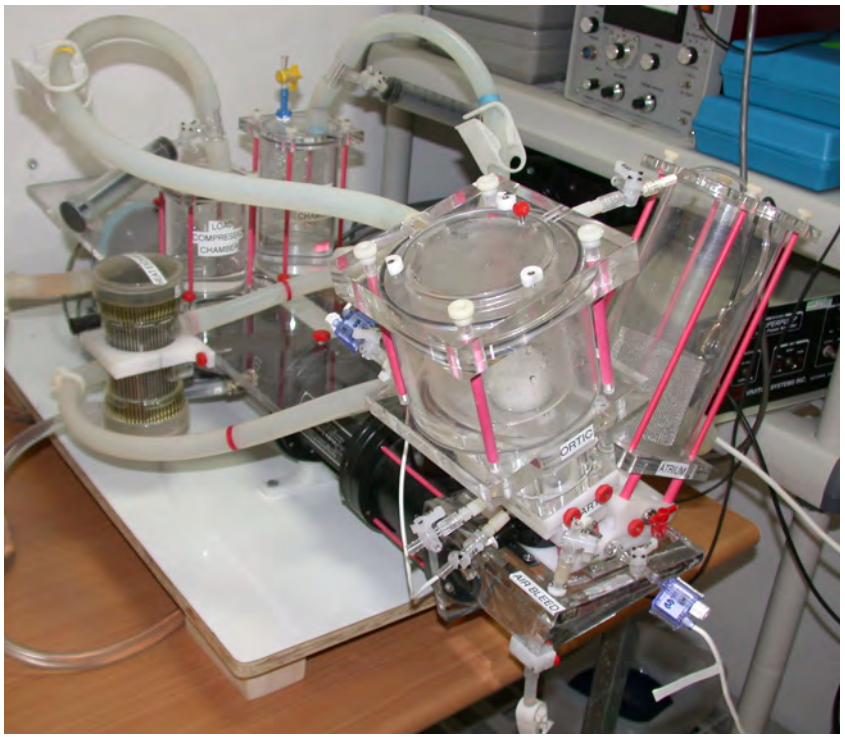


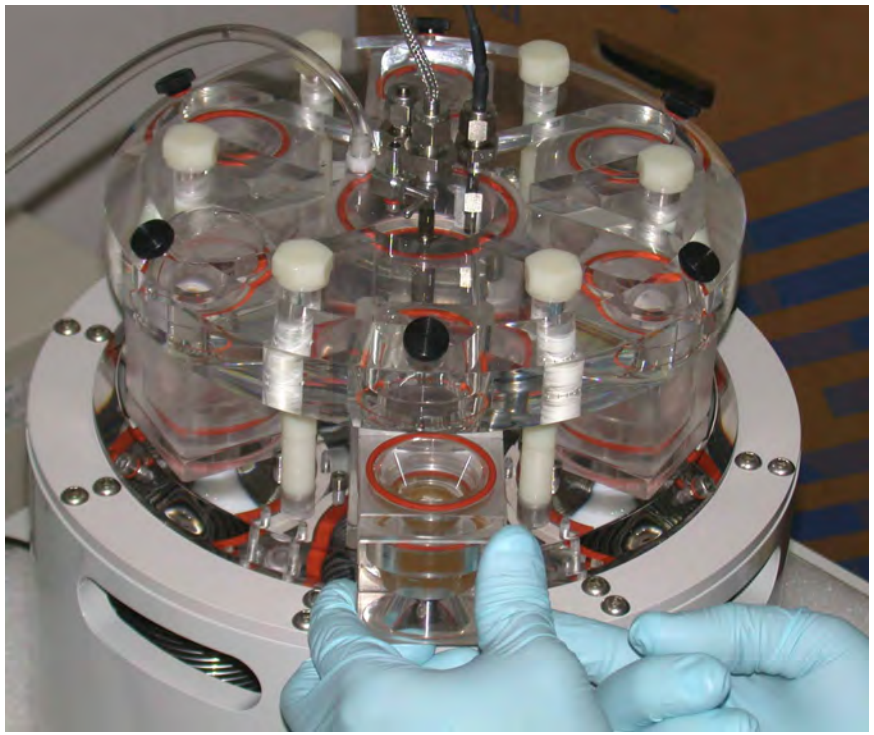
Bovine pericardium Stainless steel stent



Cribier-Edwards Aortic Bioprosthesis
Accelerated Wear Tests

> 600 M cycles (15 yrs equivalent)



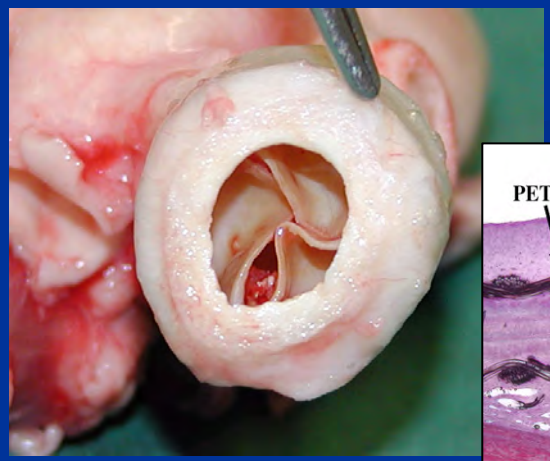


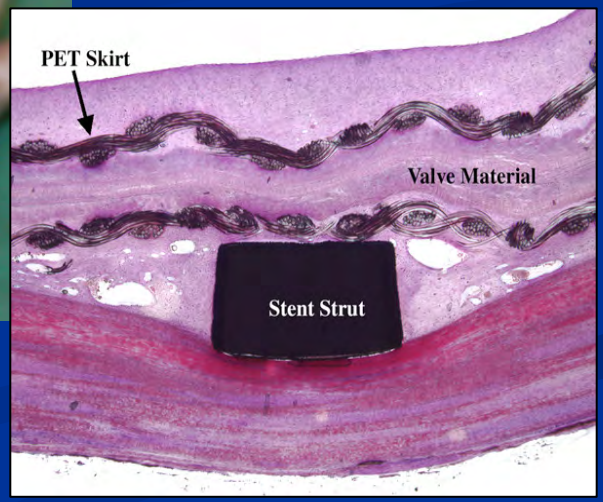
Cribier-Edwards Aortic Bioprosthesis
Animal Tests

More than 100 implantations in normal sheep (CERA, Paris and Biomatec, Lyon)

PHV IMPLANTATIONS

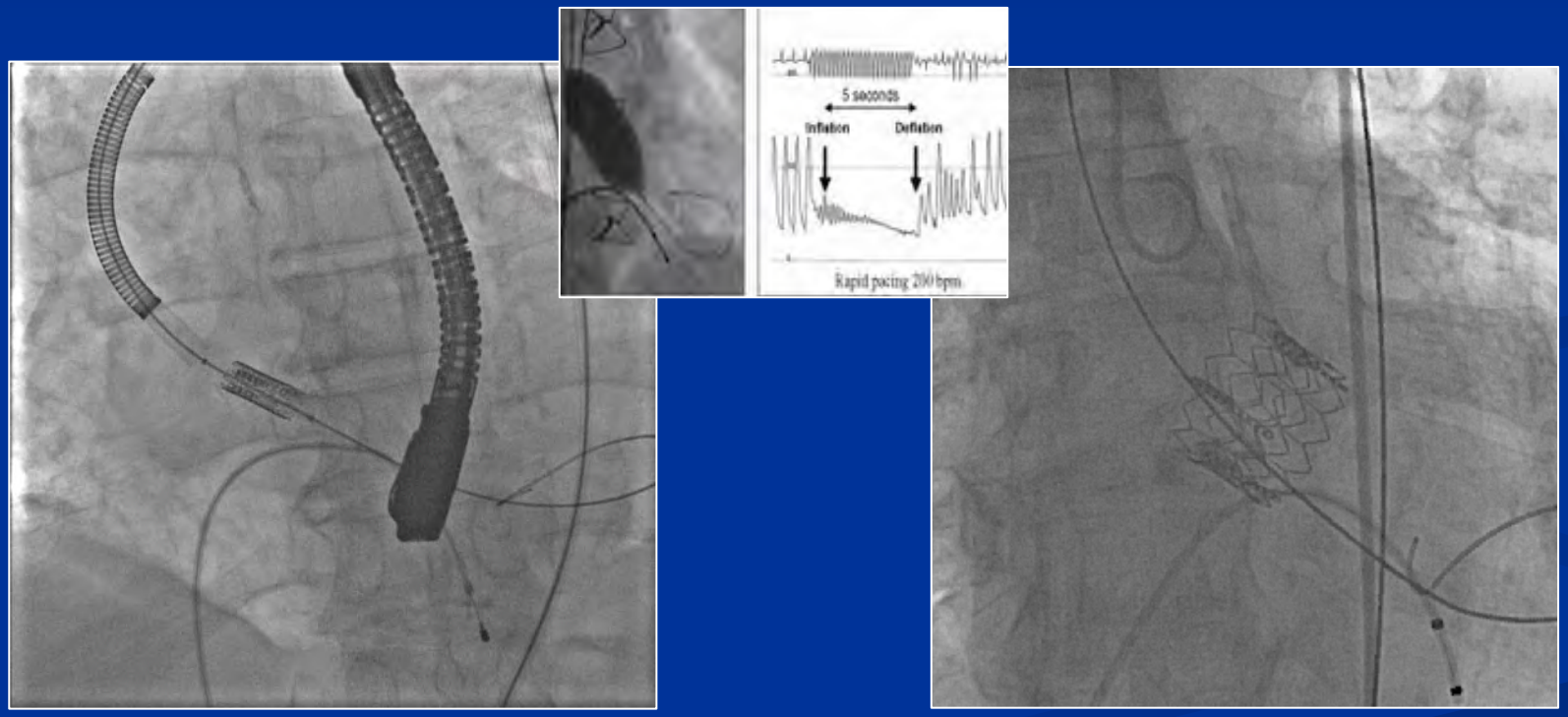
- Native aortic valve
- Native pulmonary valve
- Descending aorta





Implantation technique

Balloon valvuloplasty and valve implantation during rapid ventricular pacing (~180/min)

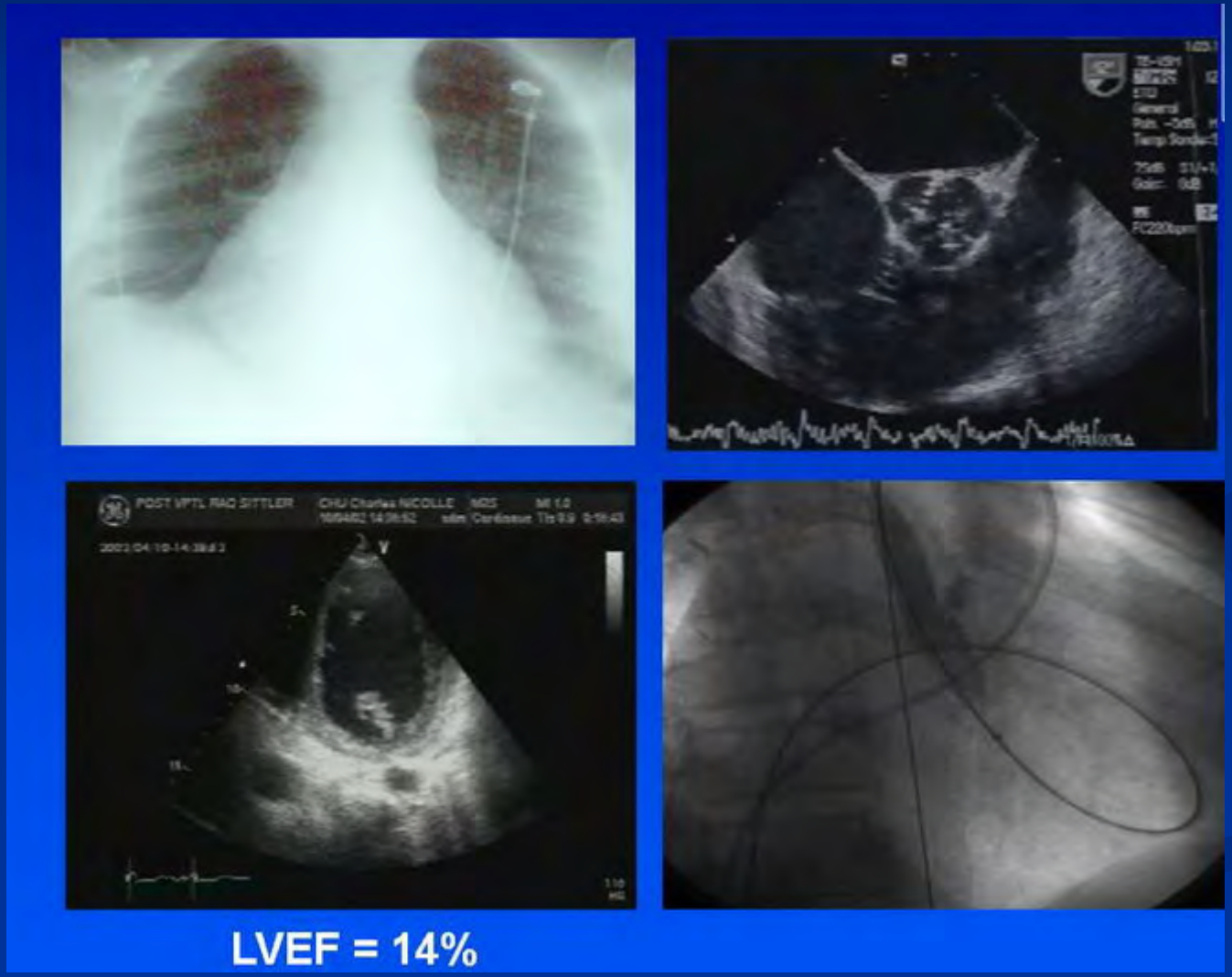


April 16th, 2002.
First in Man TAVI, Rouen, France

57 year-old man

- Severe calcific Aortic Stenosis in cardiogenic shock
- Valve replacement declined by three surgical teams due to hemodynamic instability and comorbidities
- Severe peripheral arterial disease with subacute ischemia of the right leg (occluded aorto- bifemoral bypass)
- Silicosis and lung cancer (lobectomy in 1999)
- Balloon aortic valvuloplasty proposed as a last possible option

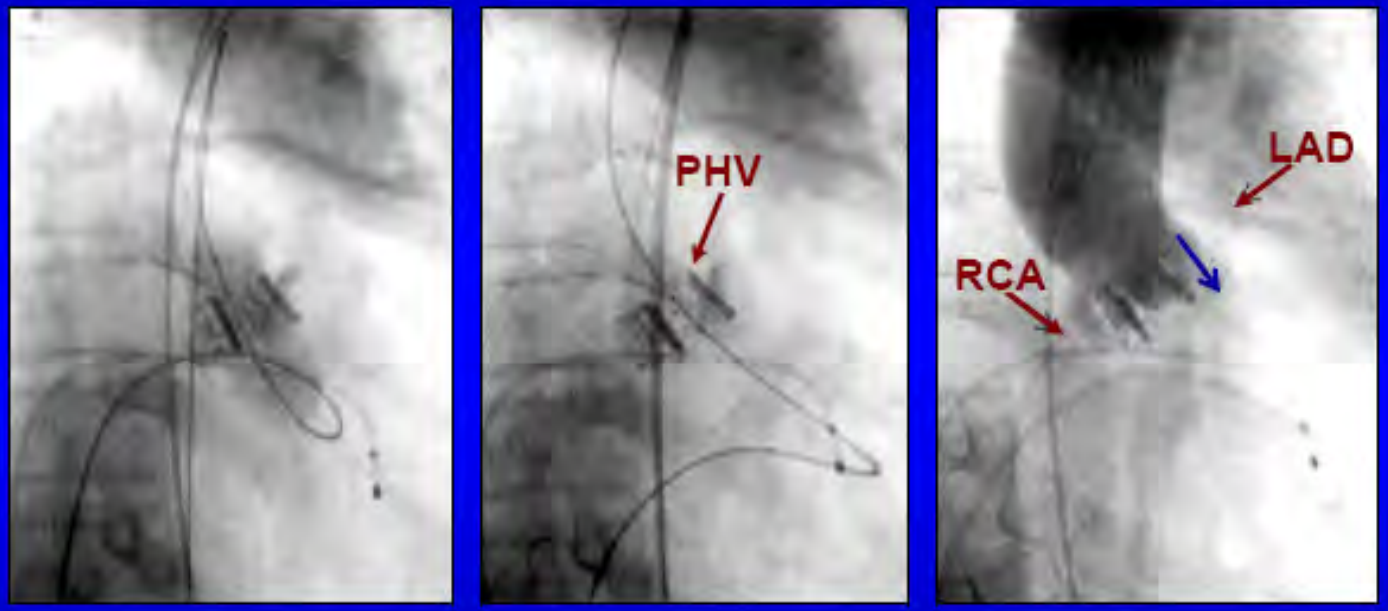
April 16th, 2002.
First in Man TAVI, Rouen, France



LVEF = 14%

April 16th, 2002.
First in Man TAVI, Rouen, France

Percutaneous Aortic Valve Replacement



Cribier et al. *Circulation* 2002;106:3006-3008

Day 8 post-implantation

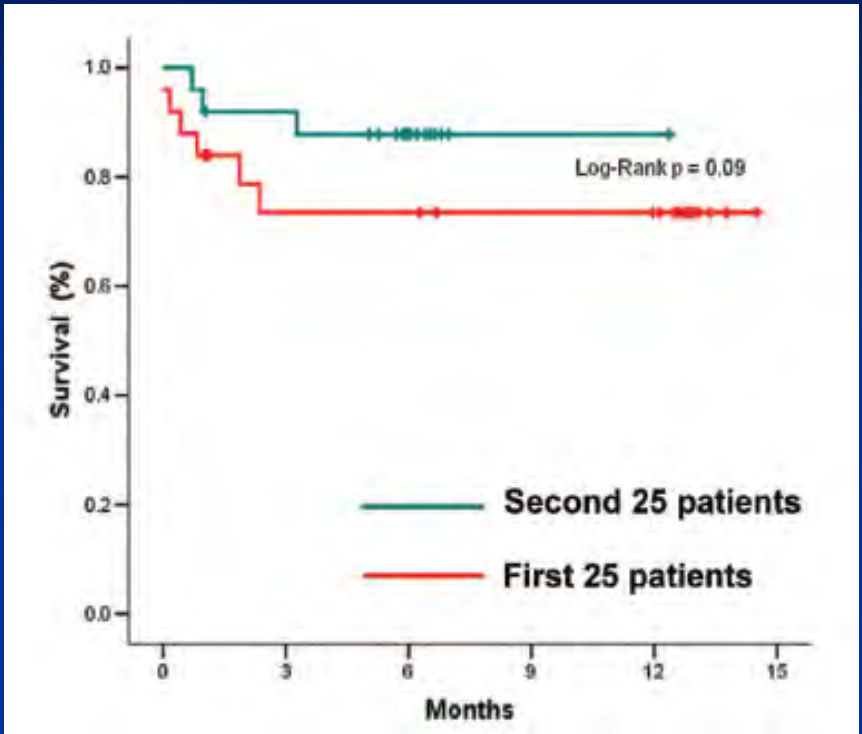
Cribier-Edwards Aortic Bioprosthesis
Animal Tests : The initial phase

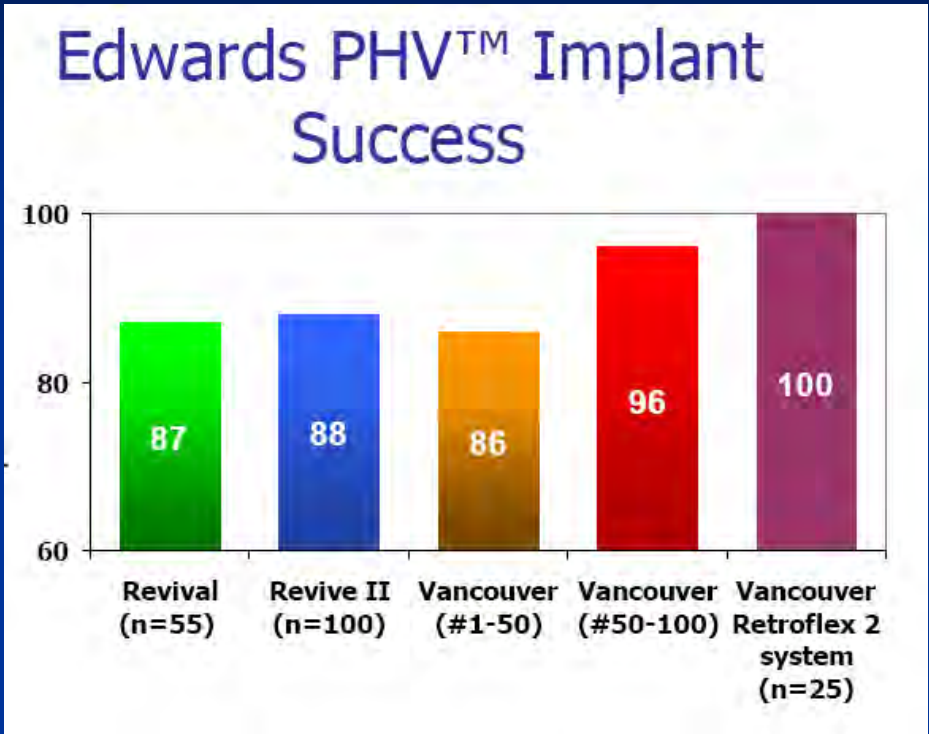
- Poorly defined patients characterization
  - Desperate cases (including those beyond cure)
- Poorly defined procedural specifications
- Prototype equipment
- Procedural learning curve
  - pioneering experiences

Yrs: 2002-2005

- ↑ procedural complications
- ↑ peri-procedural and short-term mortality
- Questionable procedural role & medical benefits

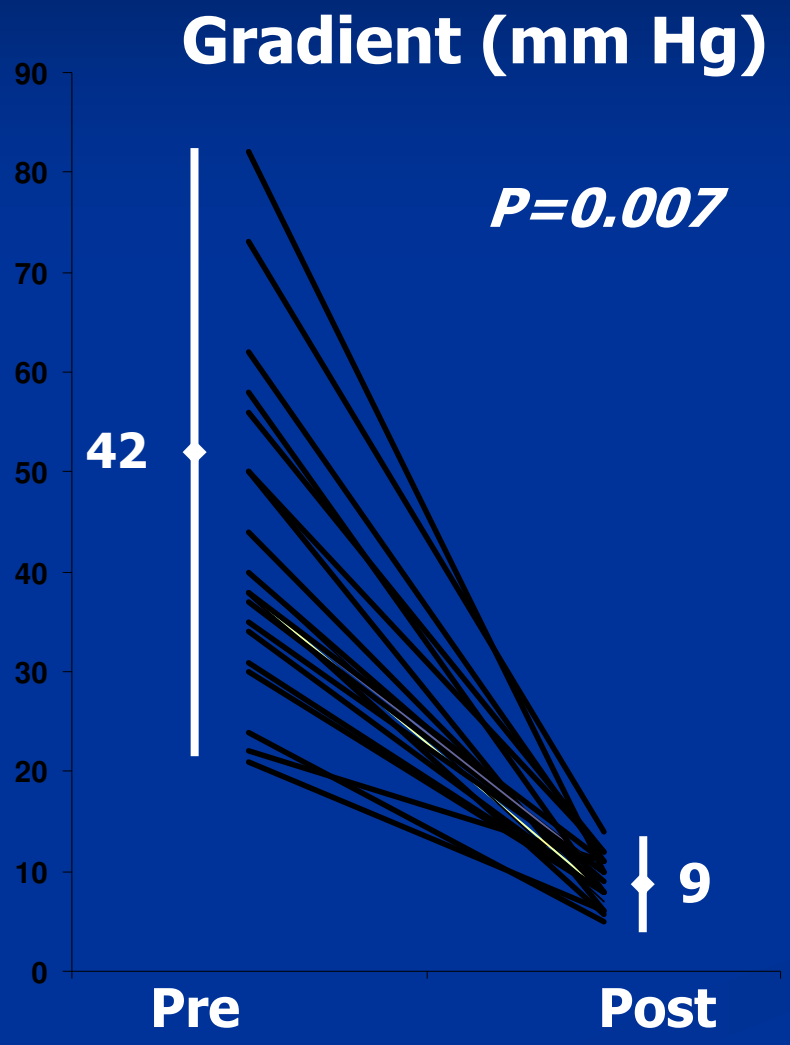
Learning Curve

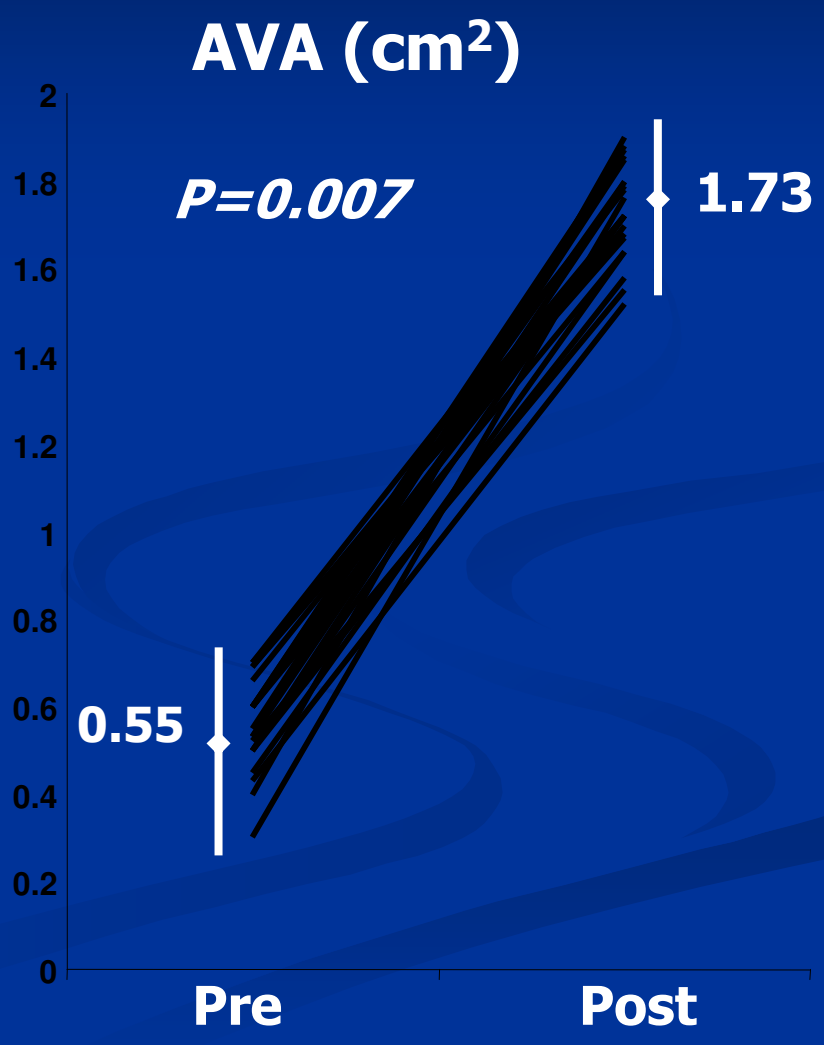




- Improved Results-
  mostly related to improved patient selection!
- The importance of meticulous screening process.

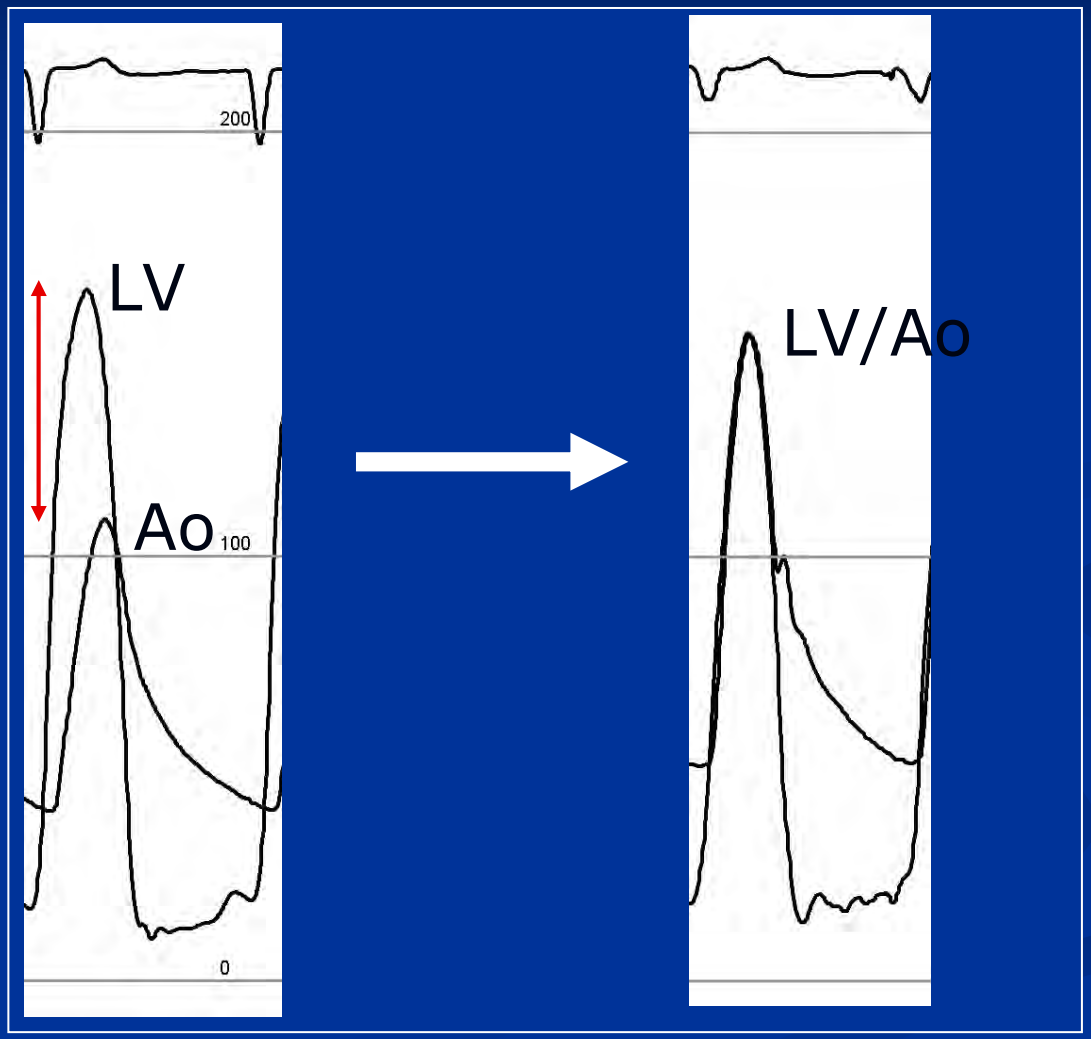
Hemodynamic Effect





Hemodynamic Effect

Gradient
55mmHg
AVA=0.6 cm^2

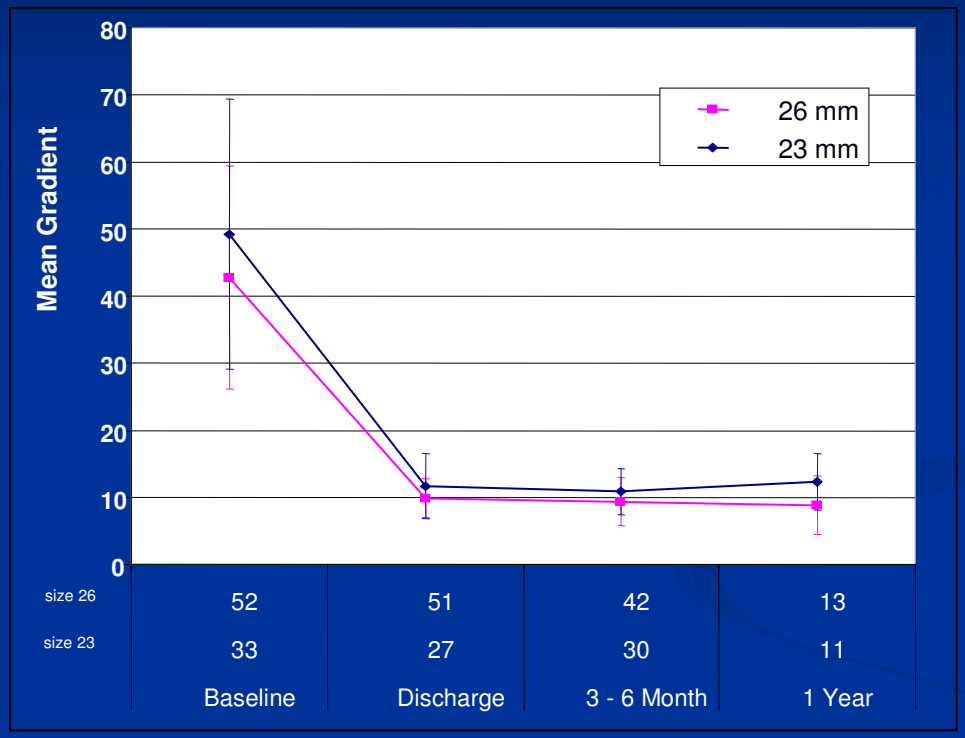


Gradient
0mmHg
AVA=1.7 cm^2

Pre PAVI

Post PAVI

Hemodynamic Effect



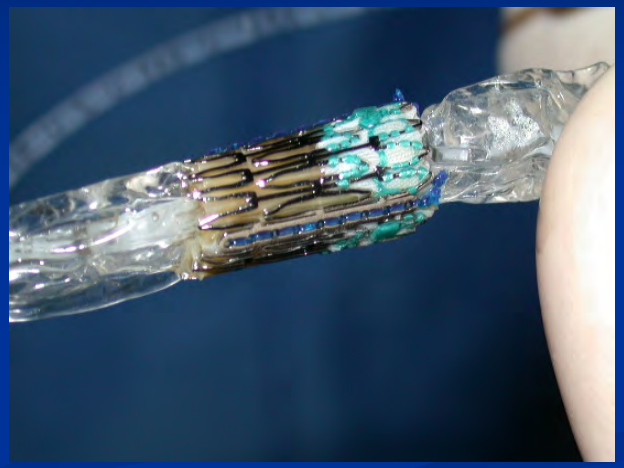
45 → 10 → 10 mmHg

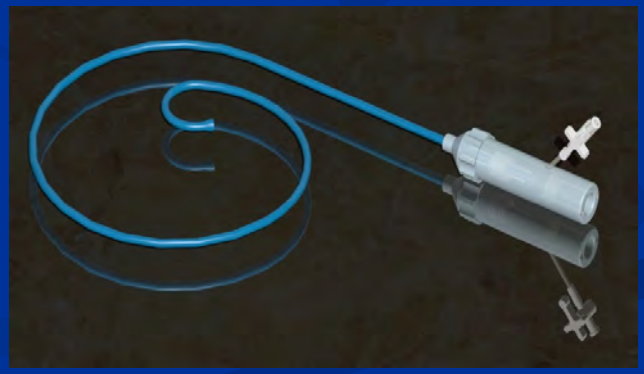
REVIVE II + REVIVAL II + CSA (n=193)

Edwards TAVI bioprosthesis

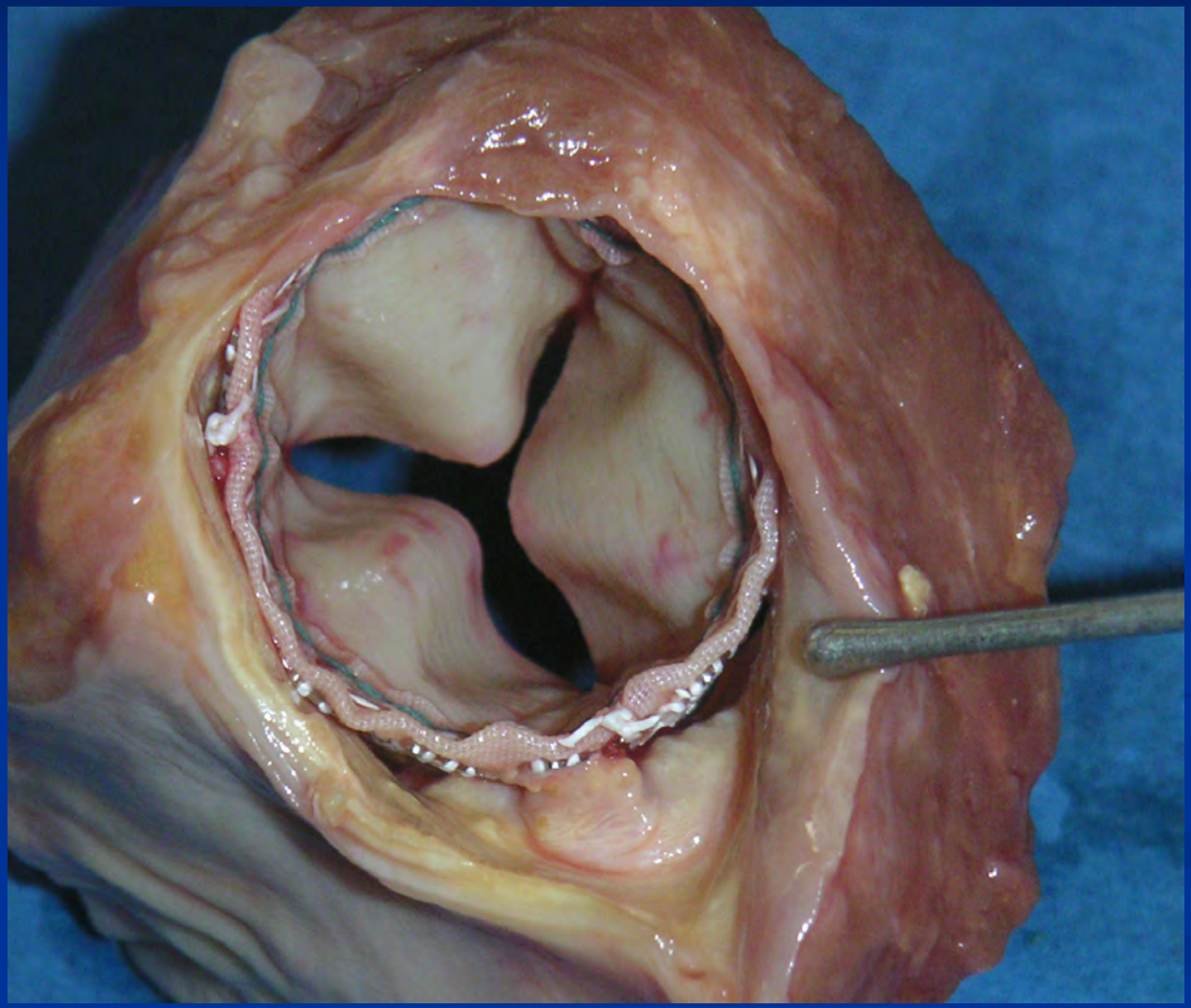
2002 FIM	2003	2005	2010
THV	THV	Cribier-Edwards	Edwards Sapien XT
			
Bovine pericardium Stainless steel frame 23mm Preclin. & FIM	Equine pericardium Stainless steel frame 23mm 2003-2006	New transapical approach	Bovine pericardium Cobalt Chrome frame 23 and 26mm Next: 20-29mm
24F	22F		18F 19F

Cribier-Edwards/Sapien™ Aortic Bioprosthesis





Cribier-Edwards/Sapien™ Aortic Bioprosthesis



Cribier-Edwards/Sapien™ Aortic Bioprosthesis

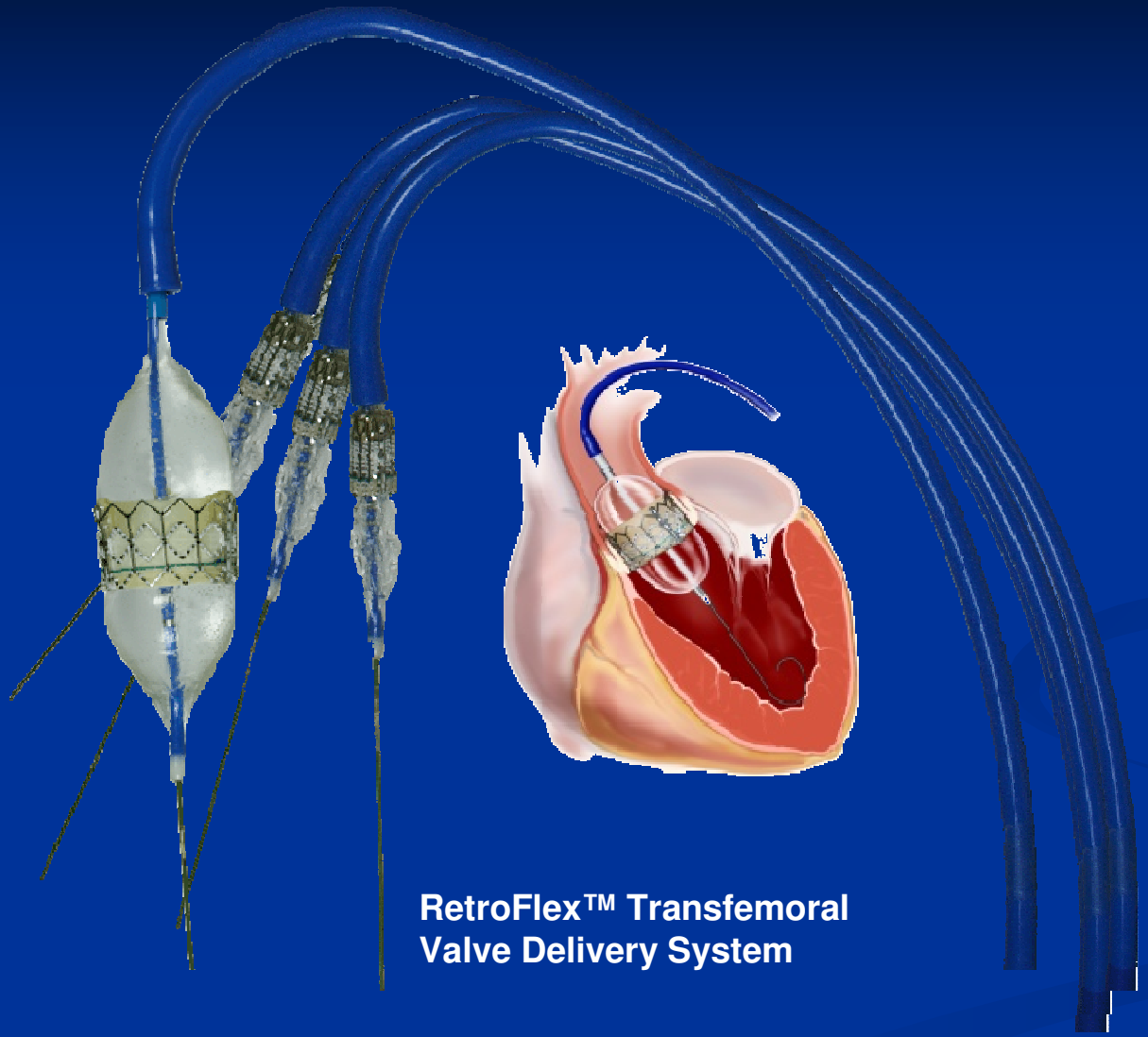
First generation - polyurethane

Trileaflet bioprosthesis

- Highly resistant stent cage
- Equine → Bovine pericardium
- Optimal hemodynamics
- > 5 years durability (bench testing)
- Two sizes
  - 23/26 mm diameter
  - (29 mm planned)
- AVA=1.7-1.9 cm^2

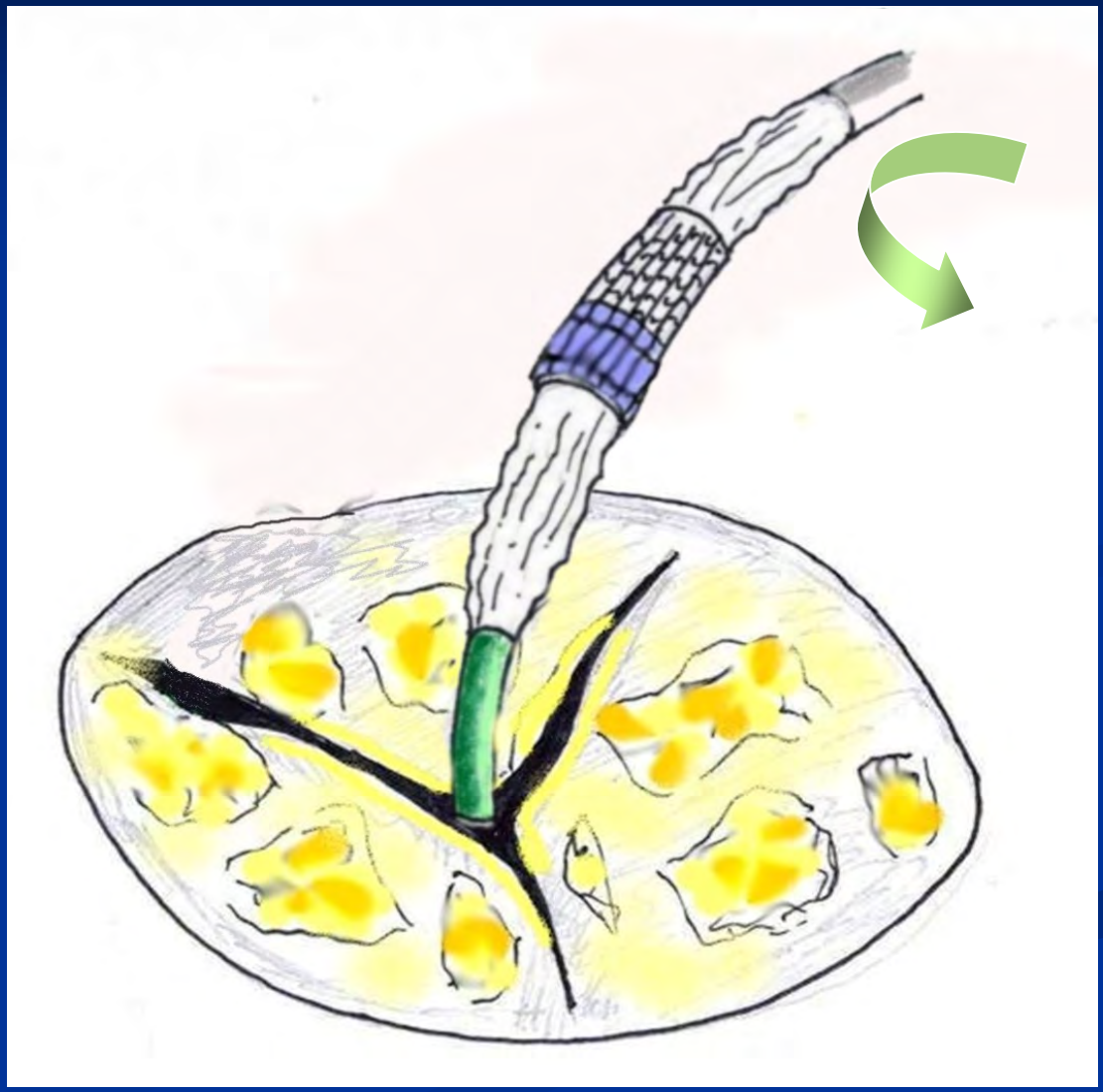
Cribier-Edwards/Sapien™ Aortic Bioprosthesis (NJ-CA-Israel)

Cribier-Edwards/Sapien™ Aortic Bioprosthesis

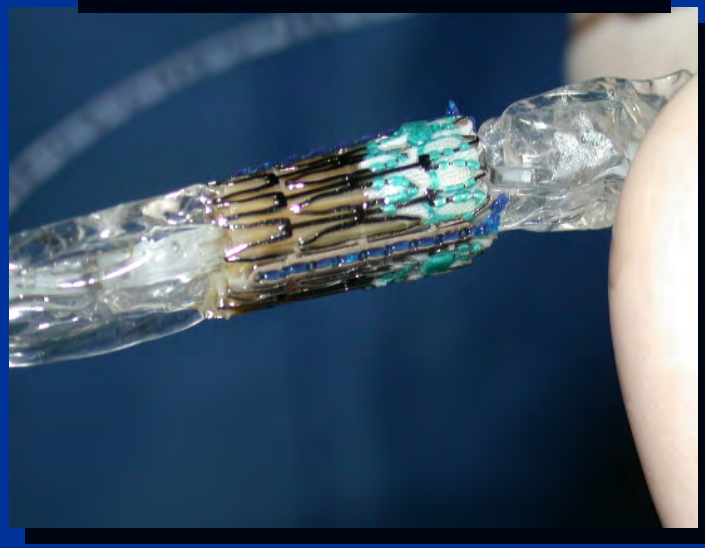


RetroFlex™ Transfemoral
Valve Delivery System

Cribier-Edwards/Sapien™ Aortic Bioprosthesis

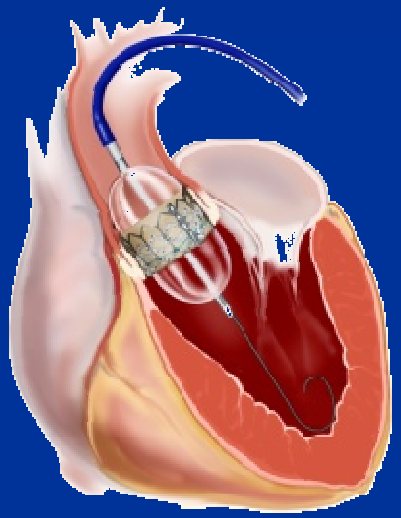


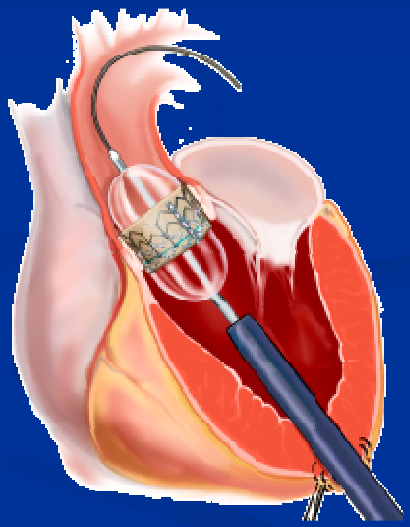
Cribier-Edwards/Sapien™ Aortic Bioprosthesis



Transfemoral Edwards implantation

Cribier-Edwards/Sapien™ Aortic Bioprosthesis

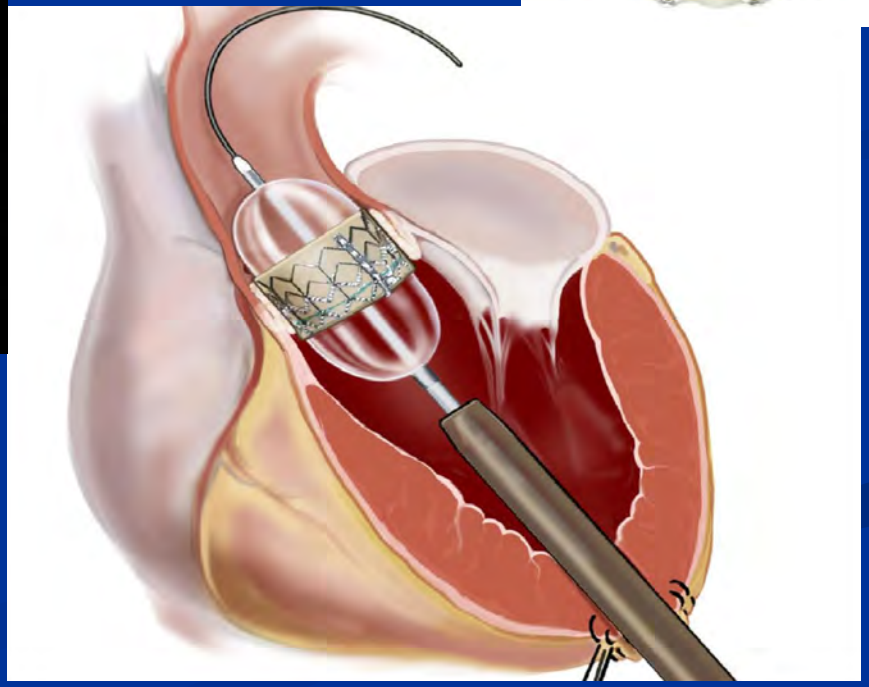




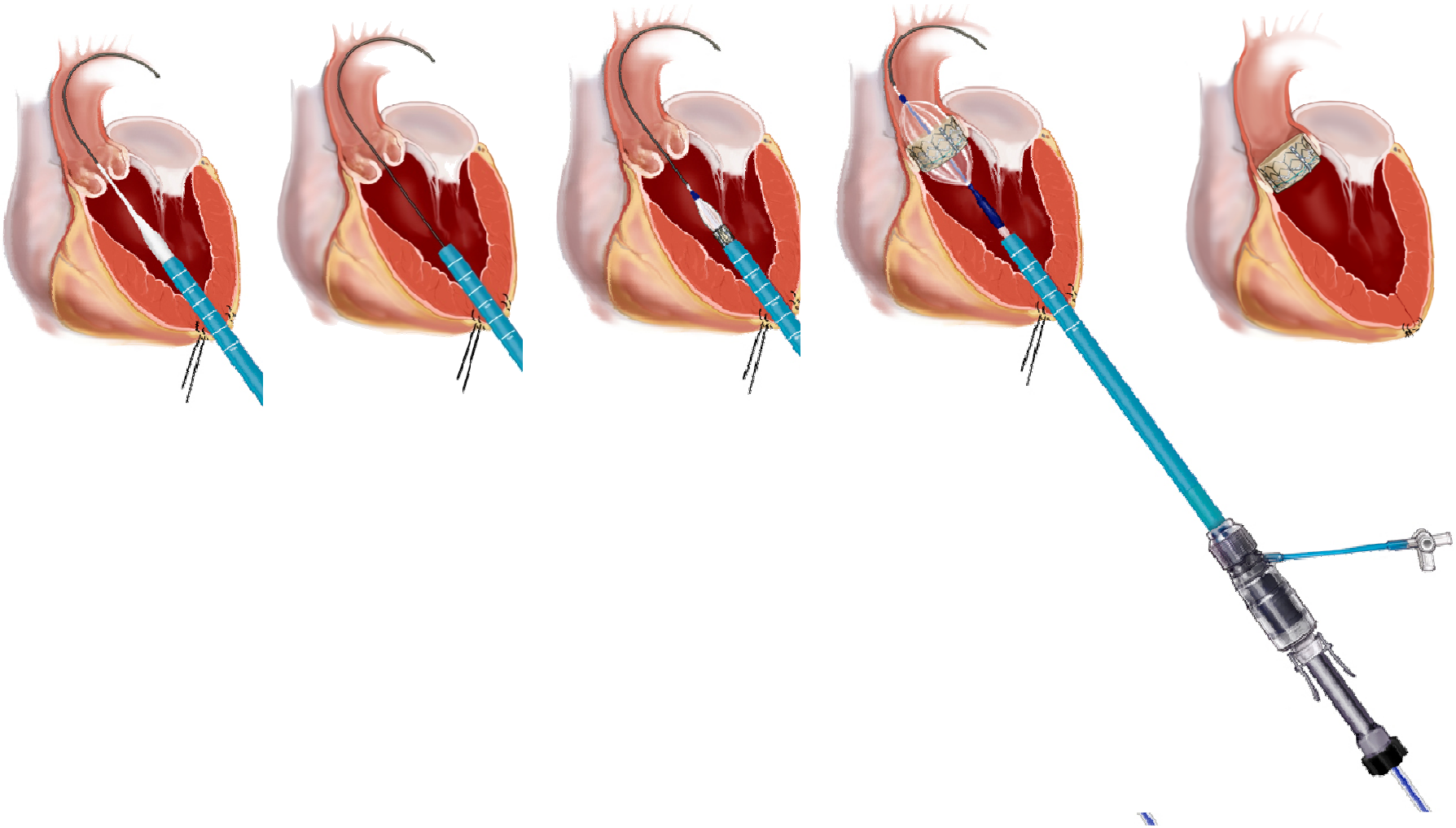
Transfemoral
approach using the
RetroFlex™ Delivery System
24 French Sheath Delivery System

Transapical
approach using the
Ascendra™ Delivery System

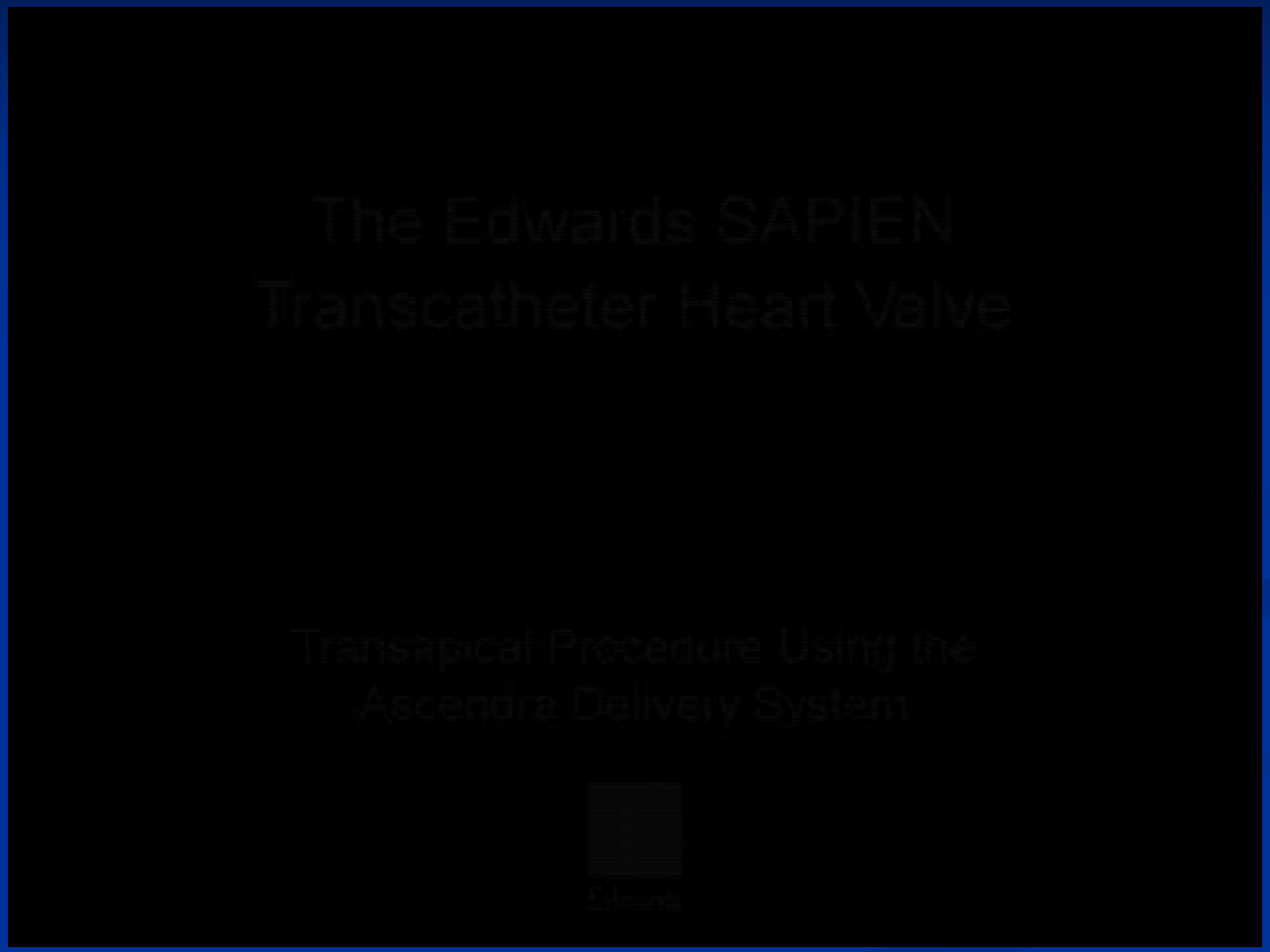
Trans-Apical Aortic Valve Implant



Transapical Procedural Steps Using The Ascendra™ Delivery System



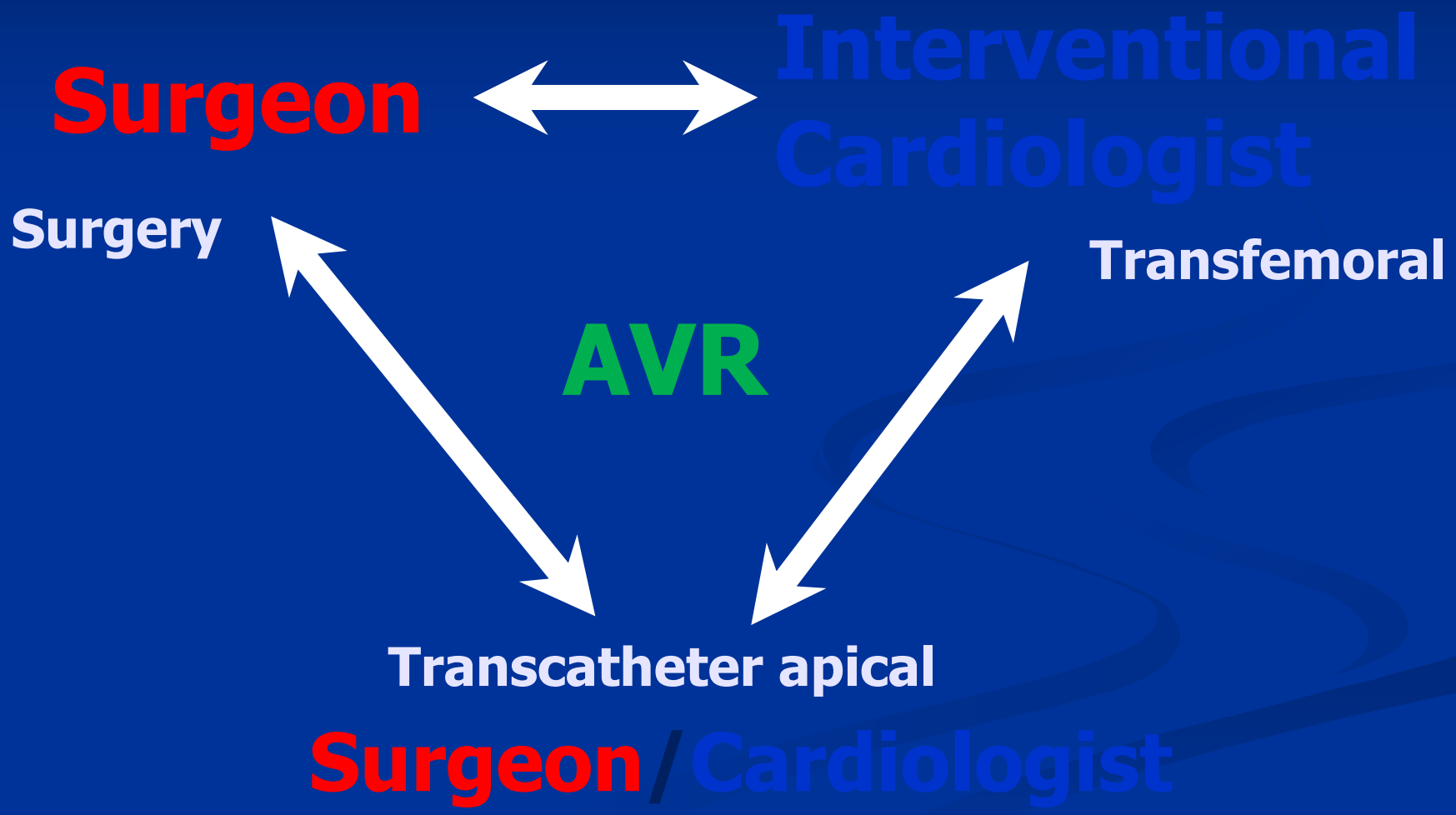
Transapical Edwards implantation



Team Approach

- interventional cardiologists
- cardiac surgeons
- echocardiographers
- vascular surgeons
- radiologist
- anesthesiologists
- ICU physicians
- electrophysiology specialists
- dedicated nursing staff
- industry specialists

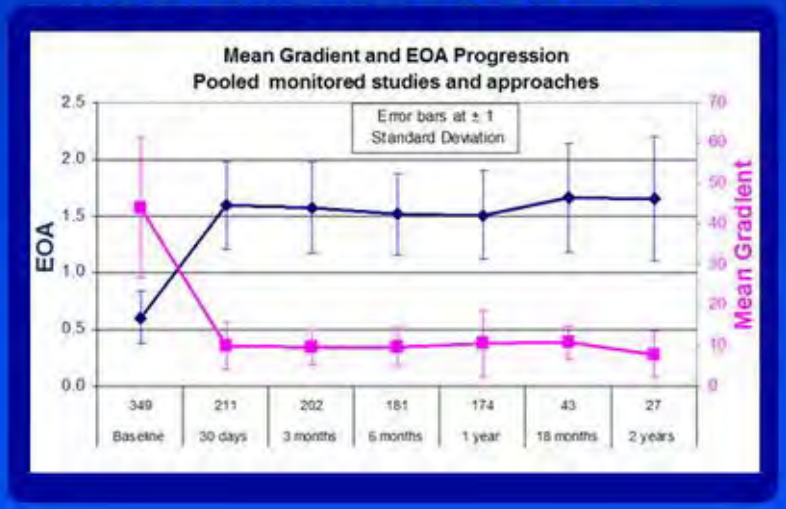
The Bipolar or Triangular Approach



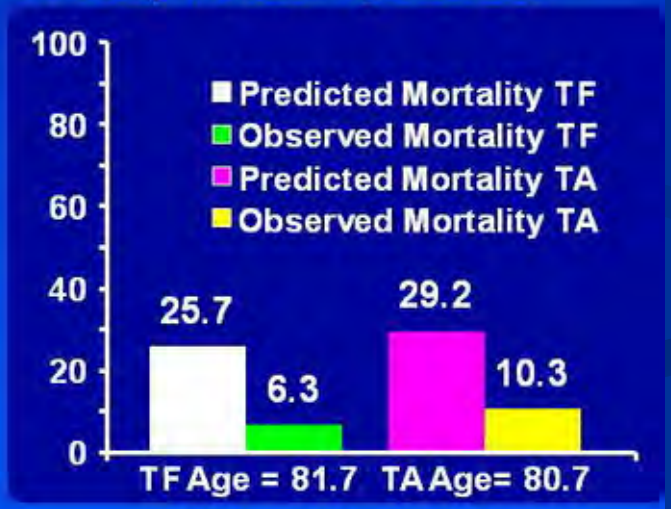
SOURCE: EuroPCR 2009
Webb: Circulation 2009
France: AHA 2009

	PARTNER N=130	SOURCE N=1038	Webb et al N=168	FRANCE N=166
Stroke	**3.0%**	**2.5%**	**4.2%**	**3.6%**
Pacemaker	**3.0%**	**7.0%**	**5.4%**	**5.4%**
Vascular Complications (major)	**10.0%**	**7.0%**	**6.6%**	**6.0%**

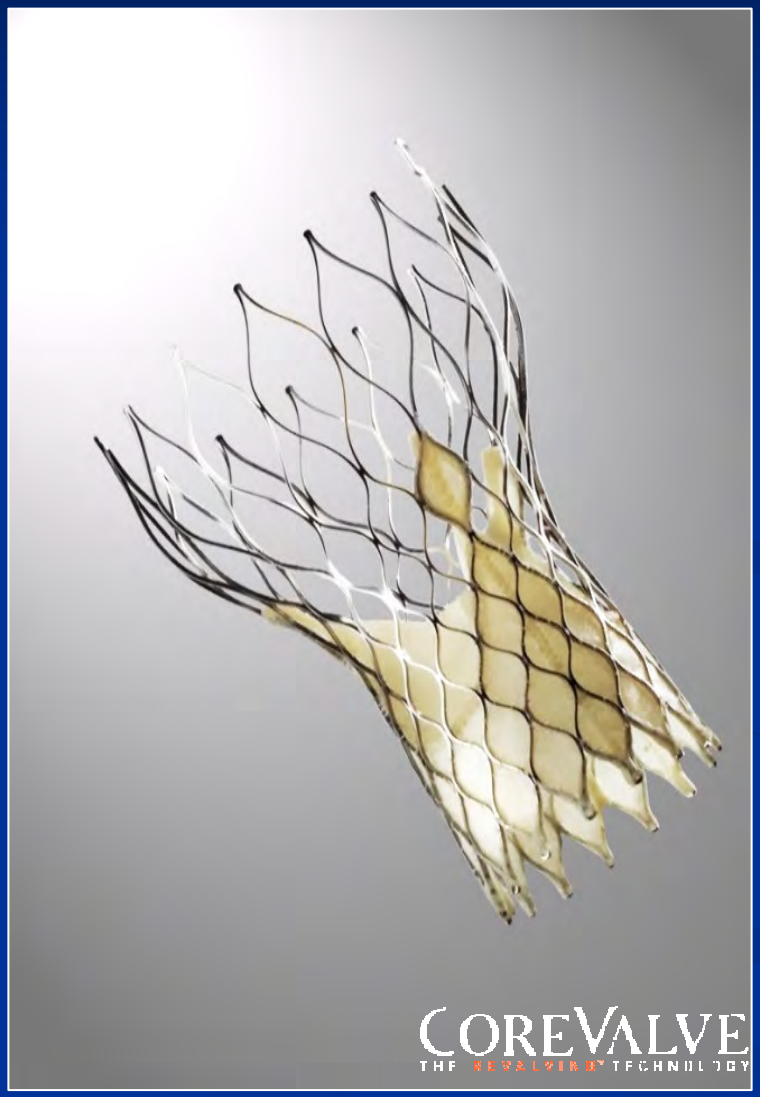
Pooled monitored studies



30-day mortality: 6-10%

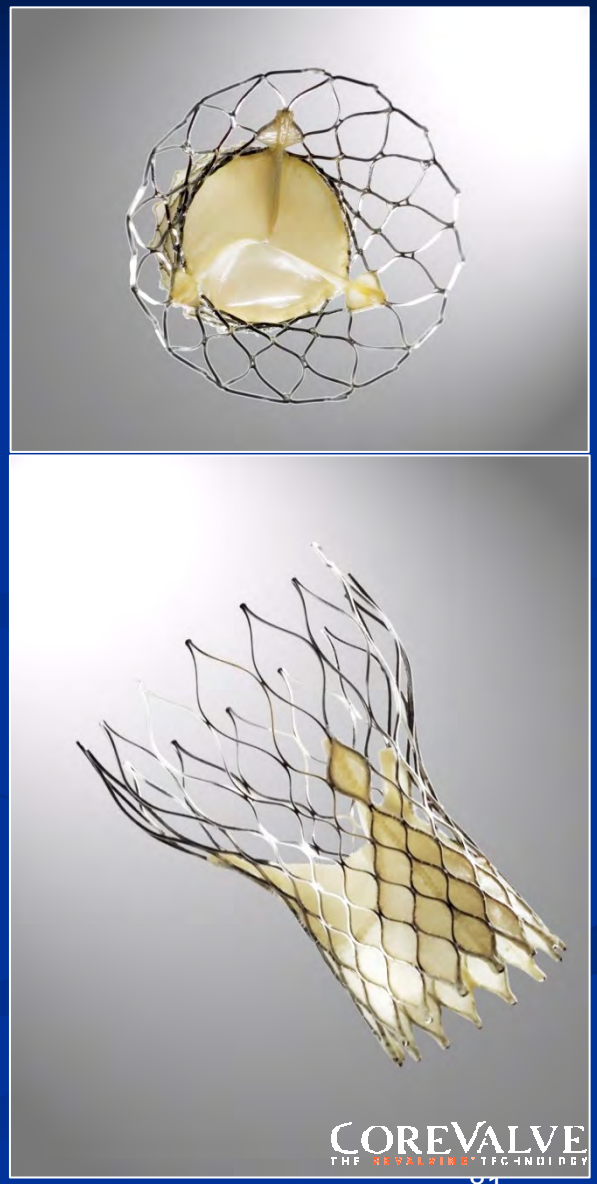


The CoreValve Self-Expandable System



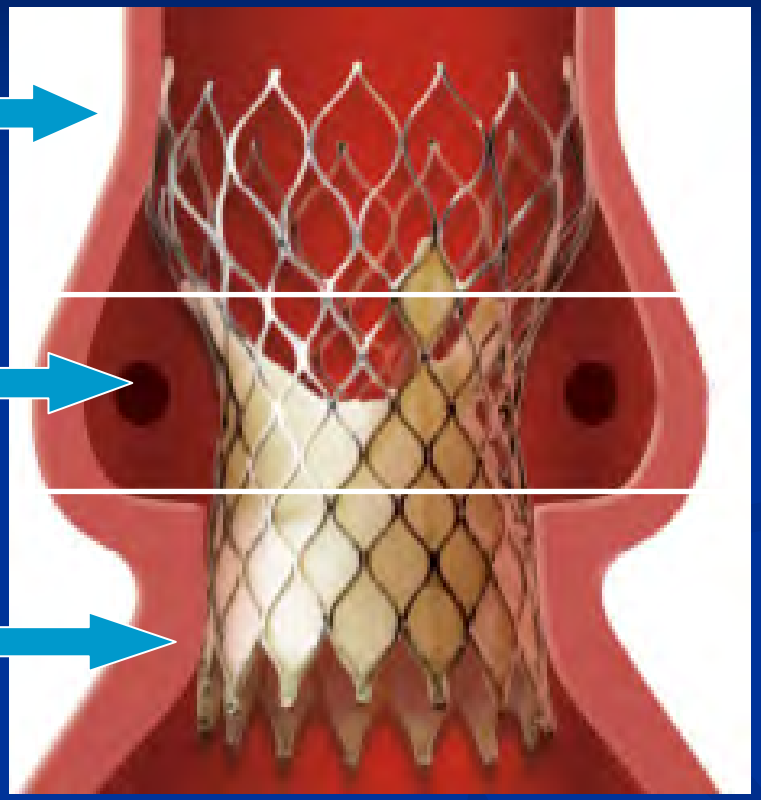
The CoreValve Self-Expandable System

- Specifically designed for transcatheter delivery
- Single layer porcine pericardium
- Tri-leaflet configuration
- Tissue valve sutured to frame
- Two sizes accommodate 90% of pts



The CoreValve Self-Expandable System

- **HIGHER PART** : fixation/axes the system
- **MIDDLE PART** : constrained to avoid coronaries / carries the valve in its lower portion
- **LOWER PART**: High radial force pushes aside the calcified leaflets -avoids recoil / para-valvular leaks (covered sleeve/skirt)



- A porcine pericardial tissue valve
- Fixed to a nitinol stent frame in a surgical manner with PTFE sutures

CoreValve Technology Progress

Generation 1
25F
Transcatheter

2004

Generation 2
21F
Transcatheter

2005

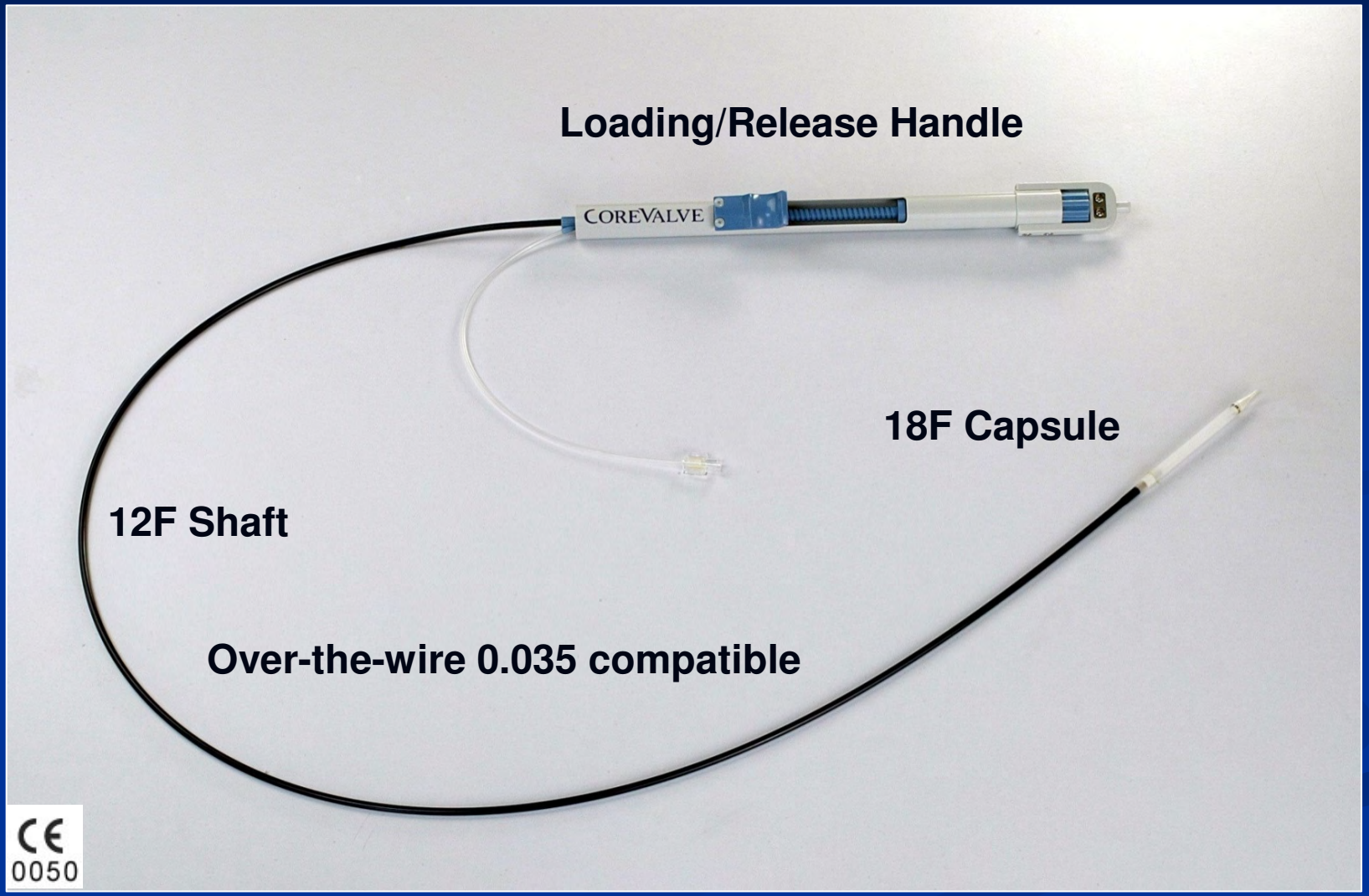
Generation 3
18F
Percutaneous

2006

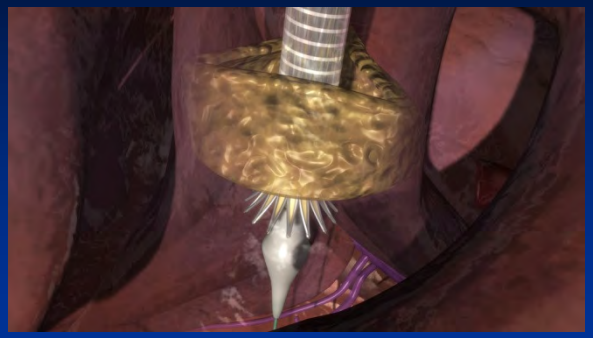
CE
0050

2007

18F Delivery Catheter System

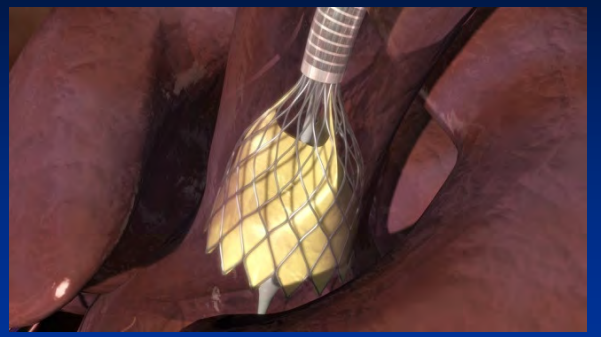


Deployment of the CoreValve System

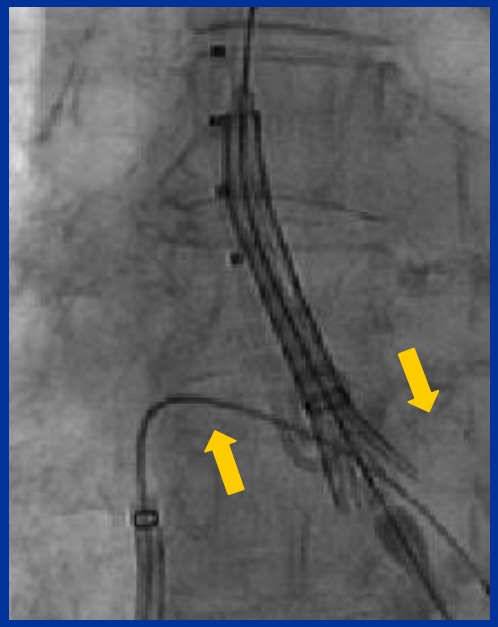


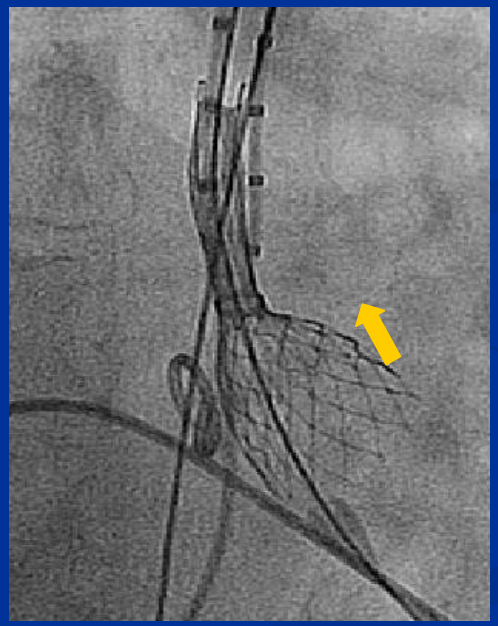
Before annular contact

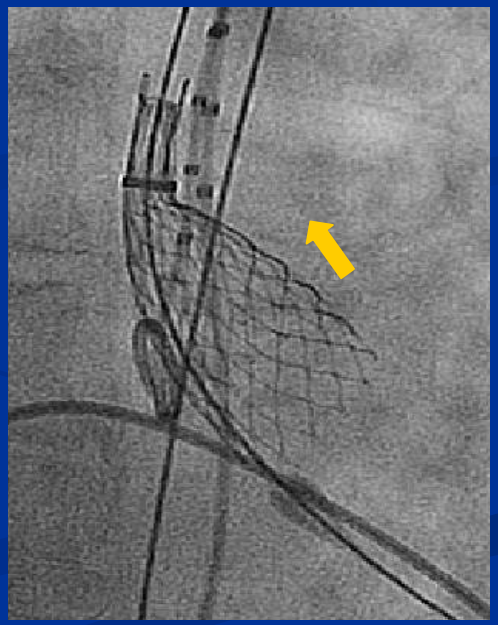
After annular contact



Before device release

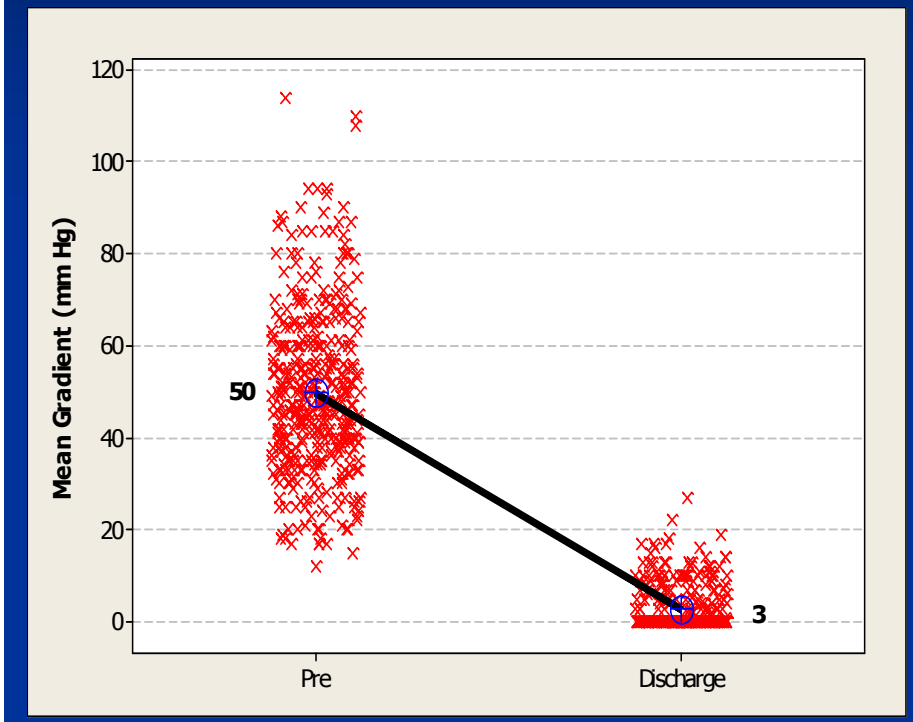


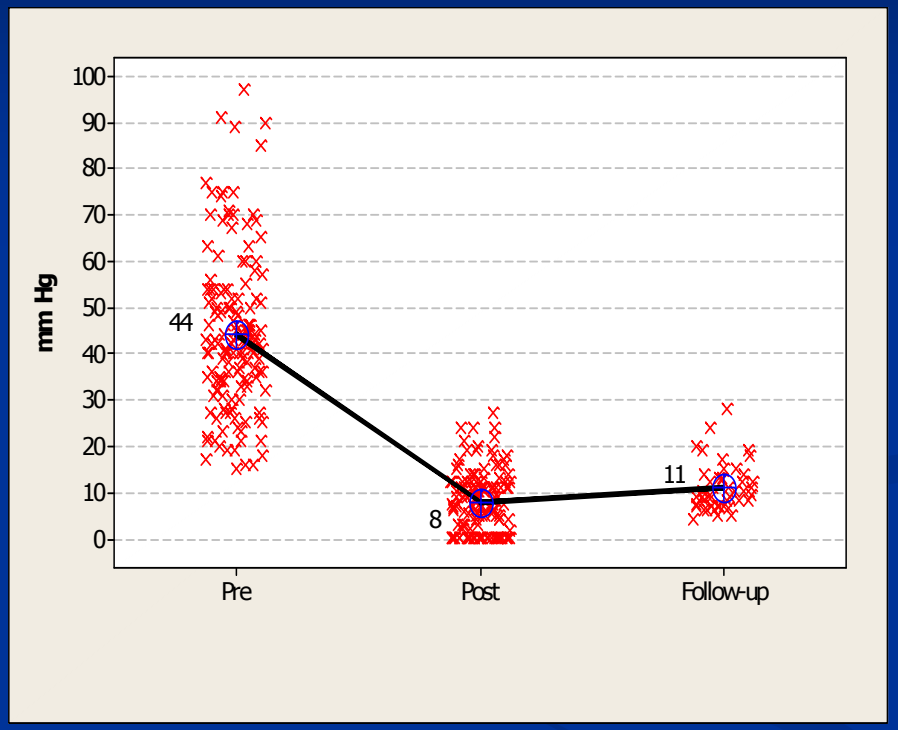




Self expandable deployment mechanism
Allows valve repositioning before final valve release

CoreValve Hemodynamic Effect



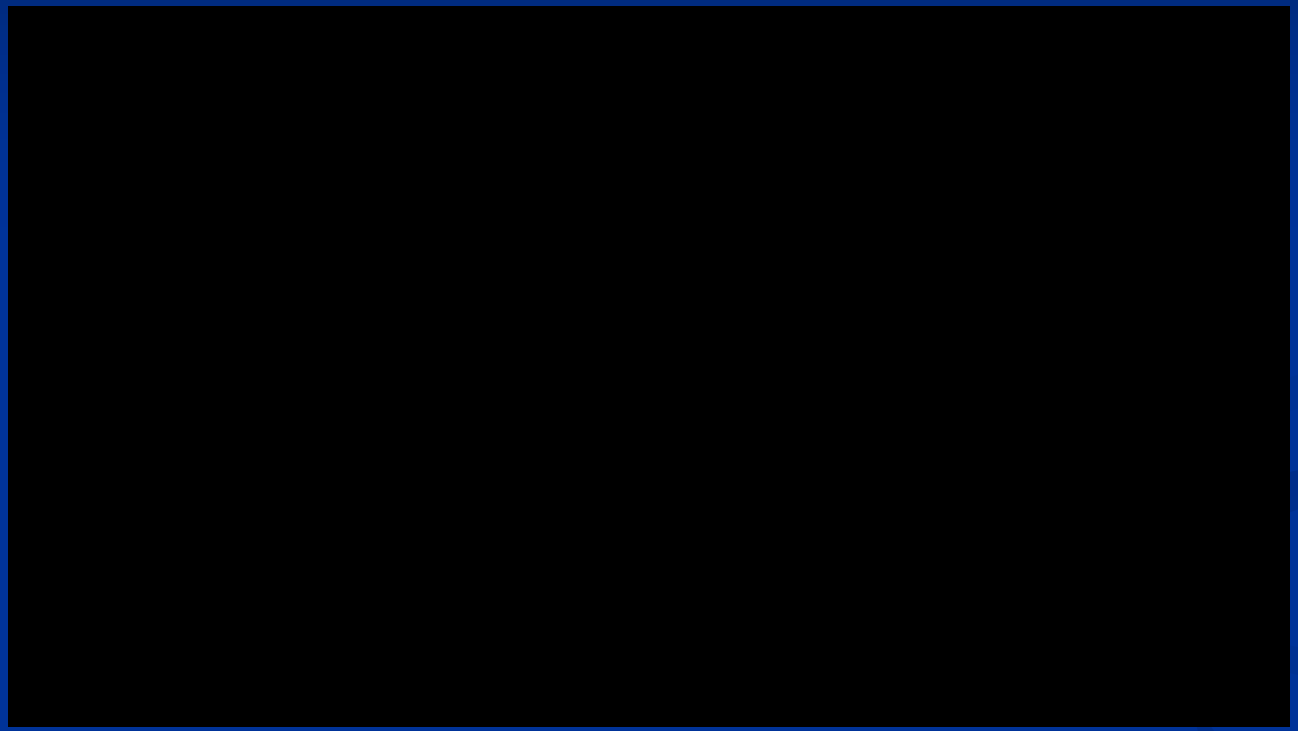


50 → 3 mmHg
(catheterization)

44 → 8 → 11 mmHg

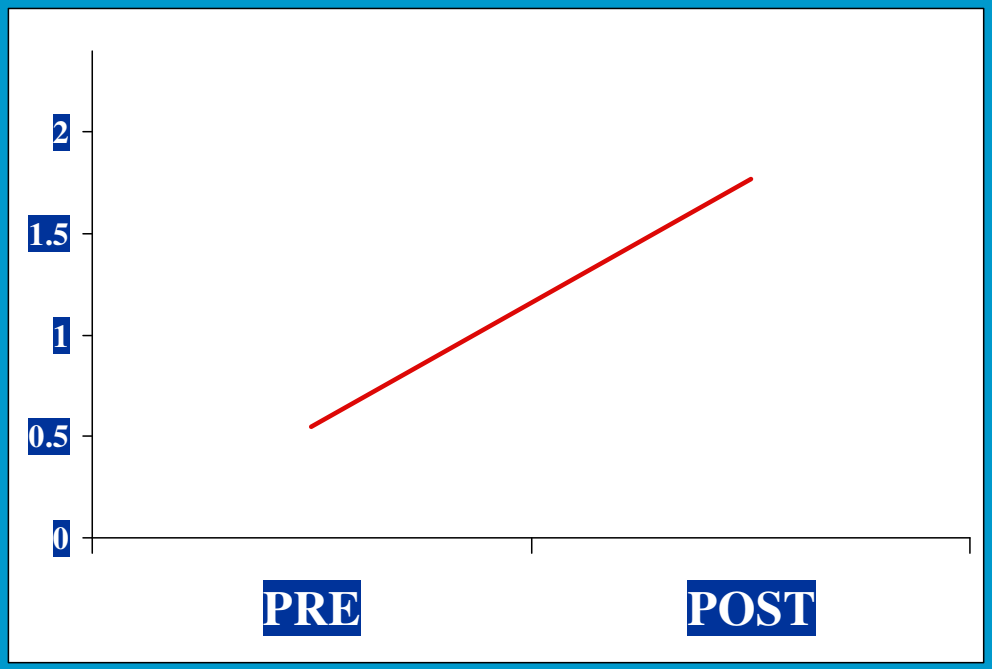
CoreValve Safety Studies (n=175)

Transfemoral CoreValve implantation

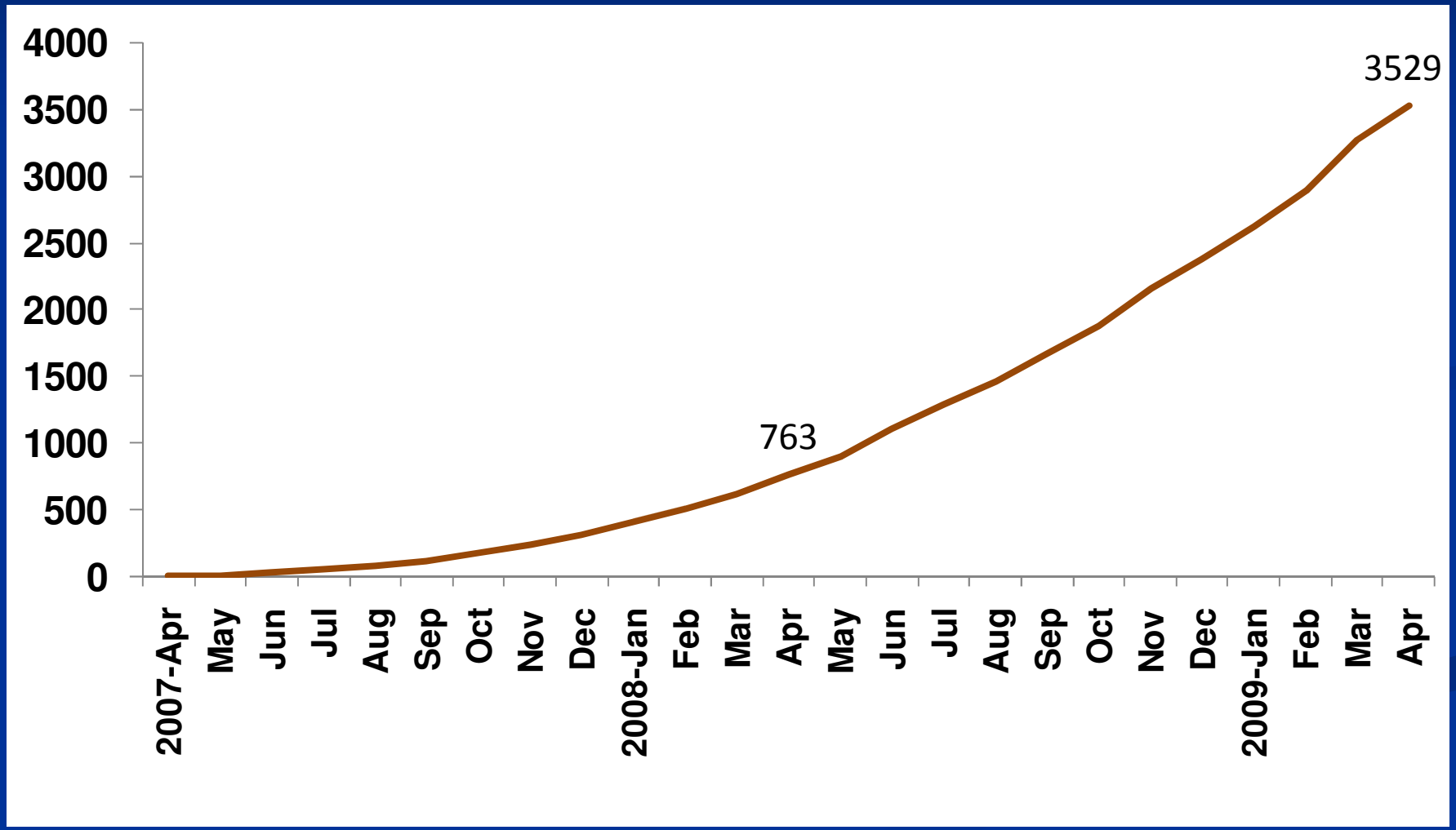


CoreValve Hemodynamic Effect

ASA (cm^2)
1.77 ±0.40 [1.1-2.6]



Global CoreValve procedures performed



TAVI–The Technology Today

	Frame + Tissue	Size	Annulus	Delivery (internal)	Femoral Artery
Edward SAPIEN™	Stainles steal, Bovine pericaridum	23 x 14.5 mm	18-22 mm	22F	≥8 mm
		26 x 16 mm	21-25 mm	24F	≥ 9 mm

*18 French system was already introduced

	Frame + Tissue	Size	Annulus	Delivery (internal)	Femoral artery
CoreValve Revalving ™	Nitinol, Porcine pericardium	26 x 53 mm	20-23 mm	18 F	≥ 6 mm
		29 x 55 mm	23-27 mm		

TAVI: Contemporary European data

Source Registry 18-F Expanded Registry

System	Edwards-Sapien (n=505)	CoreValve (n=1243)
Age (yrs)	81.8	81.0
Logistic EurosScore (%)	26.4	22.9
NYHC III/IV	9.27	8.4
AVA (before cm^2)	0.59	0.64
AVA (after cm^2)	1.7	1.5
Mean gradient (before mm Hg)	53.5	49.6
Mean gradient (after mm Hg)	4	9.1

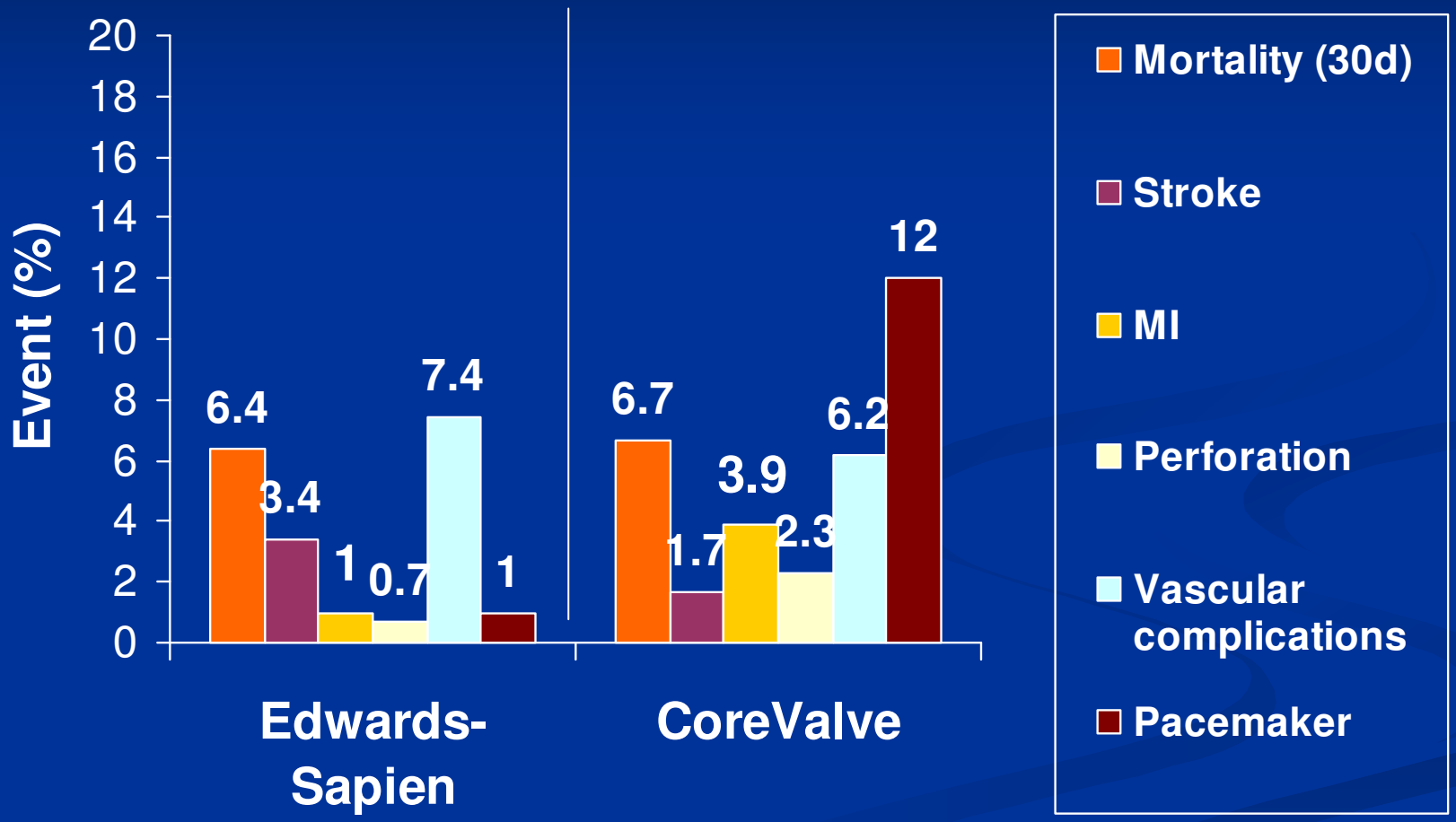
Cribier et al. JACC Int 2009

TAVI: Contemporary European data

	Source Registry	18-F Expanded Regis
System	**Edwards-Sapien (N=505)**	**CoreValve (1243)**
Procedural success (%)	95	98
30-d mortality (%)	6.4	6.7
Stroke (%)	3.4	1.7
Myocardial infarction (%)	1.0	3.9
Perforation-tamponade (%)	0.7	2.3
Vascular complications (%)	7.4	6.2
Need for pacemaker (immediate→30 days %)	1.5%	22%

Cribier et al. JACC Int 2009

TAVI: Contemporary European data



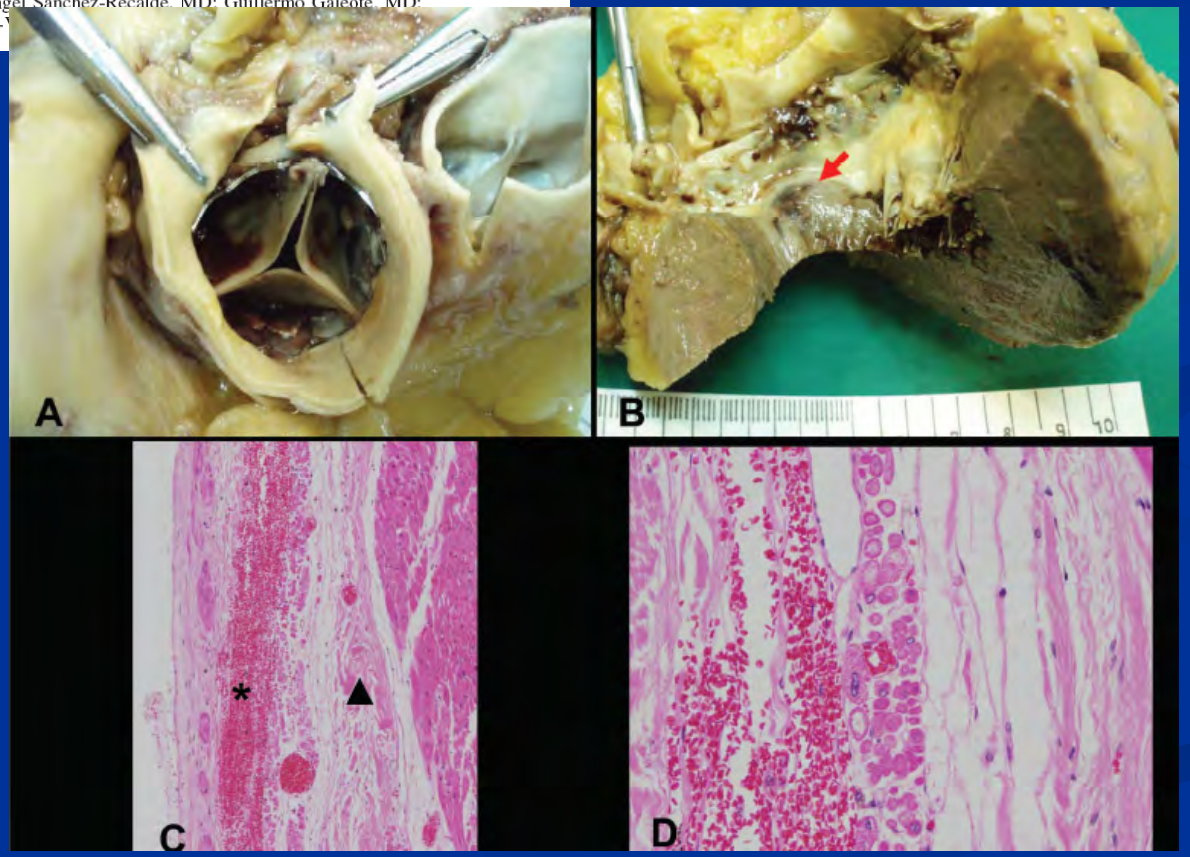
Conduction disturbances after TAVI

Cause of Complete Atrioventricular Block After Percutaneous Aortic Valve Implantation

Insights From a Necropsy Study

Raul Moreno, MD; David Dobarro, MD; Esteban López de Sá, MD; Mario Prieto, MD; Carmen Morales, MD; Luis Calvo Orbe, MD; Isidro Moreno-Gomez, MD; David Filgueiras, MD; Angel Sanchez-Recalde, MD; Guillermo Galeote, MD; Santiago Jiménez-

Circulation 2009;120(5):e29-30



Stroke after TAVI

Journal of the American College of Cardiology
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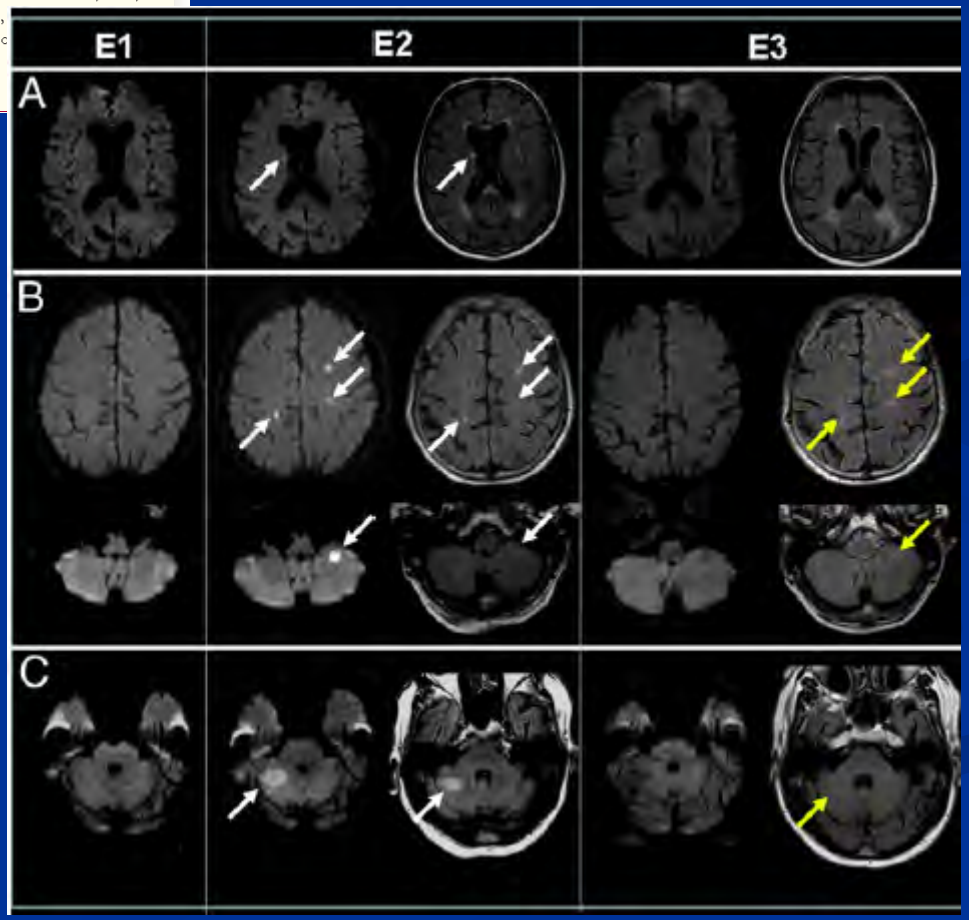
Published by Elsevier Inc.
Vol. 55, No. 14
ISSN 0735-1097/10/
doi:10.1016/j.jacc.2009.

Risk and Fate of Cerebral Embolism After Transfemoral Aortic Valve Implantation

A Prospective Pilot Study With Diffusion-Weighted Magnetic Resonance Imaging

Alexander Ghanem, MD,* Andreas Müller, MD,† Claas P. Nähle, MD,† Justine Kocurek, MD,*
Nikos Werner, MD,* Christoph Hammerstingl, MD,* Hans H. Schild, MD,
Jörg O. Schwab, MD, PHD,* Fritz Mellert, MD,§ Rolf Fimmers, MD,‡ Gec
Daniel Thomas, MD†

Bonn, Germany



Emerging AVR

Technology

Development Stage

Bench

Preclinical

Awaiting FHU

FHU

clinical

Pivotal

CoreValve — THE REVALVING TECHNOLOGY

Edwards Lifesciences

Also developing MIS method

AorTx

Sadra MEDICAL

DIRECT FLOW MEDICAL, INC.

Arbor Surgical Technologies, Inc.

Advanced Bio Prosthetic Surfaces

AorTech

SORIN BIOMEDICA — A SORIN GROUP COMPANY

Heart Leaflet Technologies

ETR

3F Valves

ATS MEDICAL

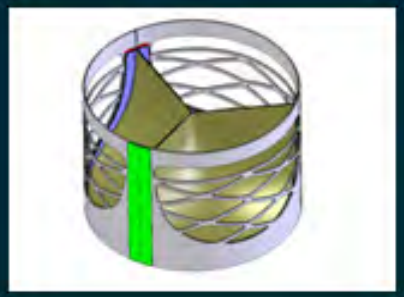
DAT

Ventor

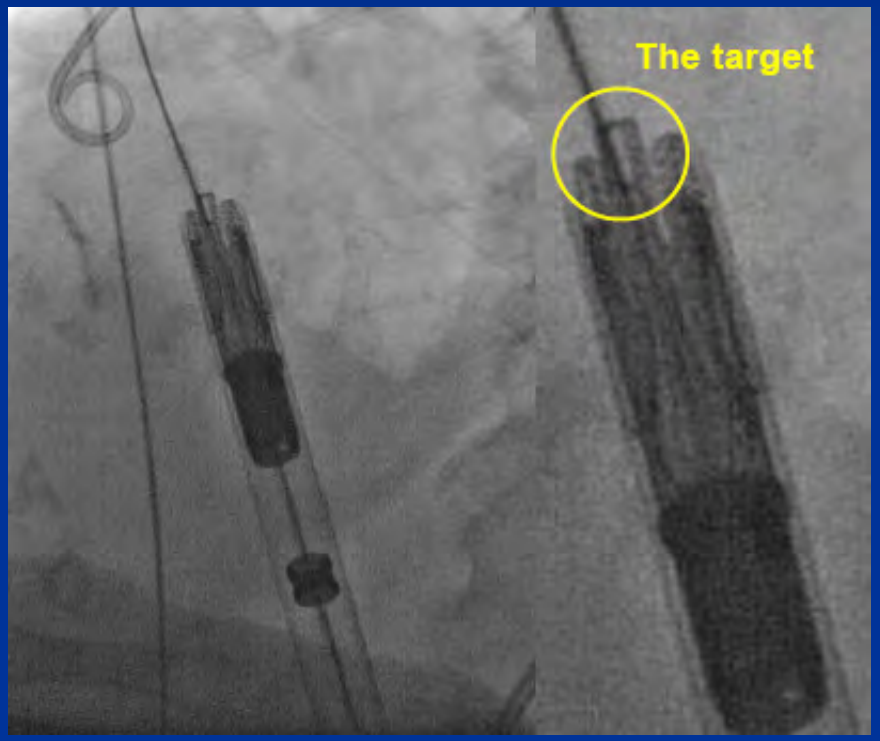
ENDOCOR

Percutaneous

Min-invasive surgery

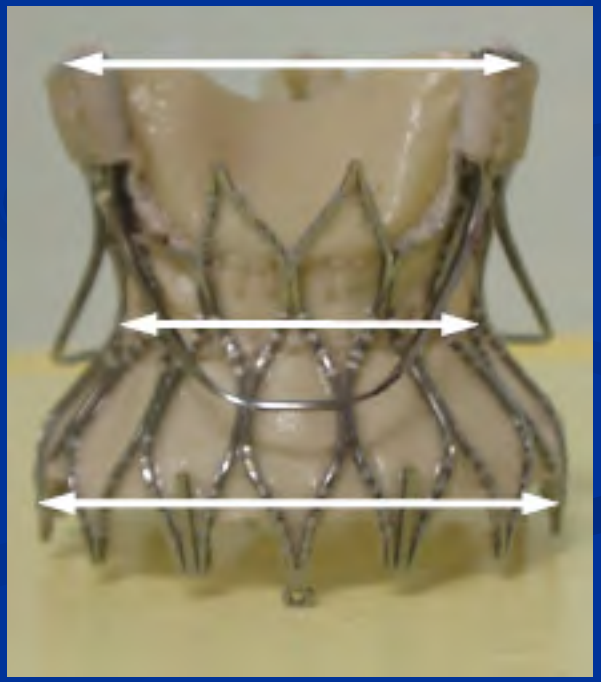


VENTOR
Ventor Technologies LTD.



Ehud Schwamenthal, MD, TCT2008

Self-expandable transcatheter valve to optimize placement and physiology



Ventor near $320 million acquisition by Medtronic

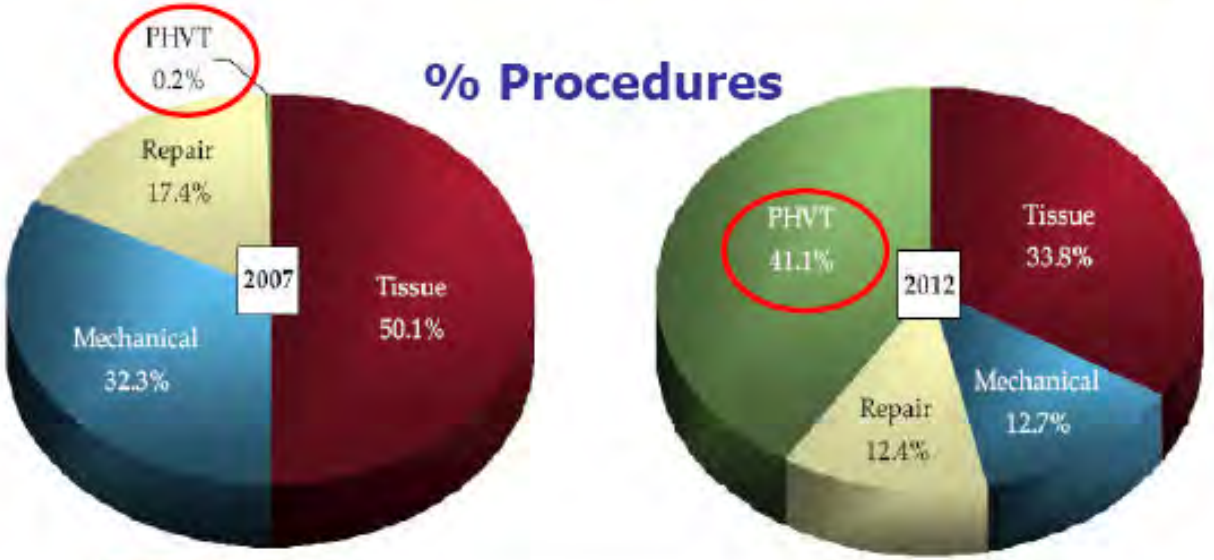
Investors in the medical device start-up can see a return of over 12 times their original investement.

Gali Weinreb17 Feb 09

Sources inform "Globes" that medical device start-up Ventor Technologies Ltd. is in advanced negotiations to be acquired by Medtronic (NYSE: MDT) for about $300 million.

Ventor and existing investors Pitango Venture Capital, Medica, and co-founder Dr. Shimon Eckhouse all denied that the firm was in talks to be sold. Medtronic did not respond.

Heart Valve Market Forecast

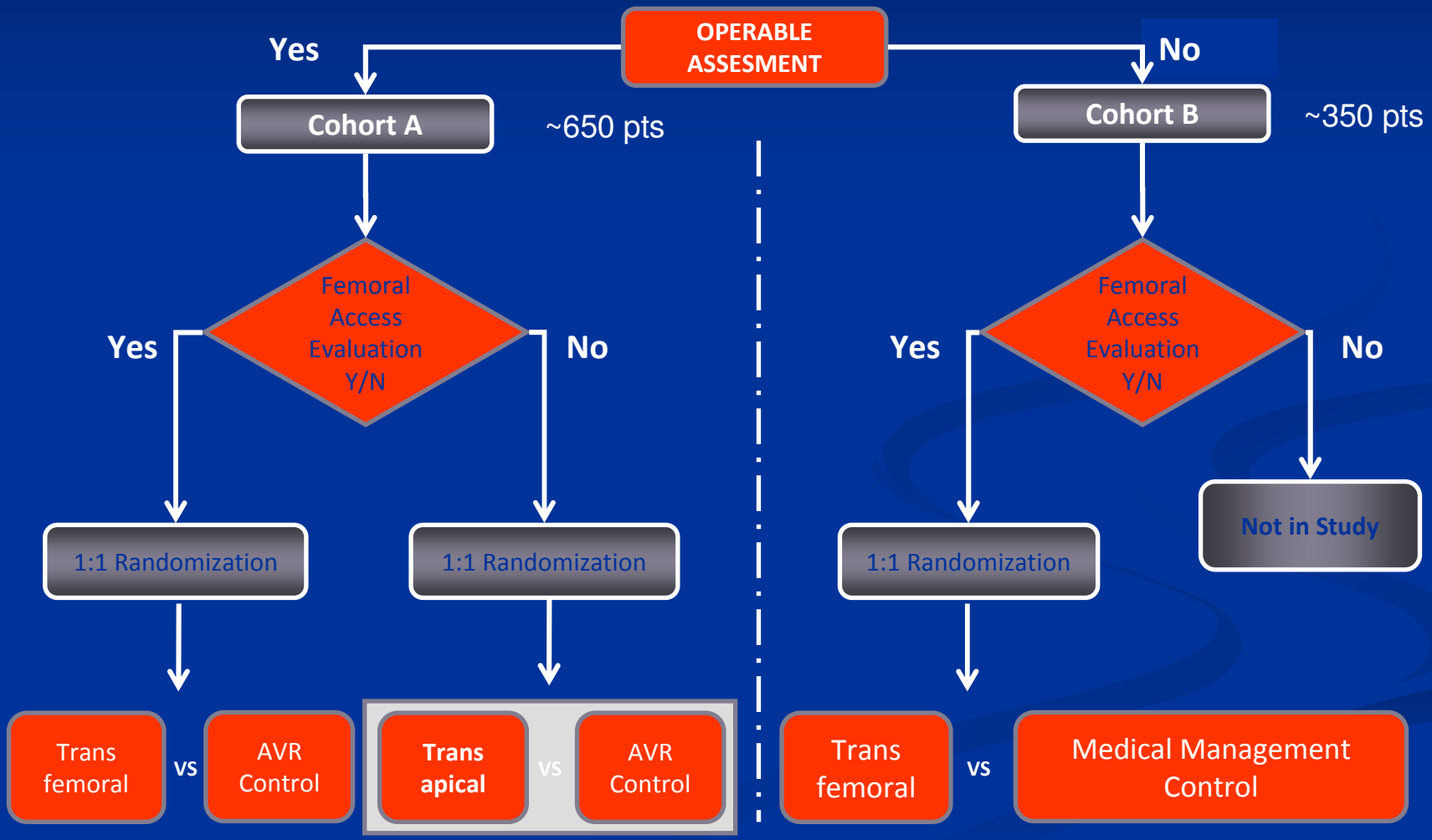


PHVT **0.2%** → **41.1%**

2007 **2012**

Source: Millennium Research Group 2008

Partner US Pivotal Trial



Screening patients for TAVI

Screening patients for TAVI

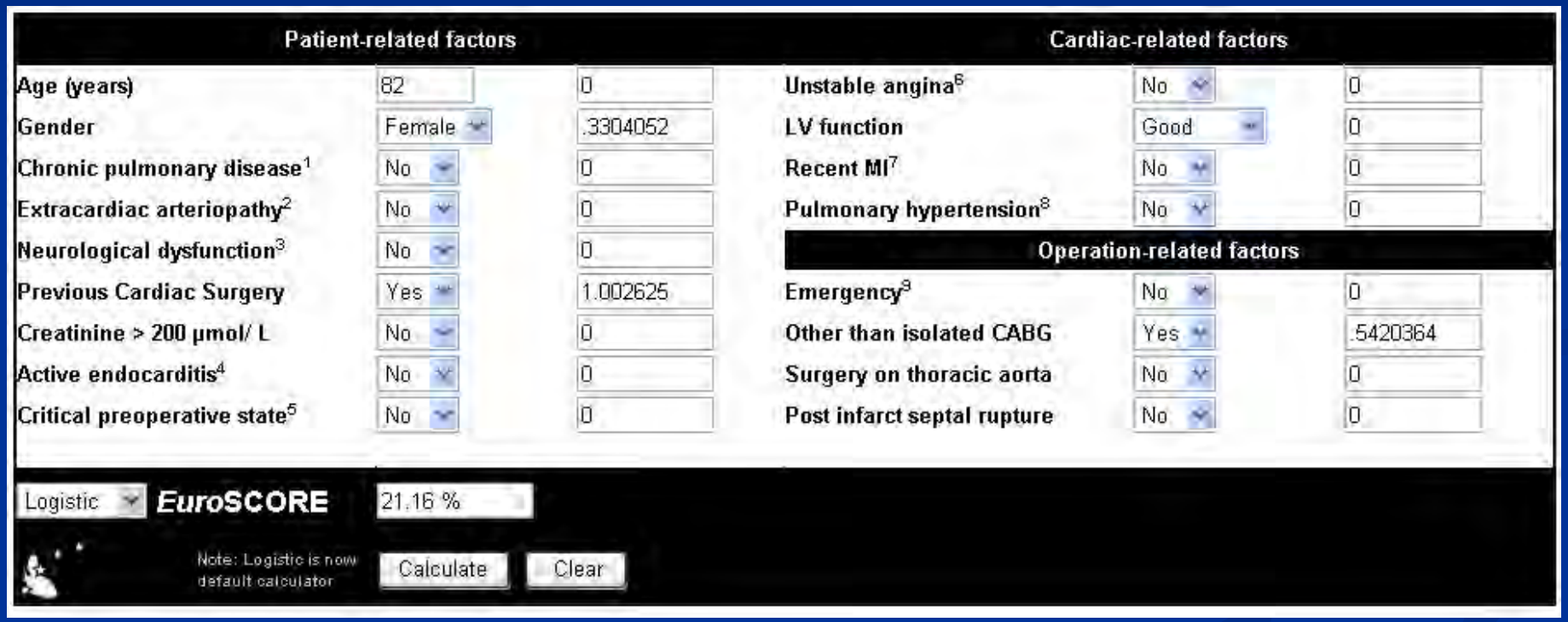
- Does the patient have severe AS?
- Is it symptomatic AS?
- Is he “high risk” for conventional surgery?

Who are the “High Surgical Risk” Aortic-Stenosis Patients?

- Octogenarians with multiple co-morbidities (LV dysf., previous cardiac surgery, …).
- Impaired rehabilitation capacity.
- High “frailty” index.
- Neurocognitive dysfunction .
- Porcelain aorta.
- Cirrhosis with portal hypertension .
- End-stage Lung disease.
- Chest wall deformities (severe).
- Radiation chest wall / heart disease .

- STS Predicted Risk >10%,
- Logistic EuroSCORE > 20%

EuroSCORE evaluation



Patient-related factors			Cardiac-related factors		
Age (years)	82	0	Unstable angina[6]	No	0
Gender	Female	.3304052	LV function	Good	0
Chronic pulmonary disease[1]	No	0	Recent MI[7]	No	0
Extracardiac arteriopathy[2]	No	0	Pulmonary hypertension[8]	No	0
Neurological dysfunction[3]	No	0	**Operation-related factors**		
Previous Cardiac Surgery	Yes	1.002625	Emergency[9]	No	0
Creatinine > 200 µmol/ L	No	0	Other than isolated CABG	Yes	.5420364
Active endocarditis[4]	No	0	Surgery on thoracic aorta	No	0
Critical preoperative state[5]	No	0	Post infarct septal rupture	No	0

Logistic EuroSCORE 21.16 %

Note: Logistic is now default calculator

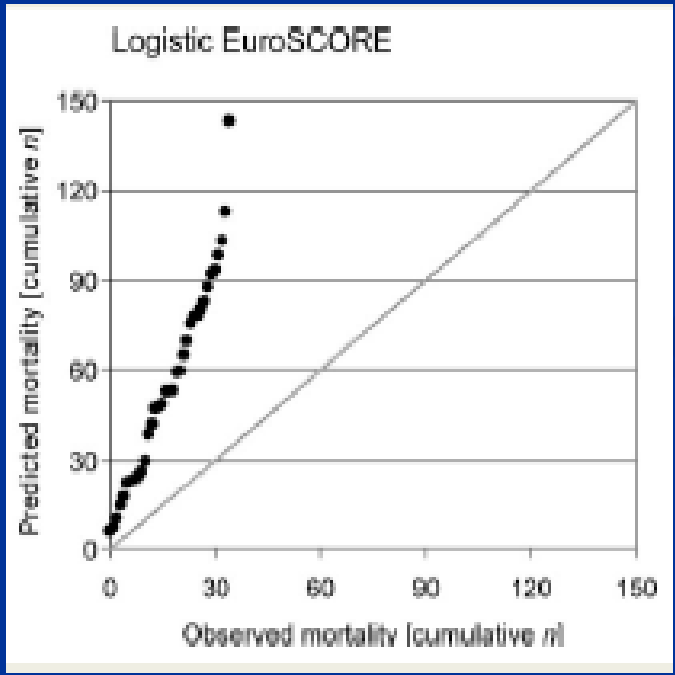
Calculate Clear

European Heart Journal (2009) 30, 74–80
doi:10.1093/eurheartj/ehn523

CLINICAL RESEARCH
Valvular and congenital heart disease

Overestimation of aortic valve replacement risk by EuroSCORE: implications for percutaneous valve replacement

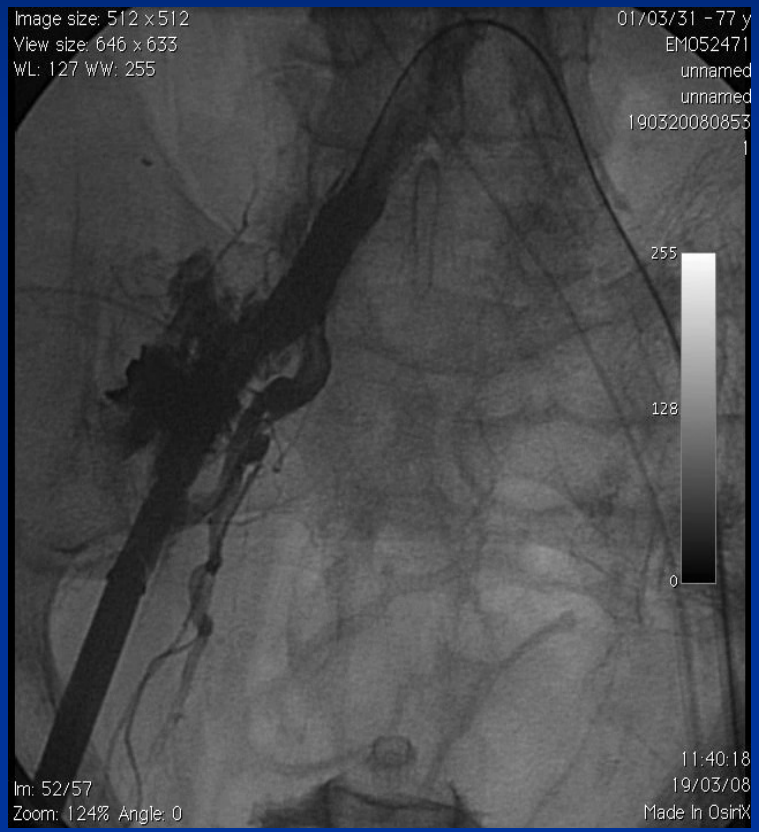
Brigitte R. Osswald[1]*, Vassil Gegouskov[2], Dominika Badowski-Zyla[2], Ursula Tochtermann[2], Gisela Thomas[2], Siegfried Hagl[2], and Eugene H. Blackstone[3,4]



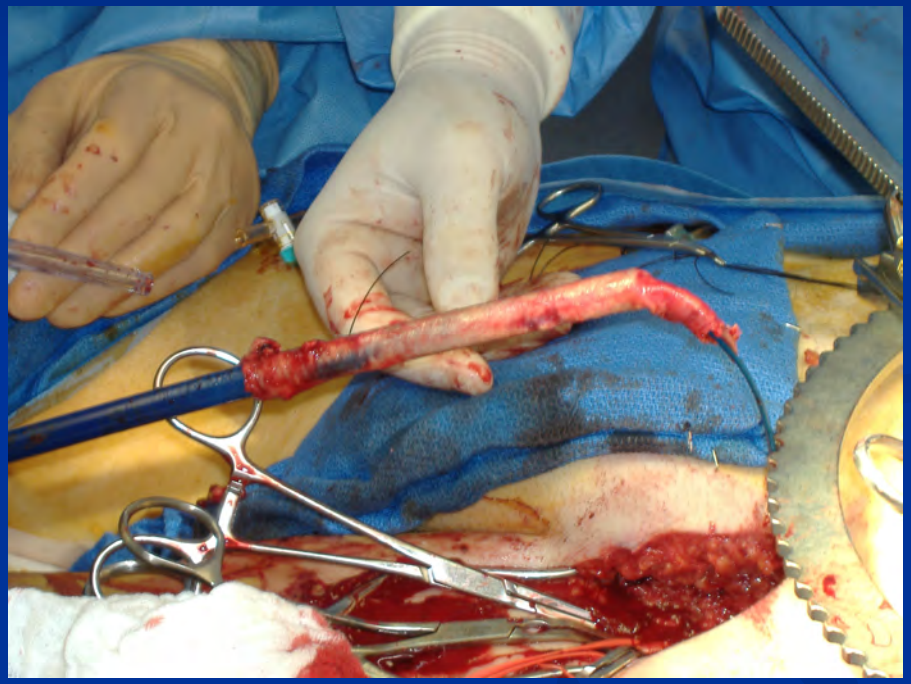
Difficult to quantify frailty?

- Both are 90 y/o and have EuroScore of 12%.
- One passes the “eyeball test”; one doesn’t.

A need for thorough screening process



Iliac rupture



"artery on a stick"

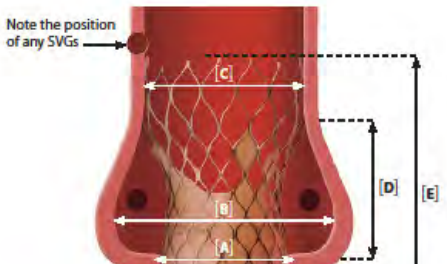
Medtronic CoreValve Patient Evaluation Criteria

Elements Below Reflect Indications For Use According To The CE Mark								
Diagnostic Findings	Non-Invasive		Angiography				Selection Criteria	
	Echo	CT/MRI	LV	Ao Root	CAG	Vascular	Recommended	Not Recommended
Atrial or Ventricular Thrombus	X						Not Present	Present
Sub Aortic Stenosis	X	X	X				Not Present	Present
LV Ejection Fraction	X		X				≥ 20%	< 20% Without Contractile Reserve
Mitral Regurgitation	X						≤ Grade 2	> Grade 2 Organic Reason
Vascular Access Diameter		X				X	≥ 6mm Diameter	< 6mm Diameter
Aortic and Vascular Disease		X				X	None to Moderate	Severe Vascular Disease
Indications For 26 mm CoreValve Device								
Annulus Diameter	X	X					20-23 mm	< 20 mm or >23 mm
Ascending Aorta Diameter		X		X			≤ 40 mm	> 40 mm
Indications For 29 mm CoreValve Device								
Annulus Diameter	X	X					24-27 mm	< 24 mm or >27 mm
Ascending Aorta Diameter		X		X			≤ 43 mm	> 43 mm

General Medical Guidance For Use Of CoreValve*								
Diagnostic Findings	Non-Invasive		Angiography				Selection Criteria	
	Echo	CT/MRI	LV	Ao Root	CAG	Vascular	Recommended	Moderate-High Risk
LV Hypertrophy	X	X					Normal to Moderate 0.6 - 1.6 cm	Severe ≥ 1.7 cm
Coronary Artery Disease		X			X		None, Mid or Distal >70%	Proximal Lesions > 70%
Aortic Arch Angulation		X				X	Large Radial Turn	Sharp Turn
Aortic Root Angulation		X				X	< 30 Degrees	30 - 45 Degrees
Aortic and Vascular Disease		X				X	No or Light Vascular Disease	Moderate Vascular Disease
Vascular Access Diameter		X				X	> 6 mm	Calcified and Tortuous < 7mm
Anatomic Considerations For 26 mm CoreValve Device								
Sinus of Valsalva Width	X	X		X			≥ 27 mm	< 27 mm
Sinus of Valsalva Height	X	X		X			≥ 15 mm	< 15 mm
Anatomic Considerations For 29 mm CoreValve Device								
Sinus of Valsalva Width	X	X		X			≥ 29 mm	< 29 mm
Sinus of Valsalva Height	X	X		X			≥ 15 mm	< 15 mm

* General medical guidance reflects the experience to date with the product, but final judgment remains with the implanting physician(s).

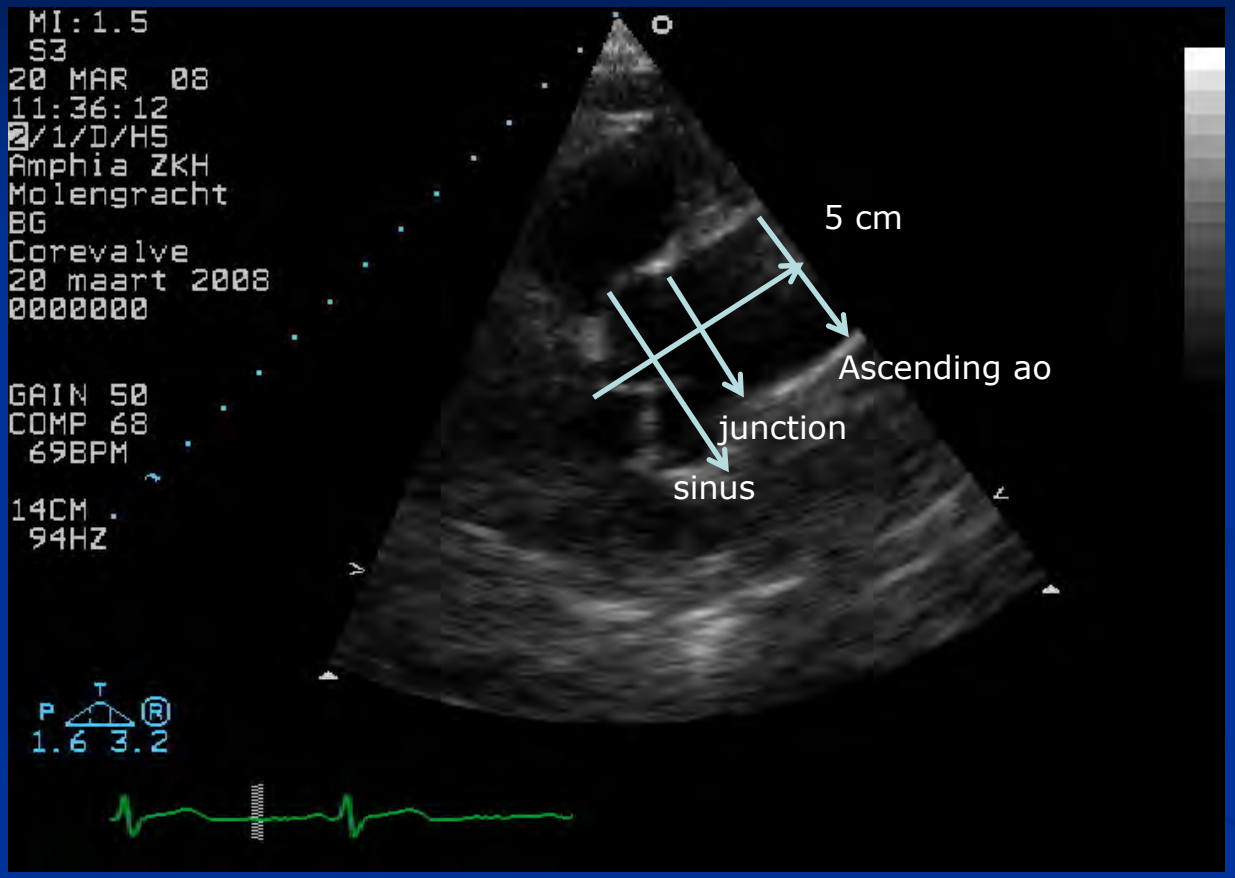
Consult with a certified proctor to determine if your patient is Moderate-High Risk.



[A] Annulus Diameter
[B] Sinus of Valsalva Width
[C] Ascending Aorta Diameter
[D] Sinus of Valsalva Height
[E] Frame Height (≈ 5 cm)

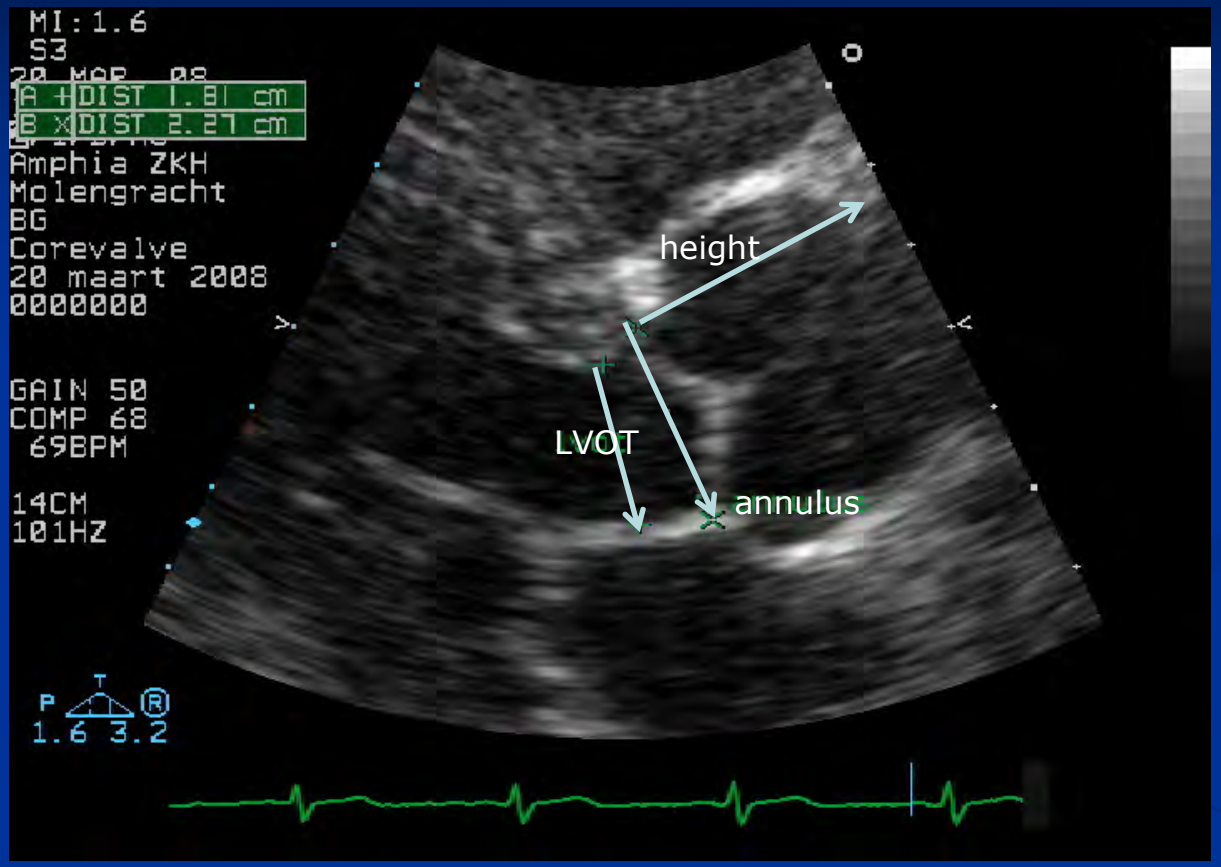
illustration not to scale.

Echo: Parasternal Long Axis



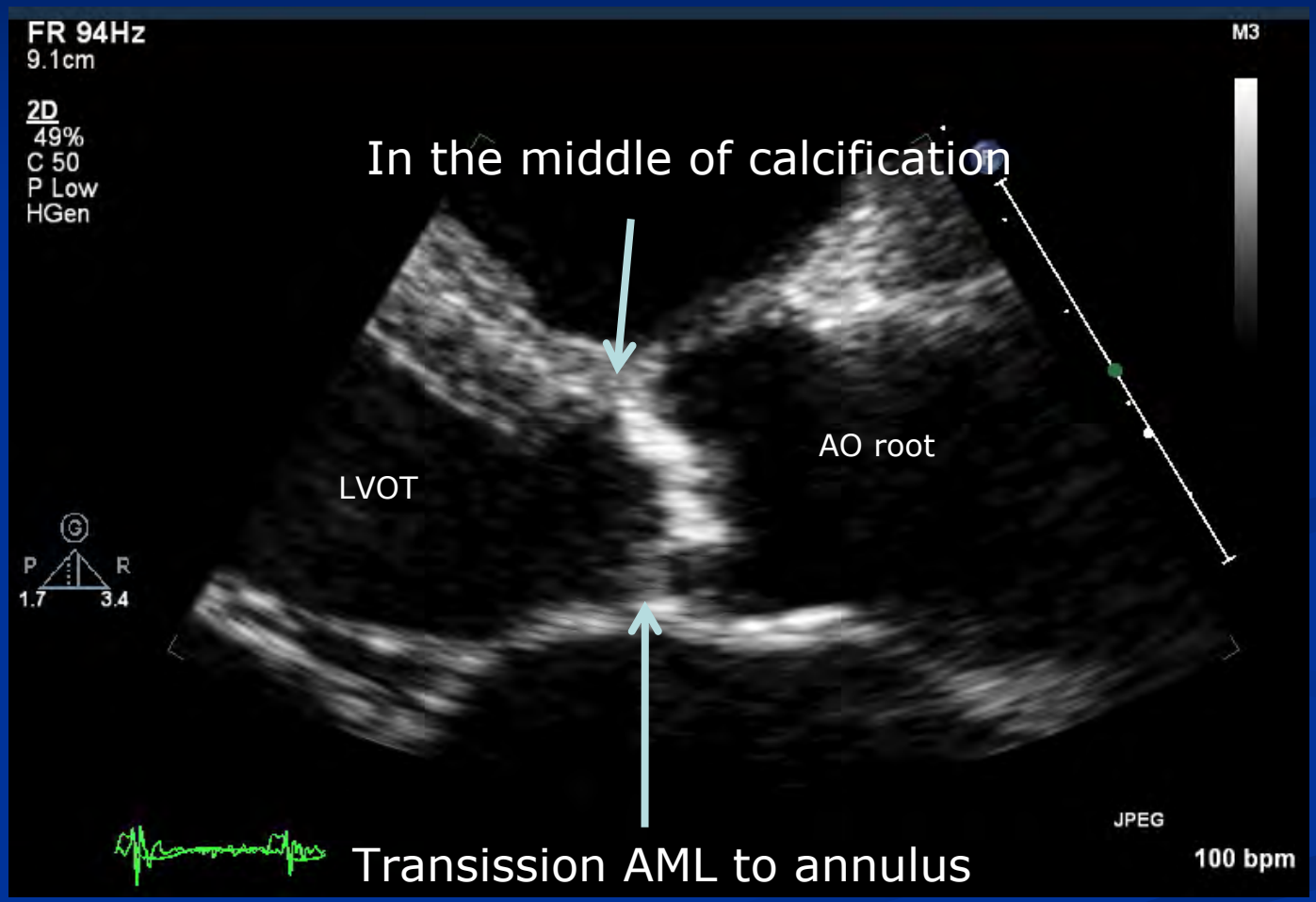
Aorta root measurements

Echo: Parasternal Long Axis

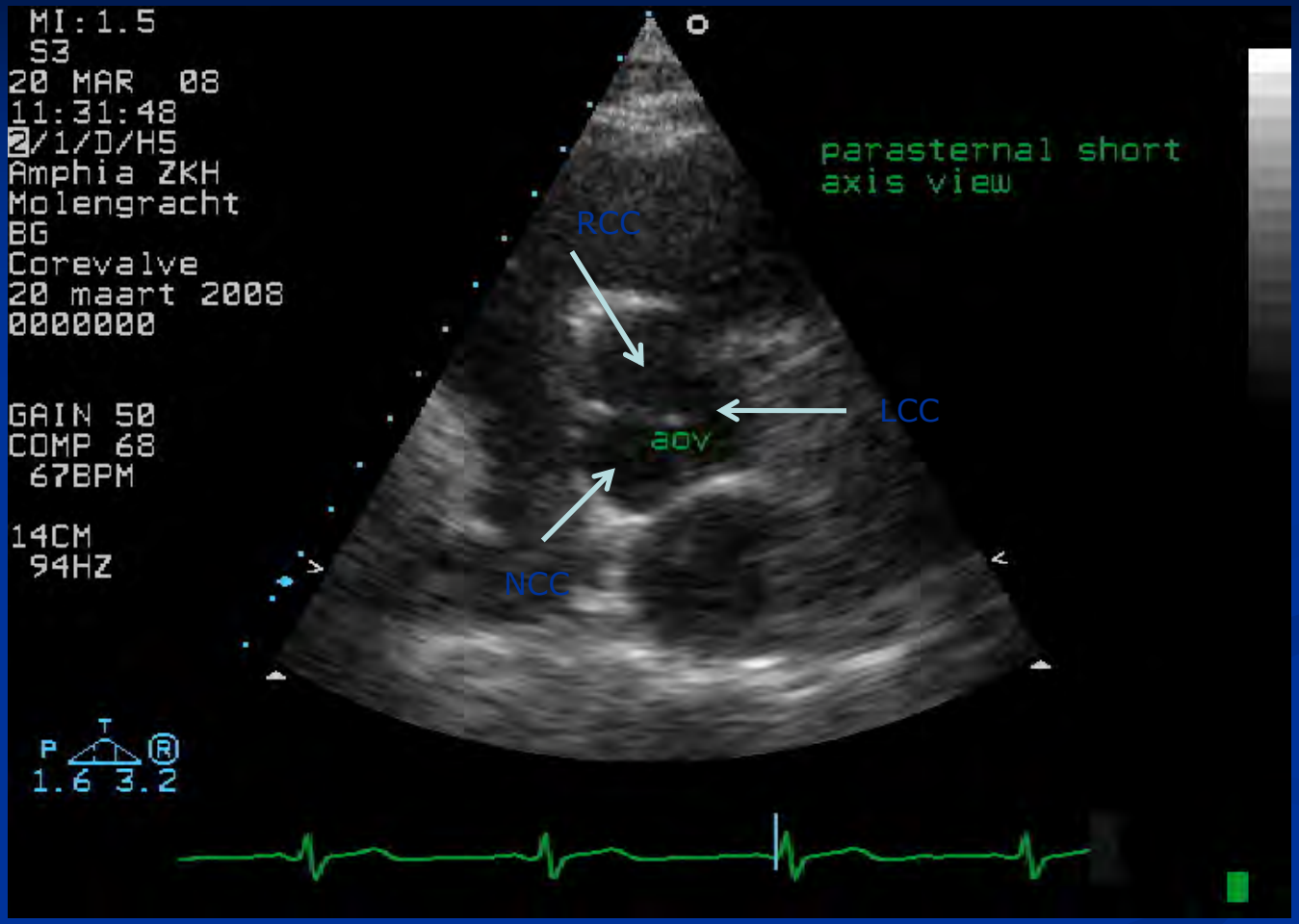


Annulus – LVOT measurement

Echo- annulus measurements

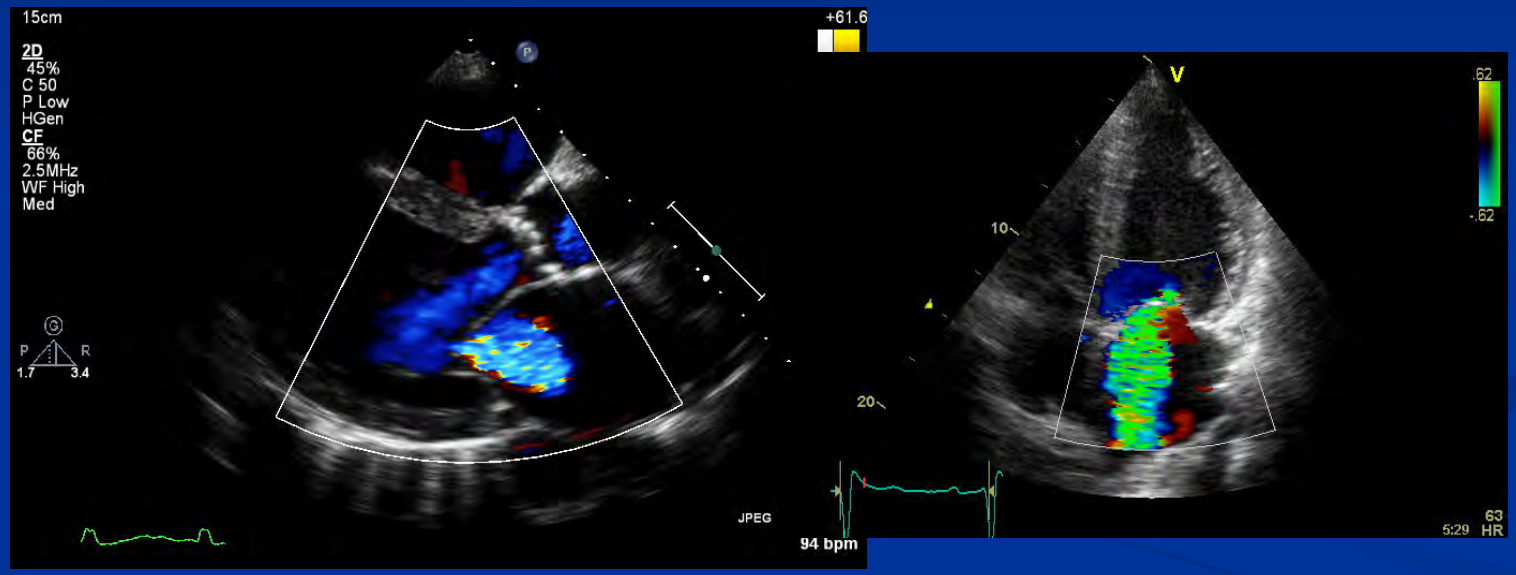


Echo: Parasternal Short Axis



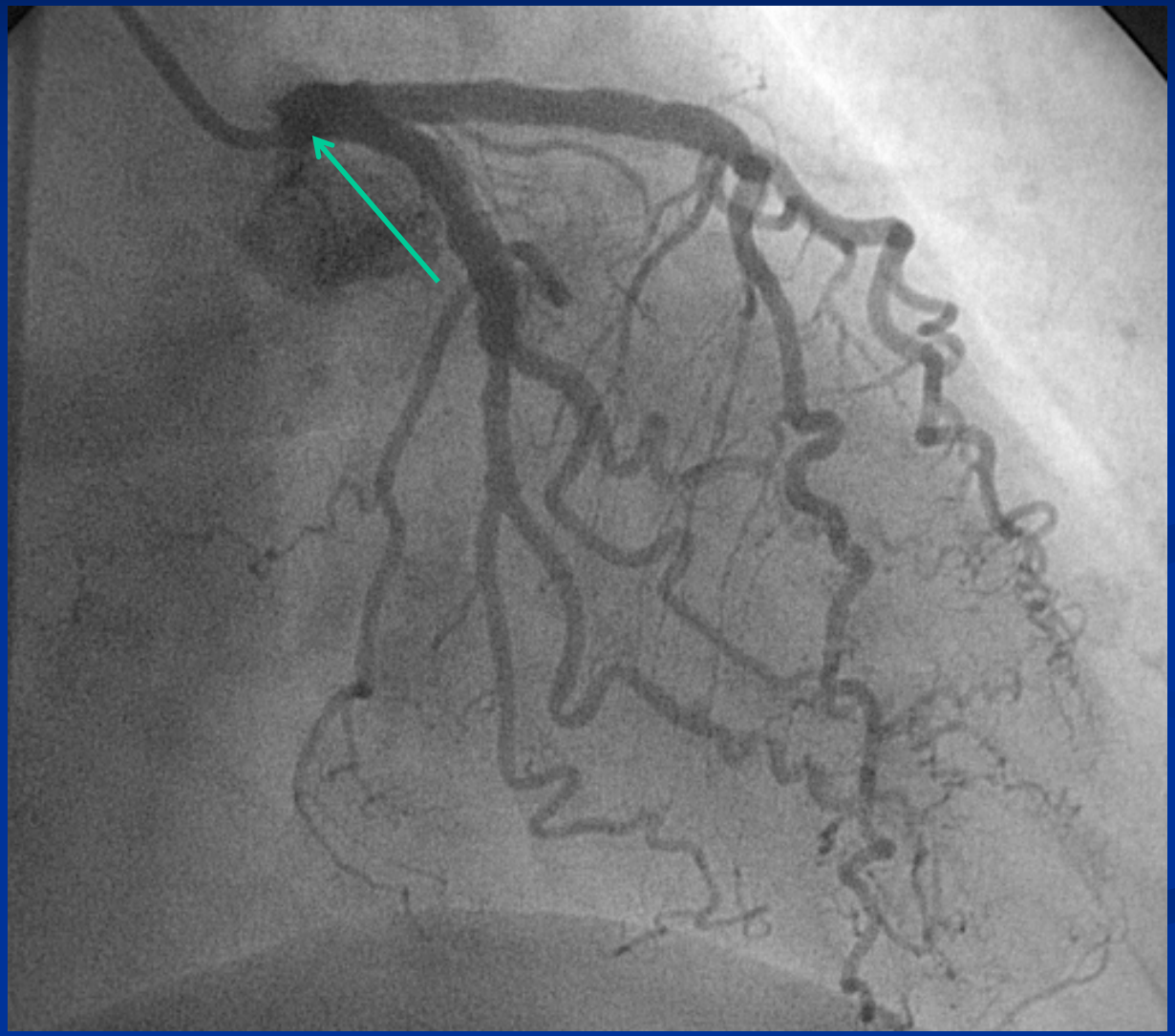
Tricuspid aortic-valve

Parasternal Long Axis View

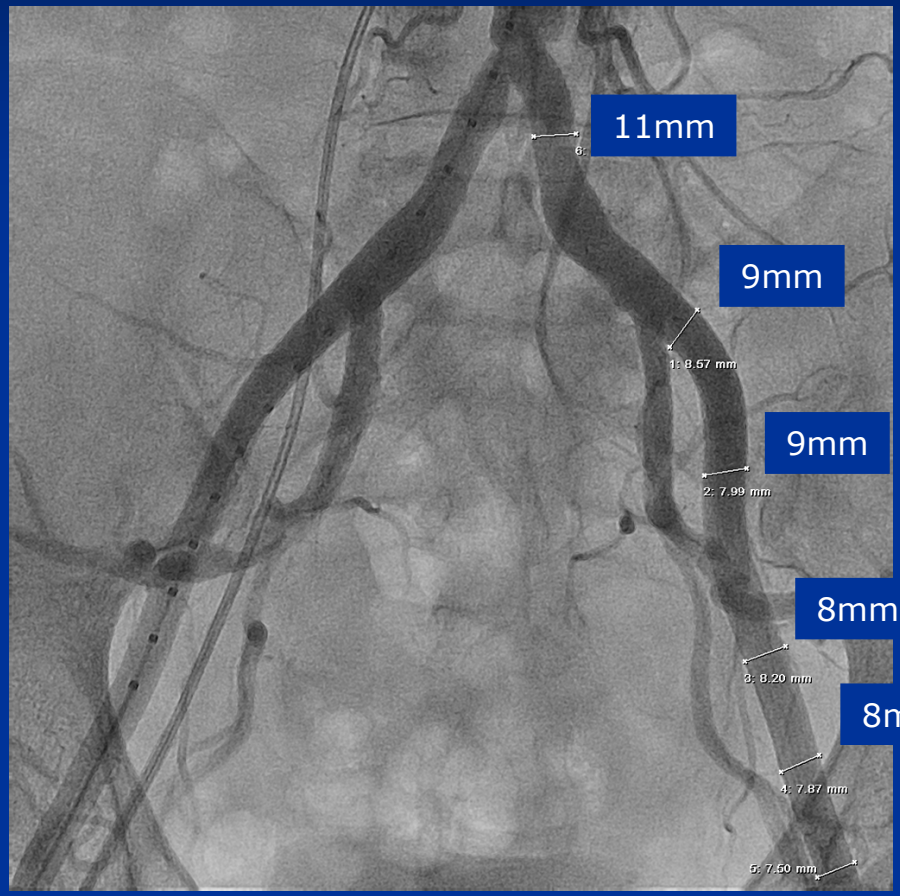


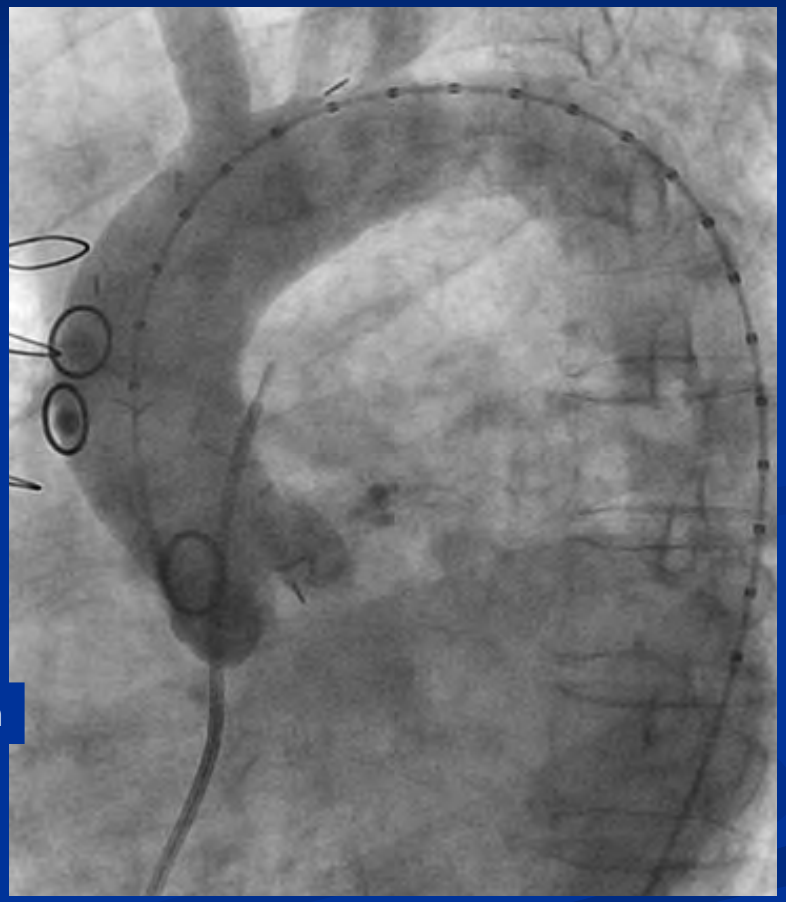
mitral regurgitation

Coronary & bypass vessels angio



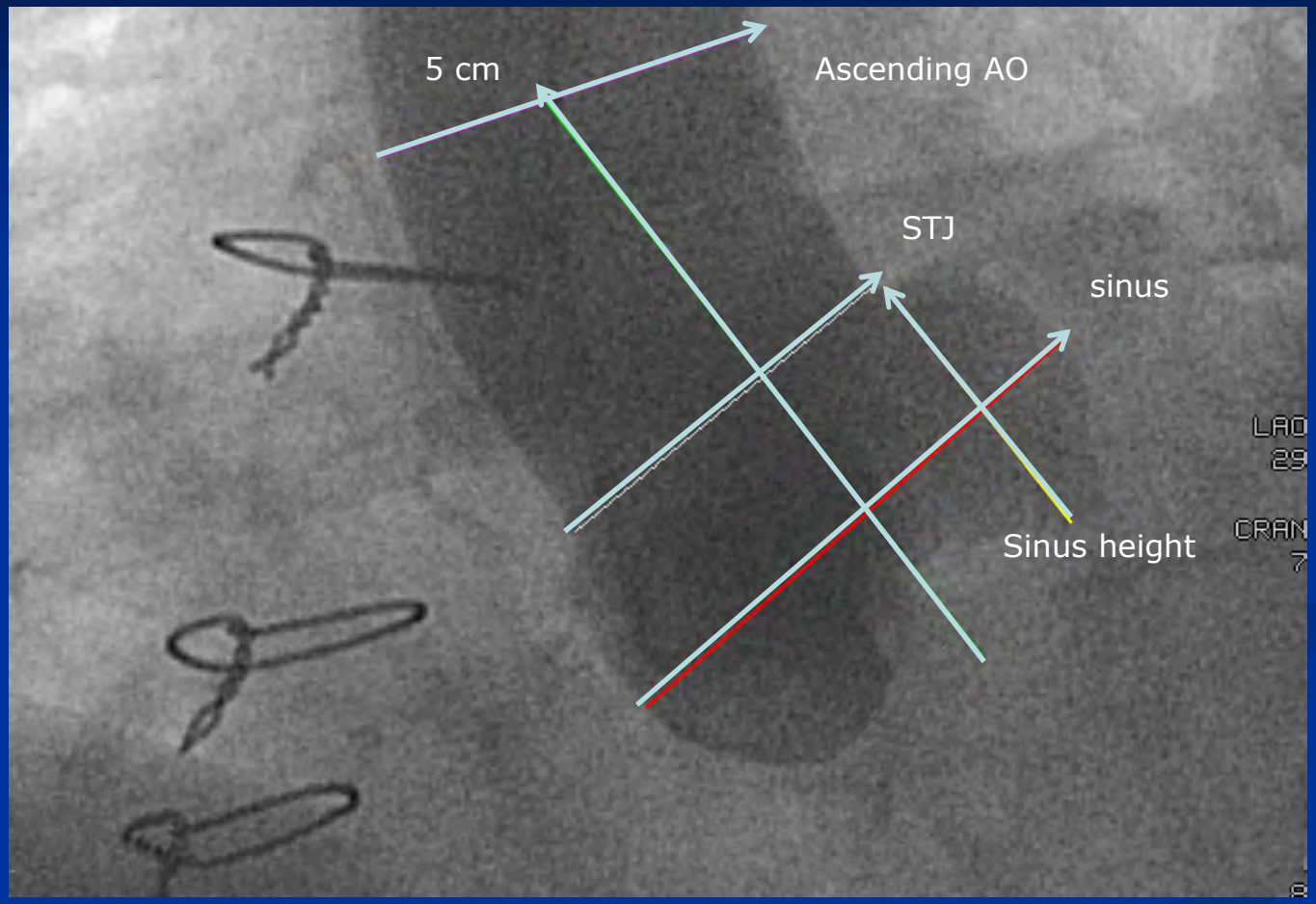
Aorta and Peripheral Angiography



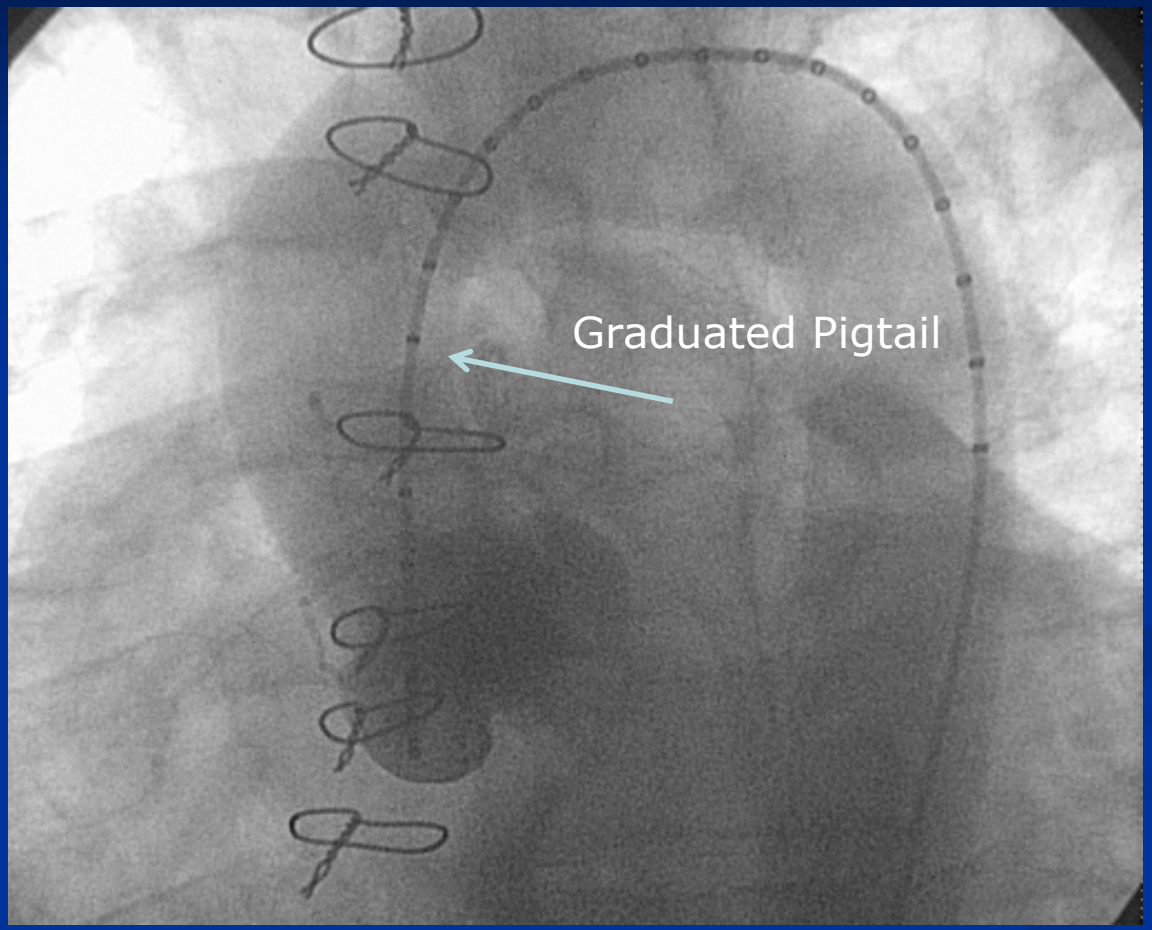


- Iliacs > 8mm bilaterally
- Annular and arch examined

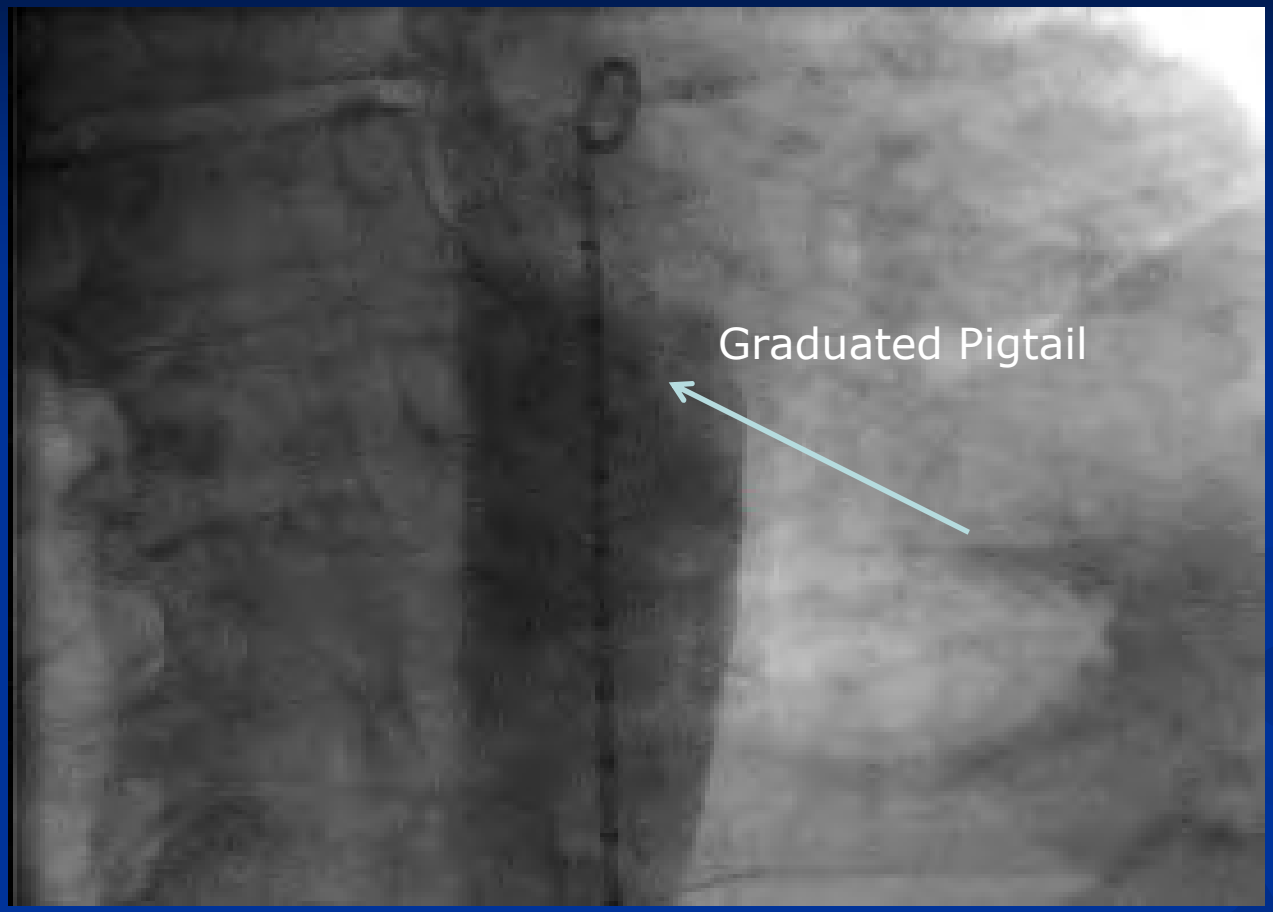
Angio: Aortic Root



Angio: Aortic Arch

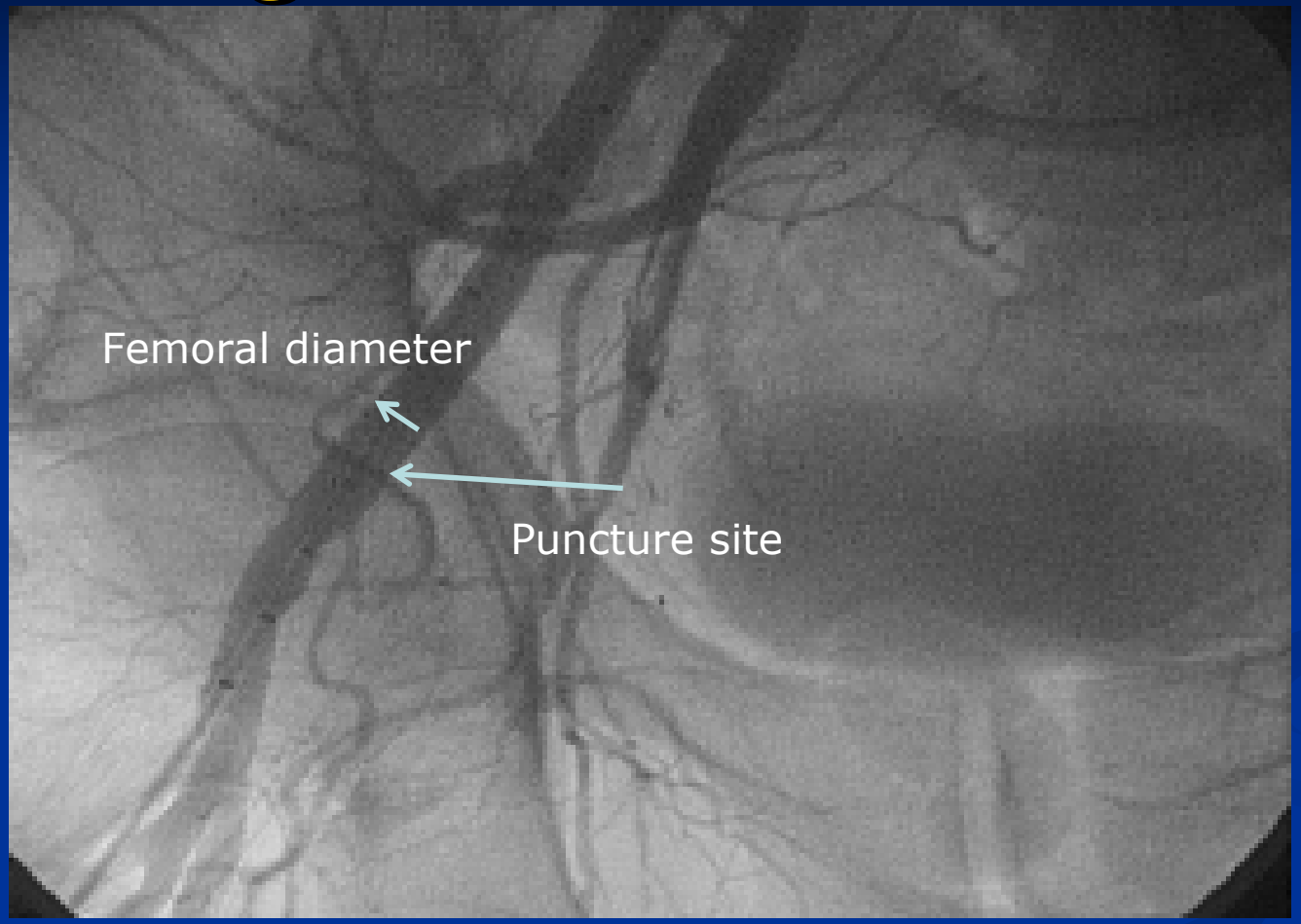


Angio: Abdominal Aorta

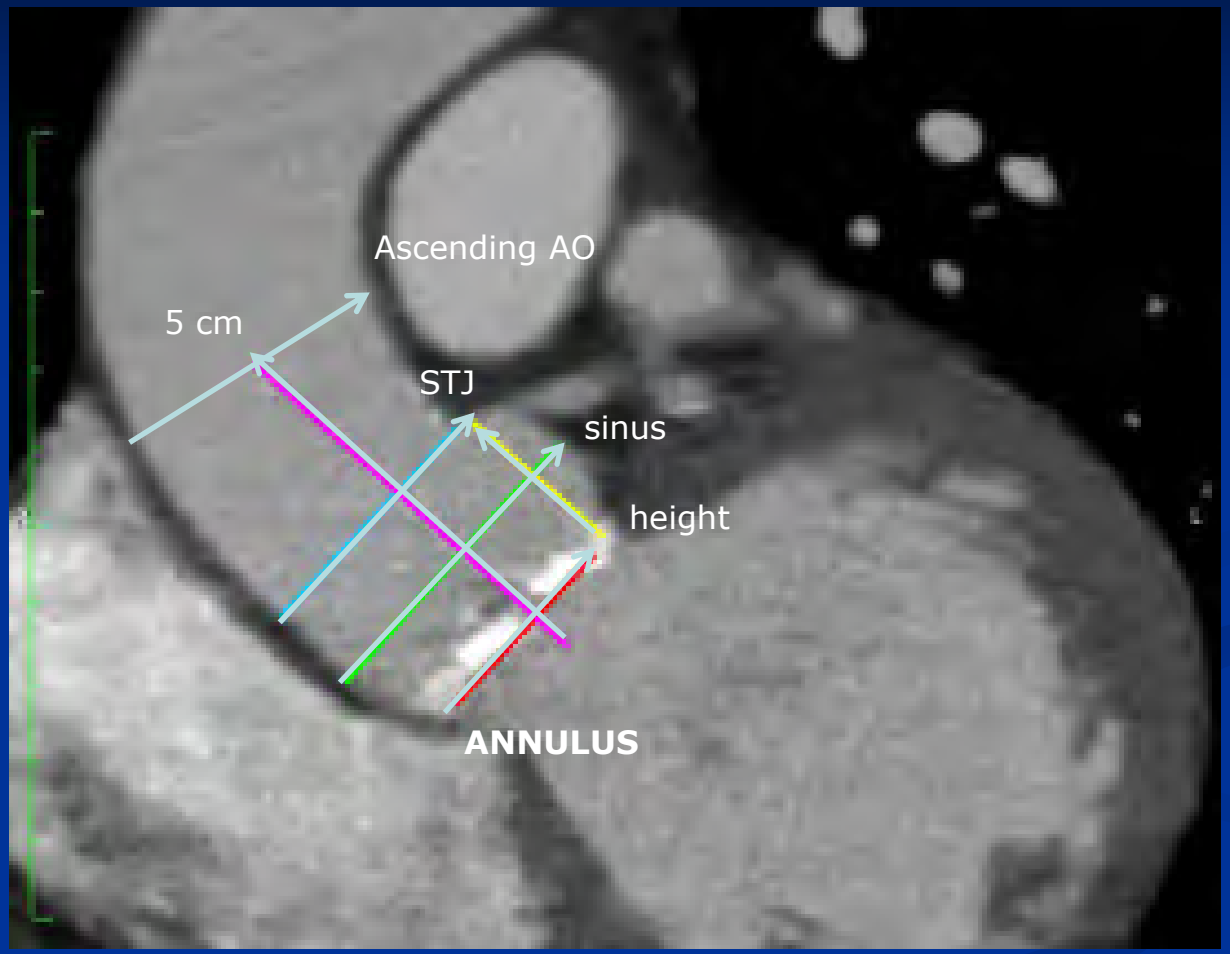


Angio: iliacs bifurcation

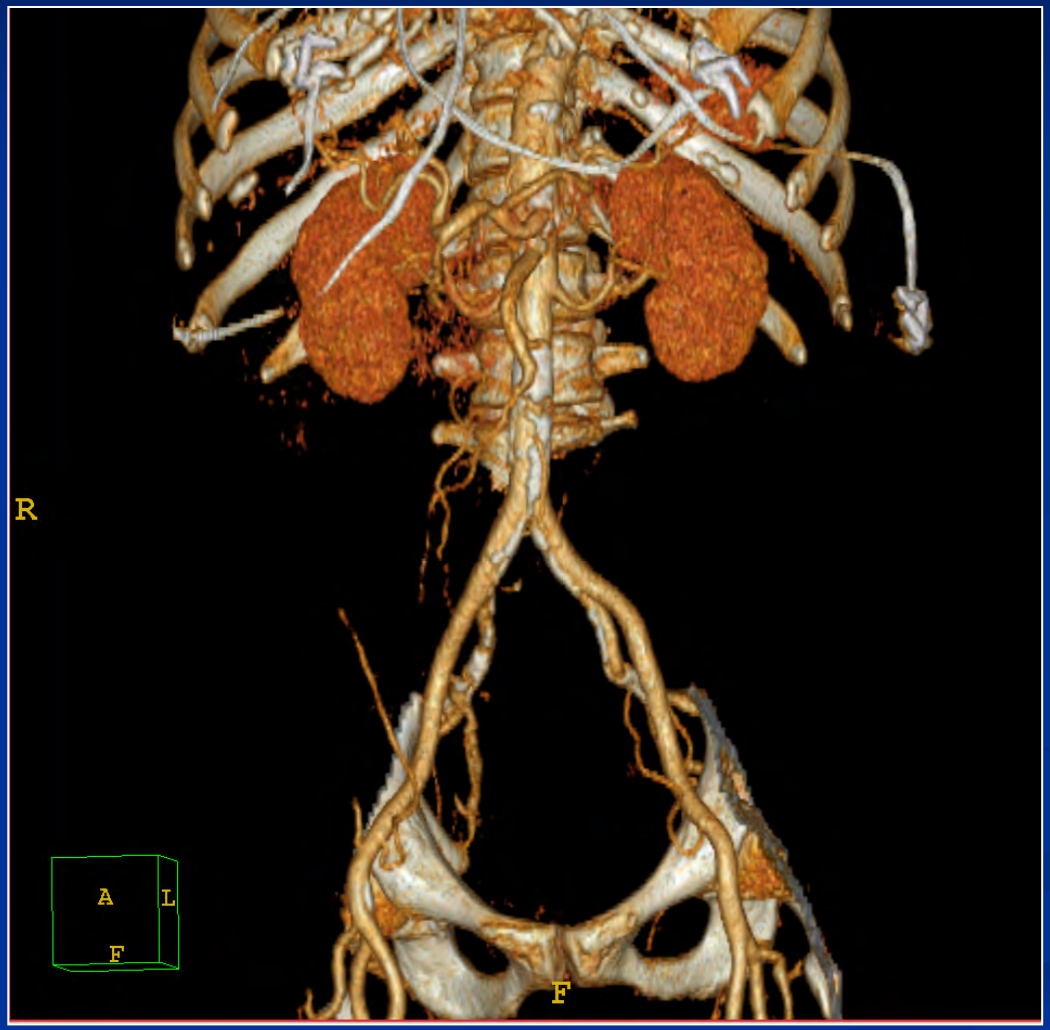
Angio: femoral arteries



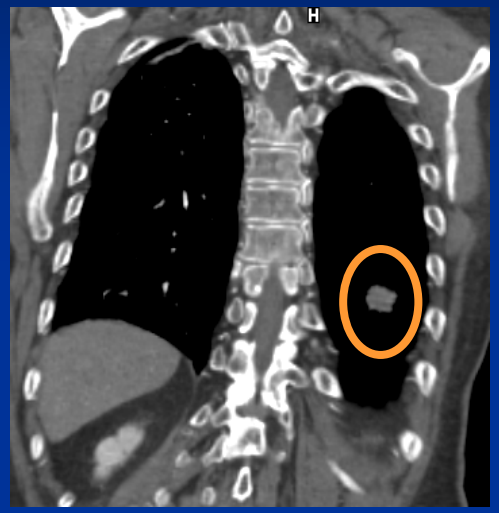
CT angio: aortic root

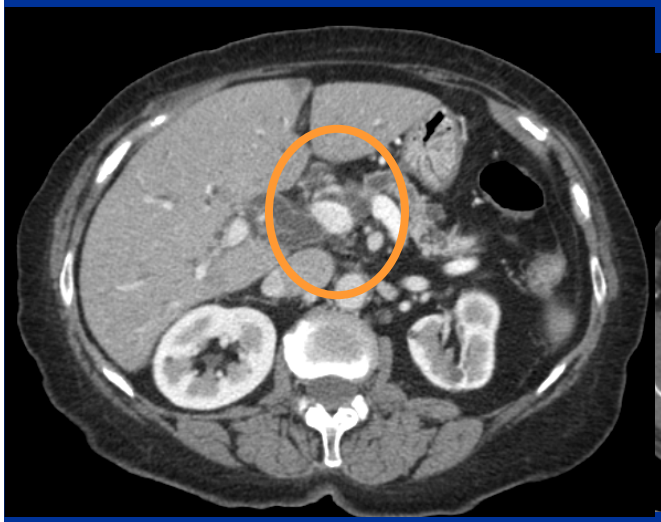


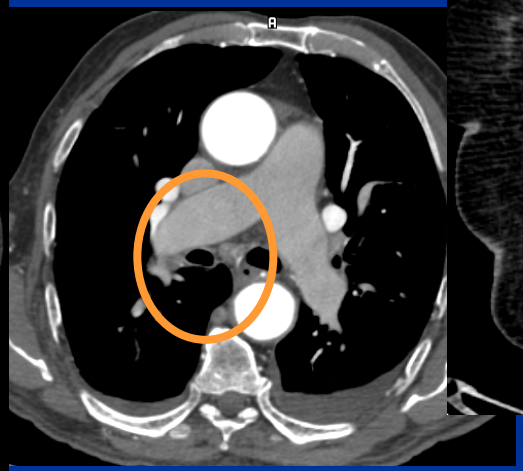
CT angio

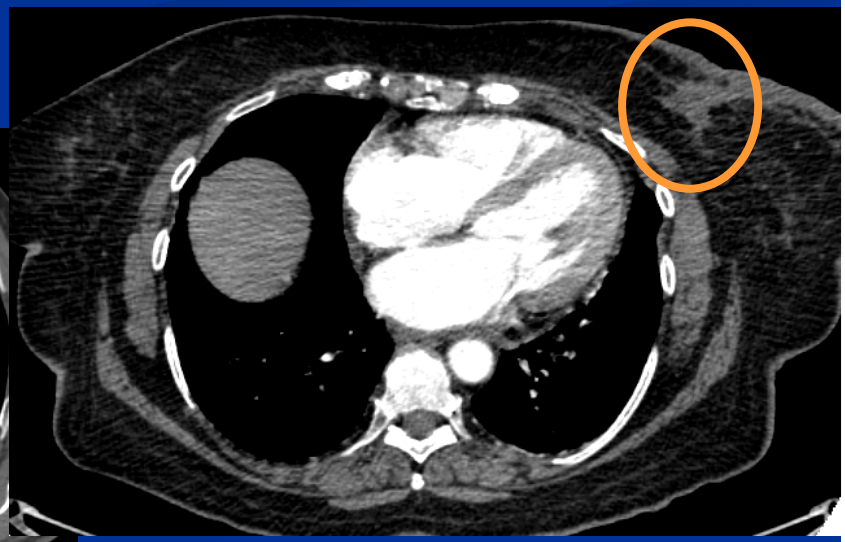


Extracardiac findings per CT







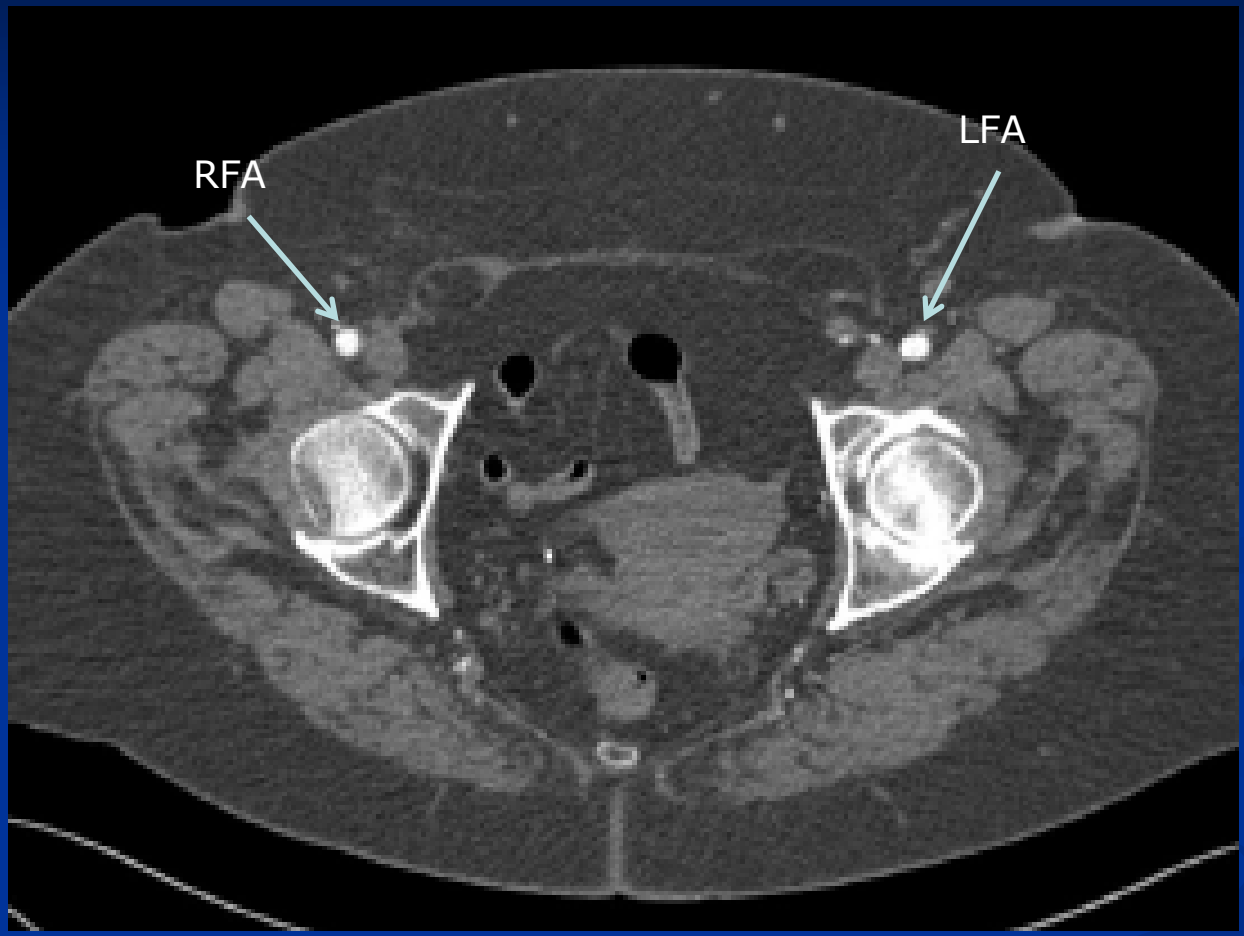


CT angio

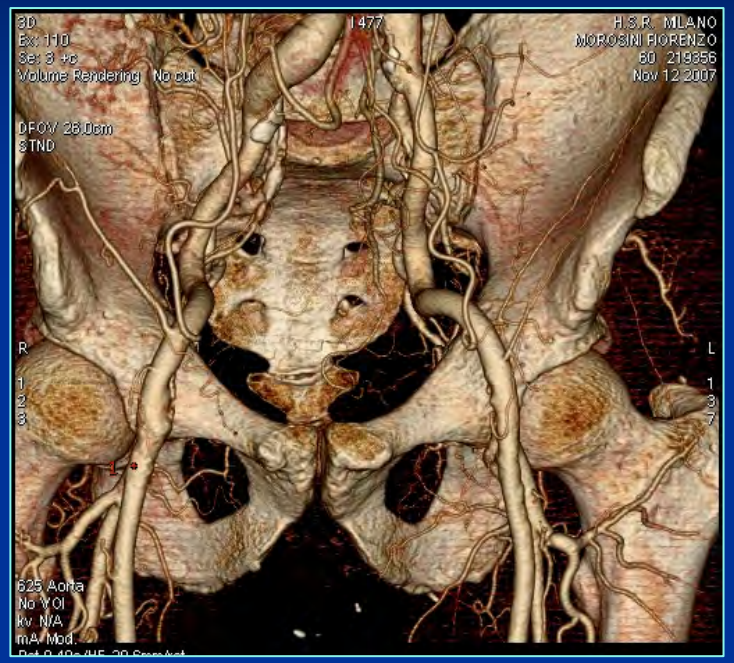
Peripheral arteries are large enough:
Rt & Lt common iliac ~ 1.0cm.

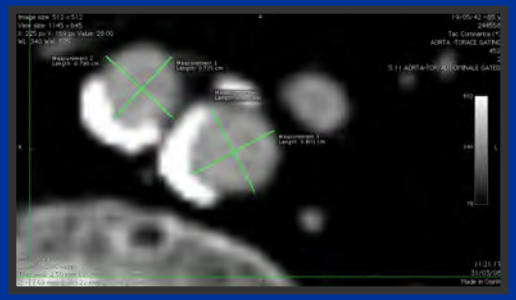
CT angio

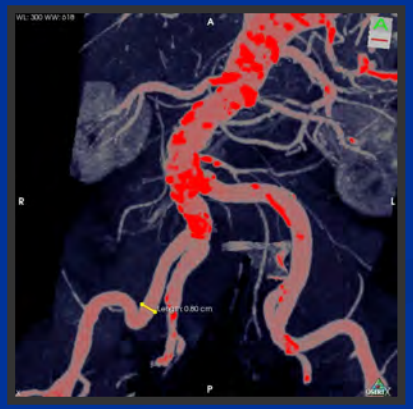
CT angio

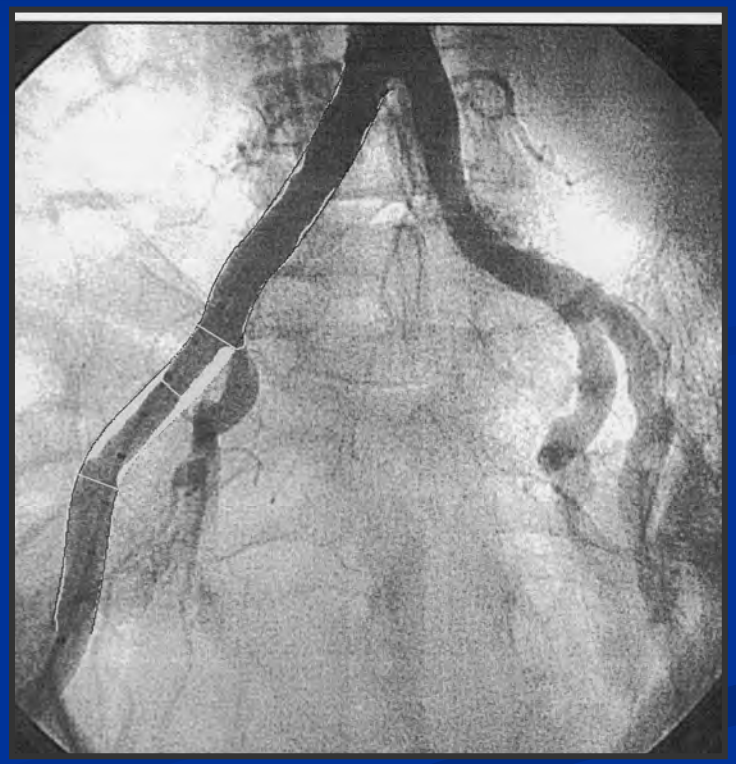


CT angio

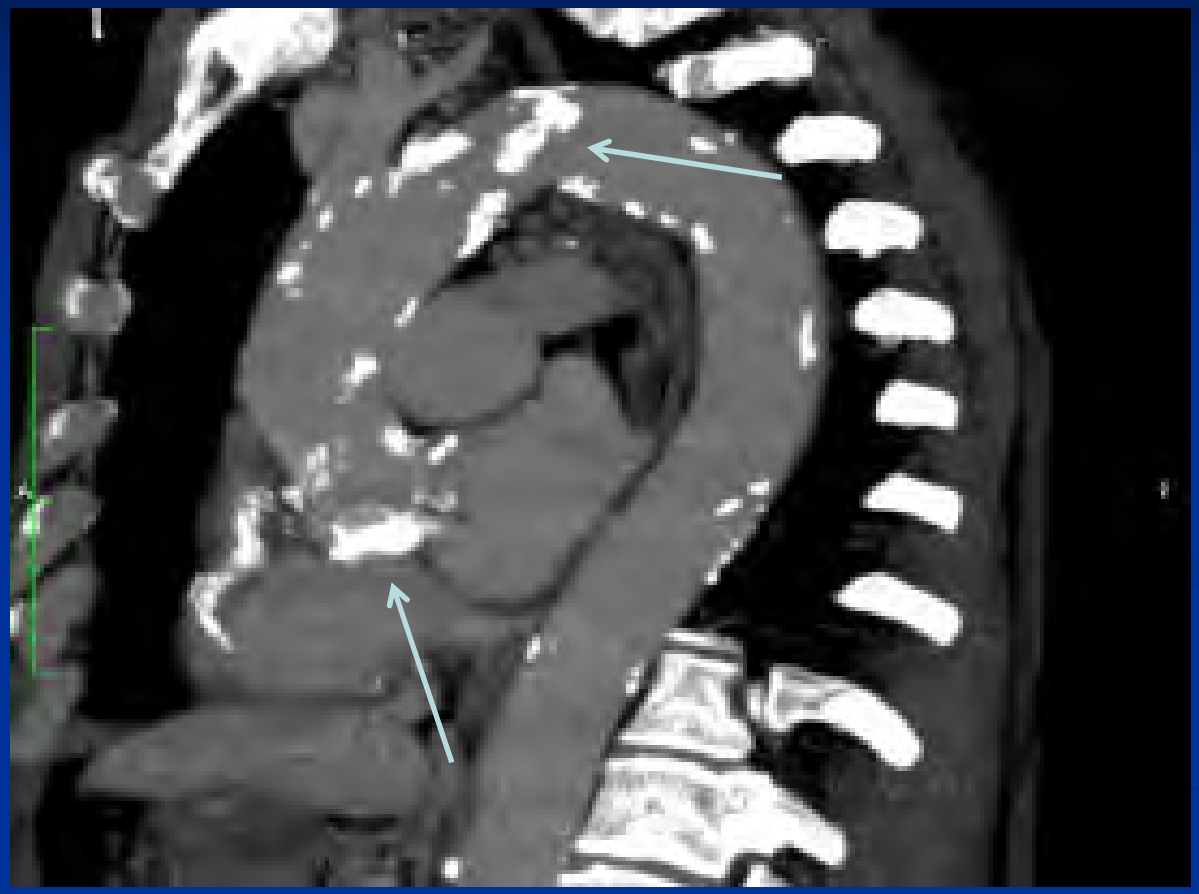

3D
Ex: 110
Se: 3 +c
Volume Rendering No cut
1477
H.S.R. MILANO
MOROSINI FIORENZO
80 219356
Nov 12 2007
DFOV: 28.0cm
STND
R
L
625 Aorta
No VOI
kv N/A
mA Mod.



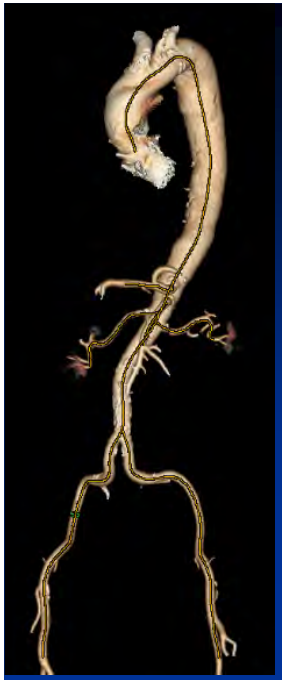




CT- evaluation of calcification

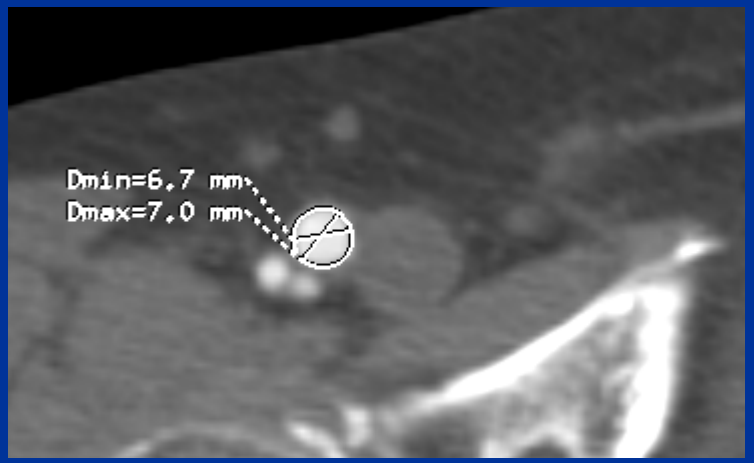


Calcifications are clearly visible

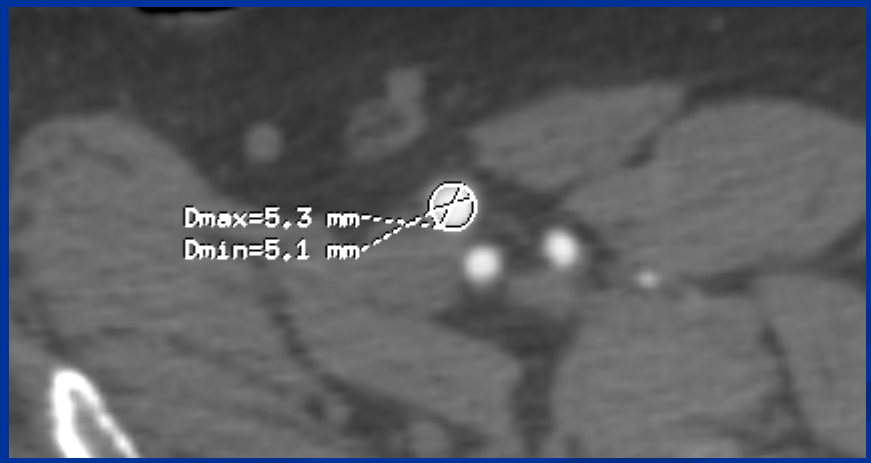


Rejection d/t Narrow Peripheral Vessels

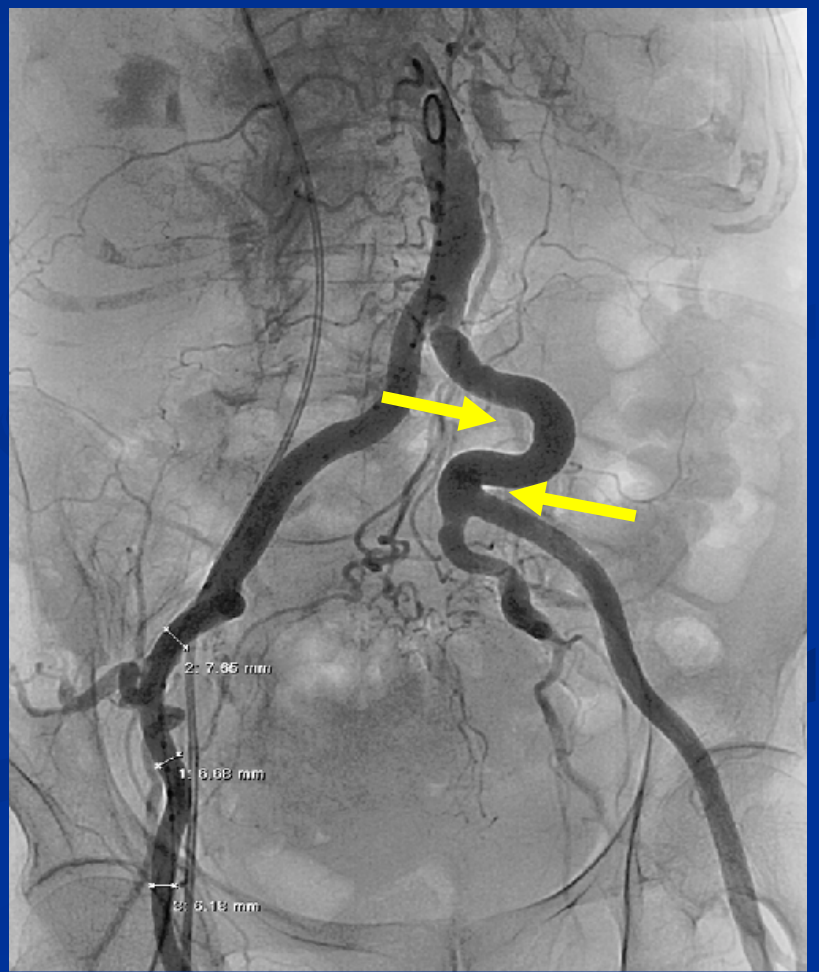
Rt ext iliac



Lt ext iliac

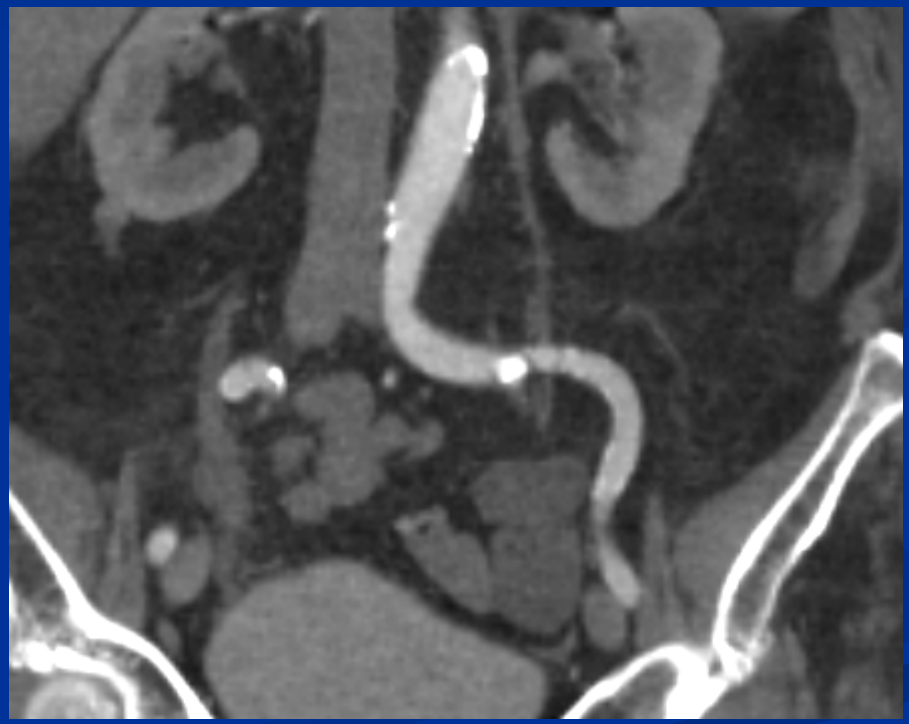


Rejection d/t
Severe Peripheral Vessel Tortuosity

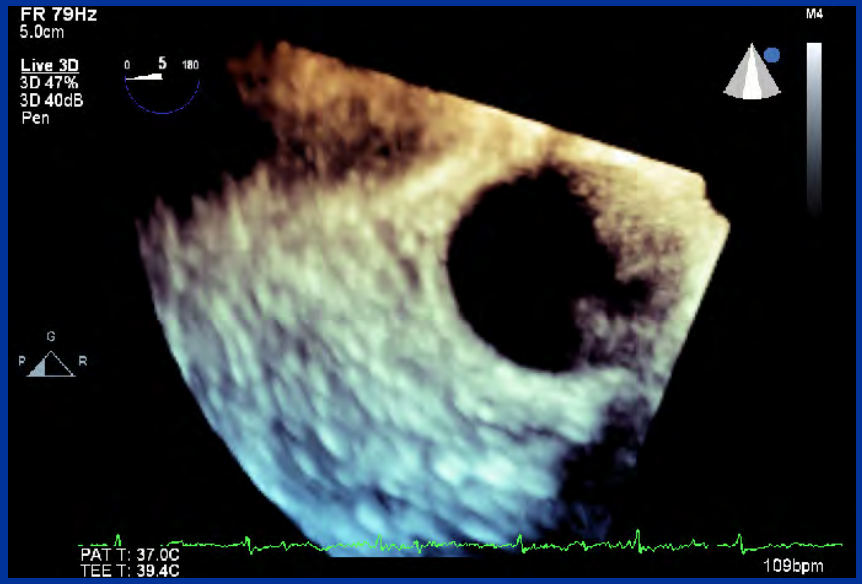


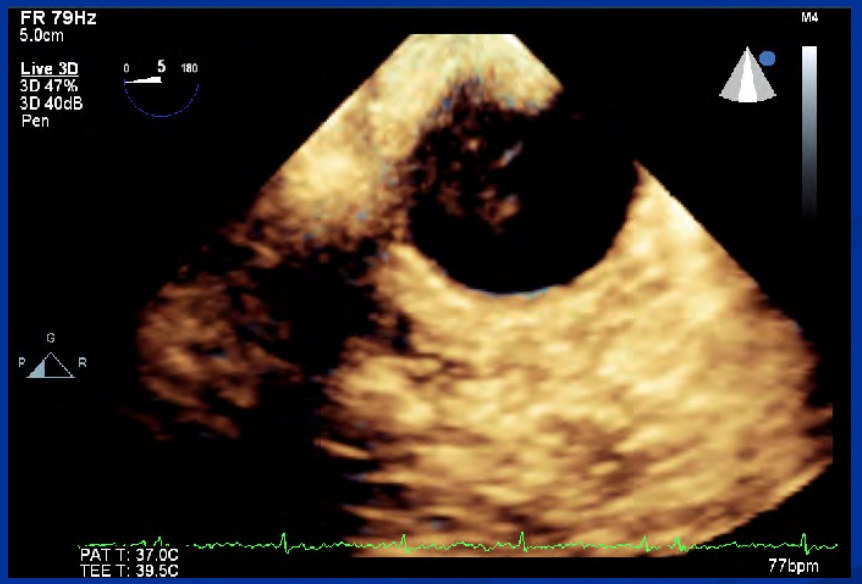
Rejection d/t
Severe Peripheral Vessel Tortuosity

Tortuosity & Calcification
Worst!

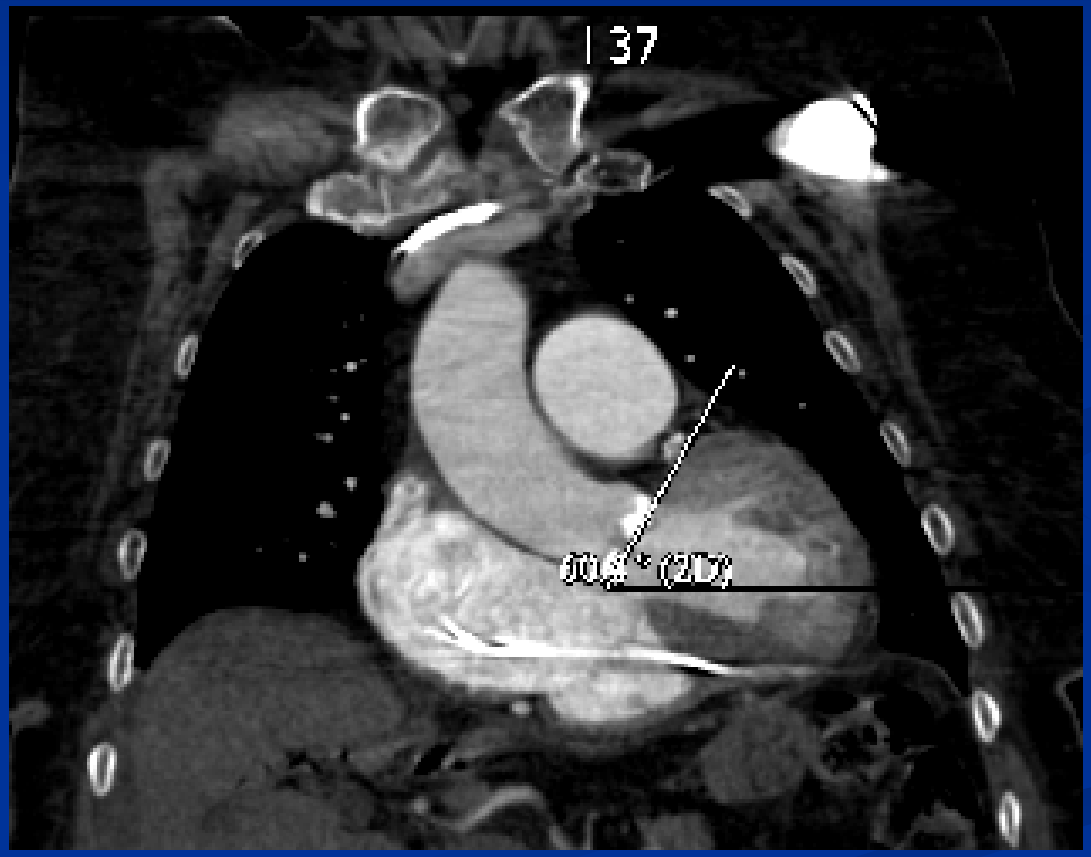


Protruding Aortic Atheroma

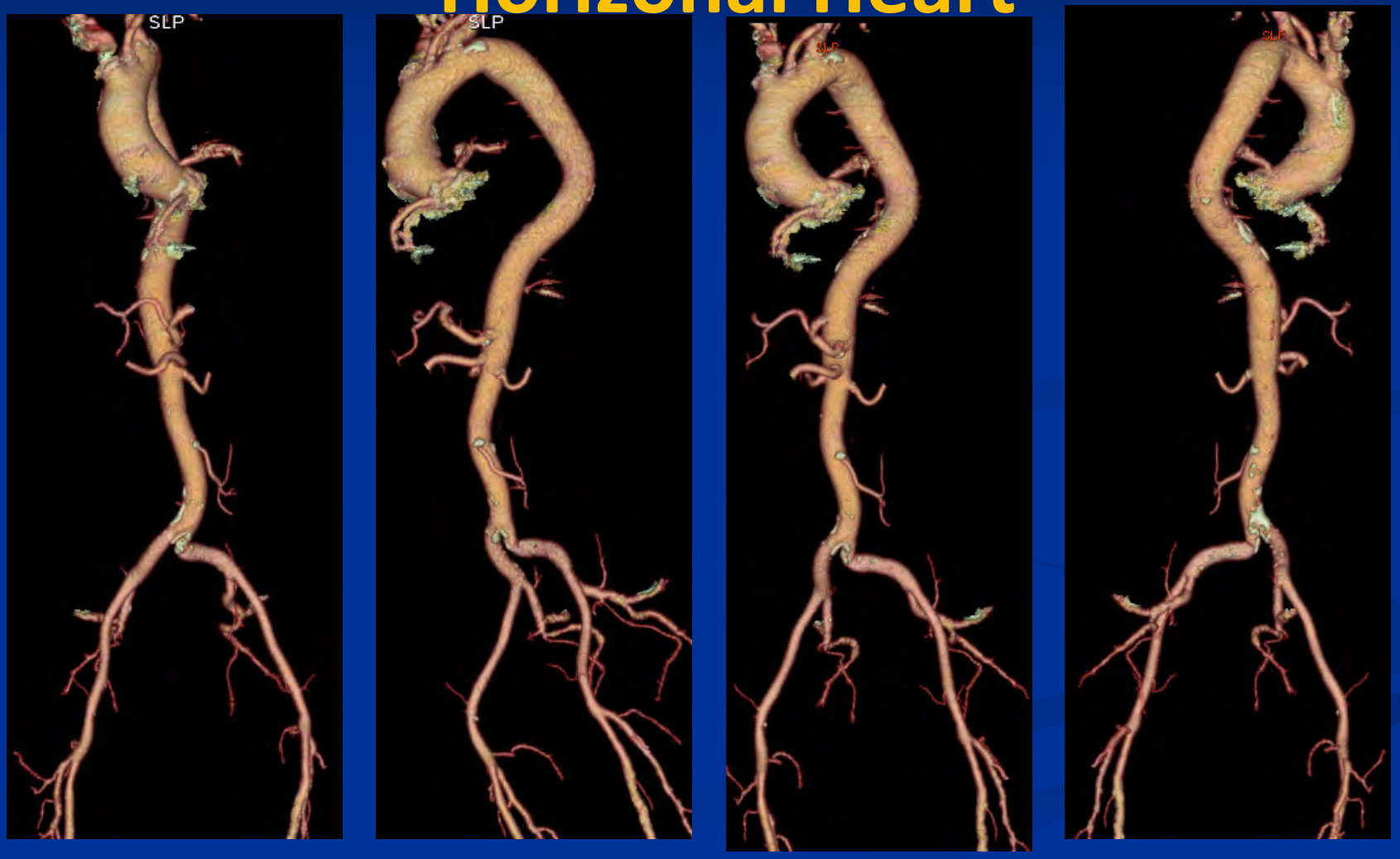


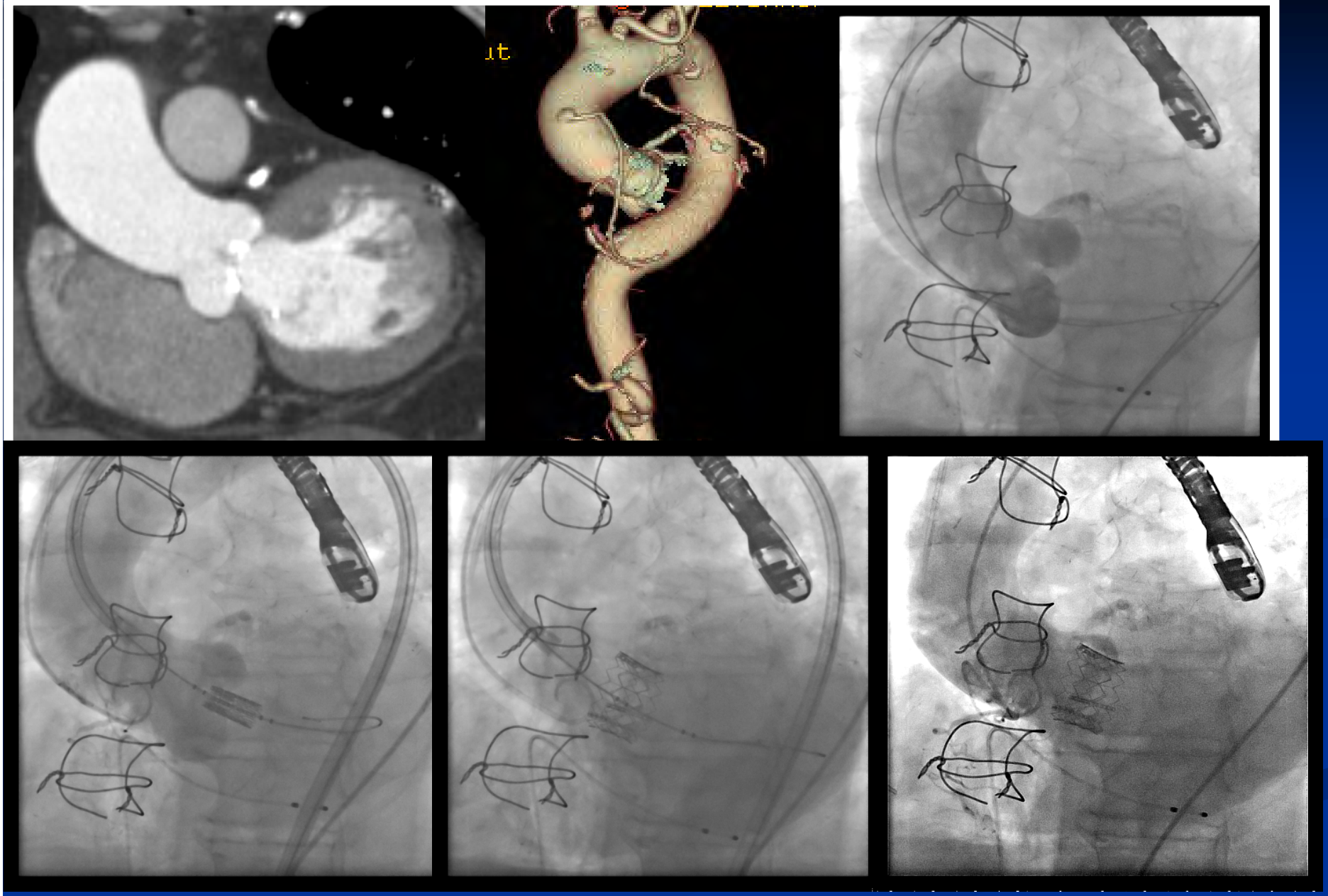


High angulation between Aorta & Aortic-Valve "Horizonal Heart"



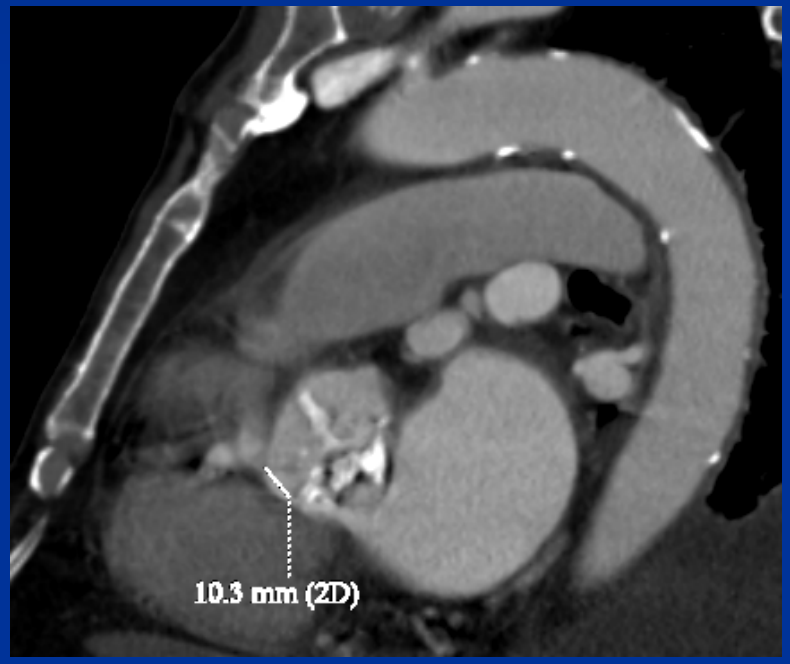
High angulation between Aorta & Aortic-Valve "Horizonal Heart"

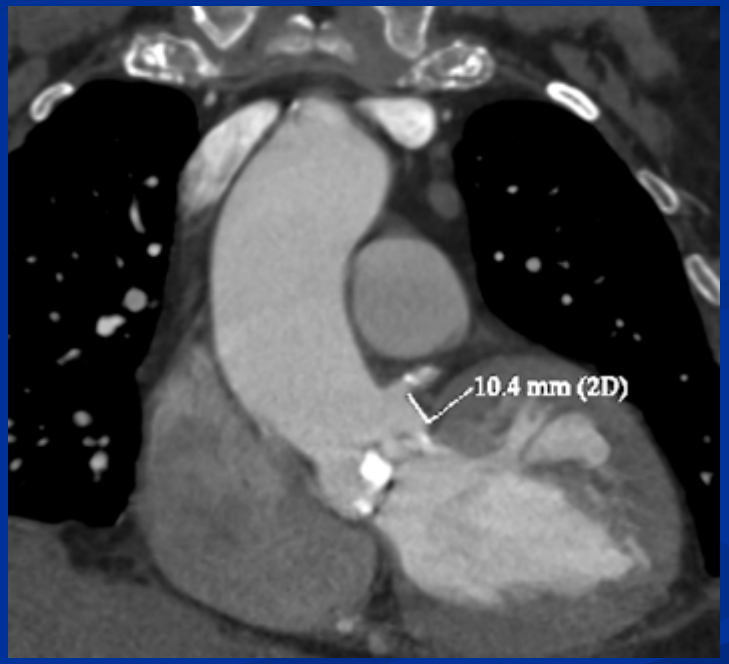




Dvir D et al. Catheter Cardiovasc Interv 2009

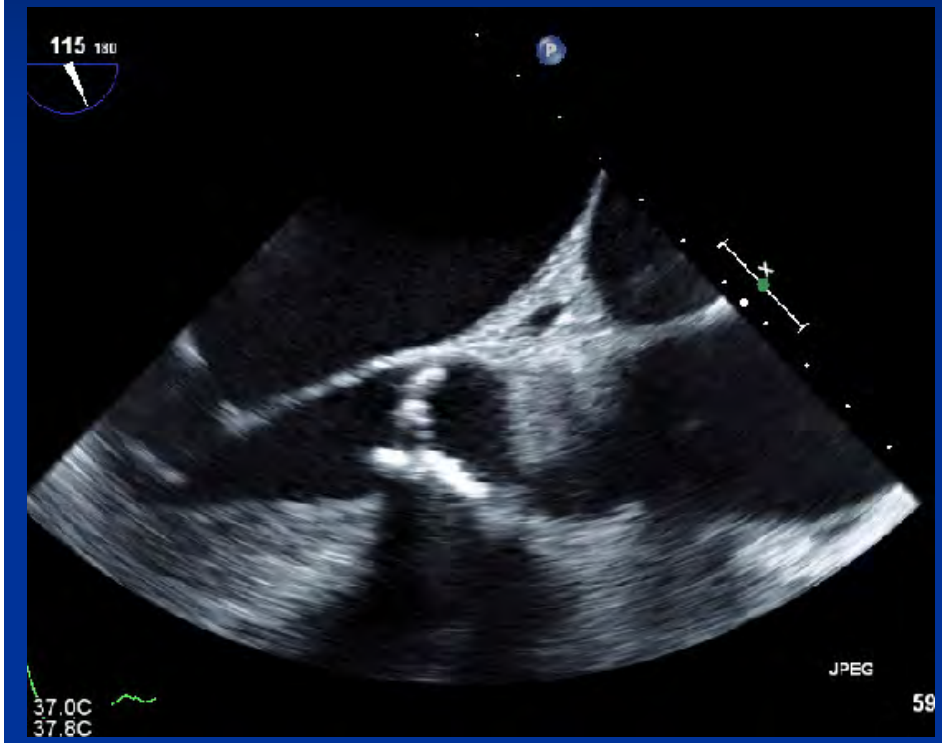
Evaulating the distance between Aortic-Valve and Coronary Ostia

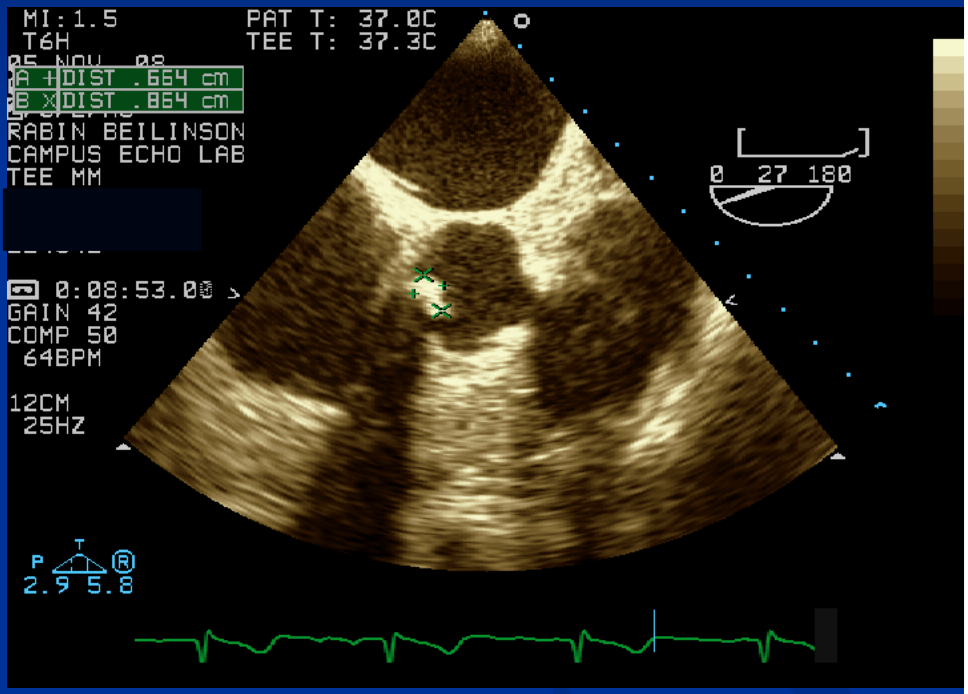




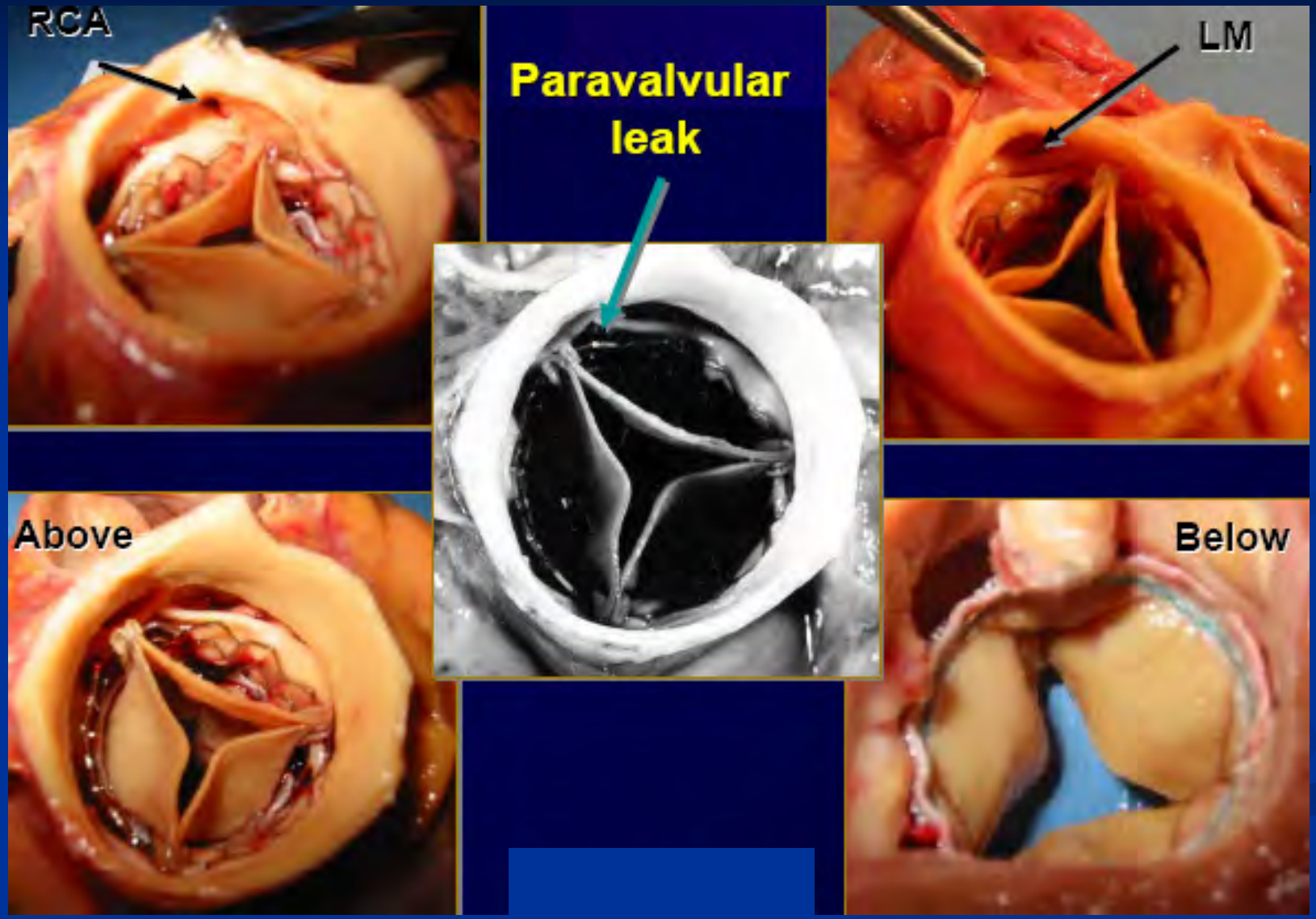
Blocking The Coronary Ostia

Rejection d/t
Calcified Tissue near Coronary Ostia

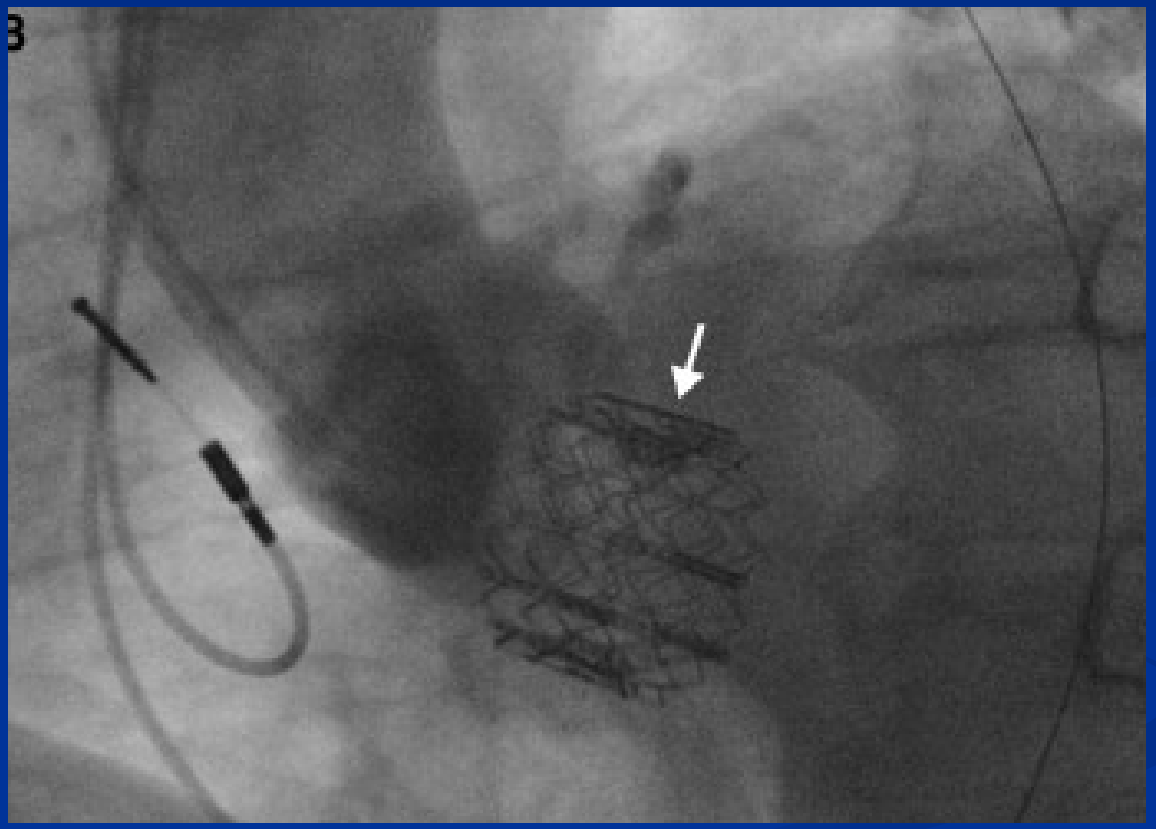




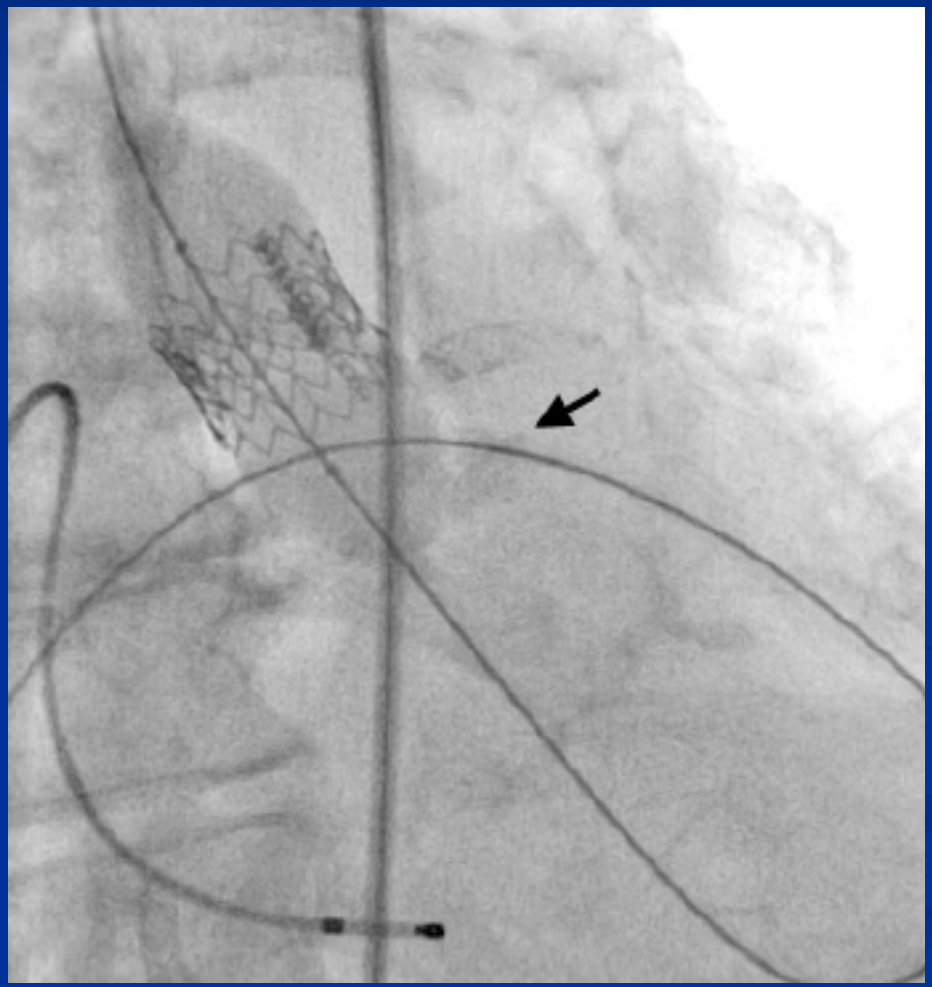
Paravalvular Leak



Failed Implantation

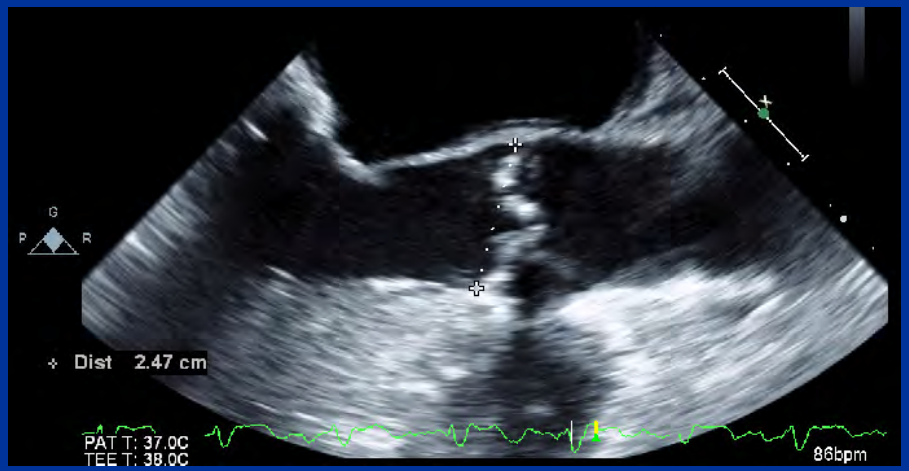


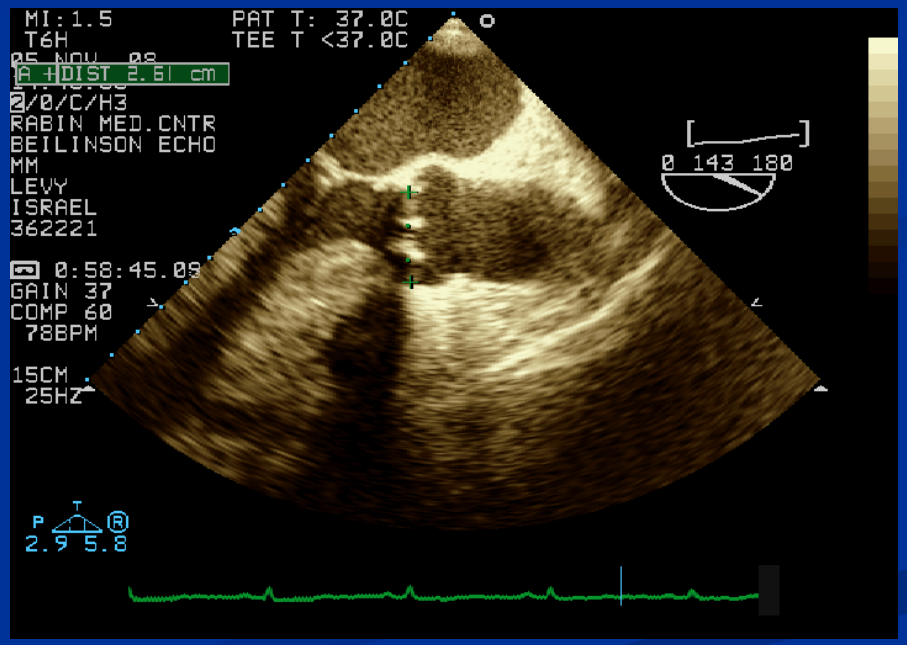
Failed Implantation



Rejection d/t Inadequate Annulus size

- Edwards: 18-25mm
- CoreValve: 20-27mm





Bicuspid Aortic-Valve

Bicuspid Aortic-Valve

JACC Vol. 51, No. 5, 2008
February 5, 2008:579–84

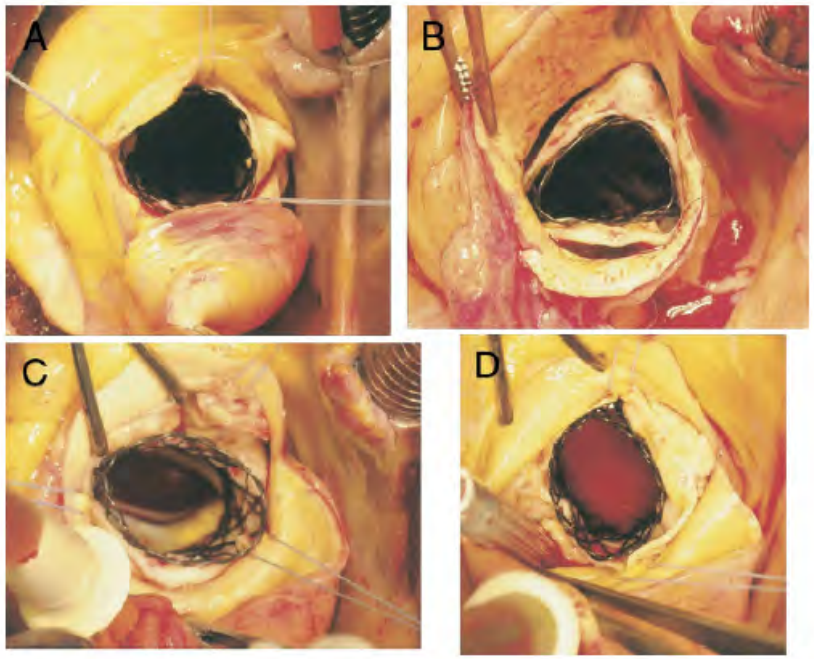


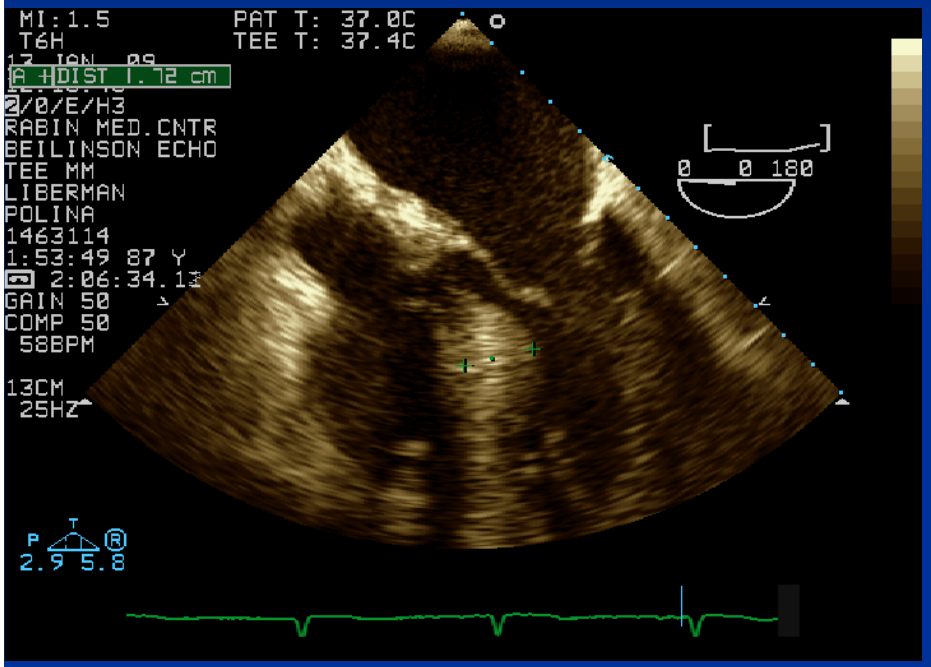
Figure 1 Different Shapes of Stent Deployment Encountered

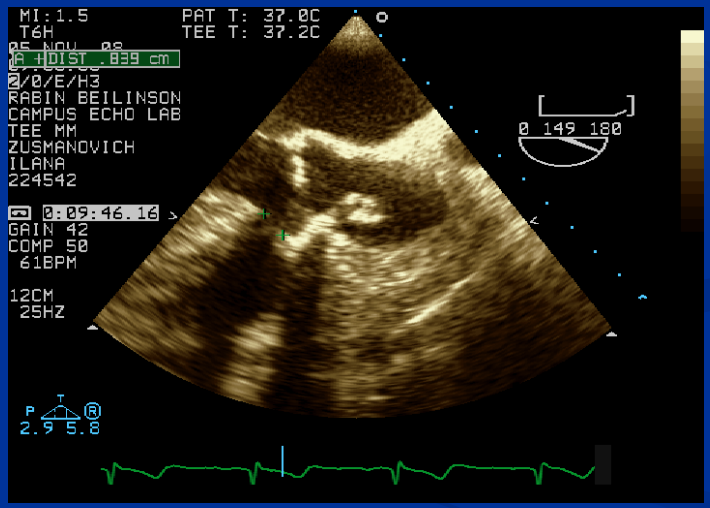
Circular **(A)**, triangular **(B)**, and elliptic **(C and D)**. Note the round calcifications crossing the stent frame.

Table 3 Stent Shape After Deployment According to Aortic Valve Pathology

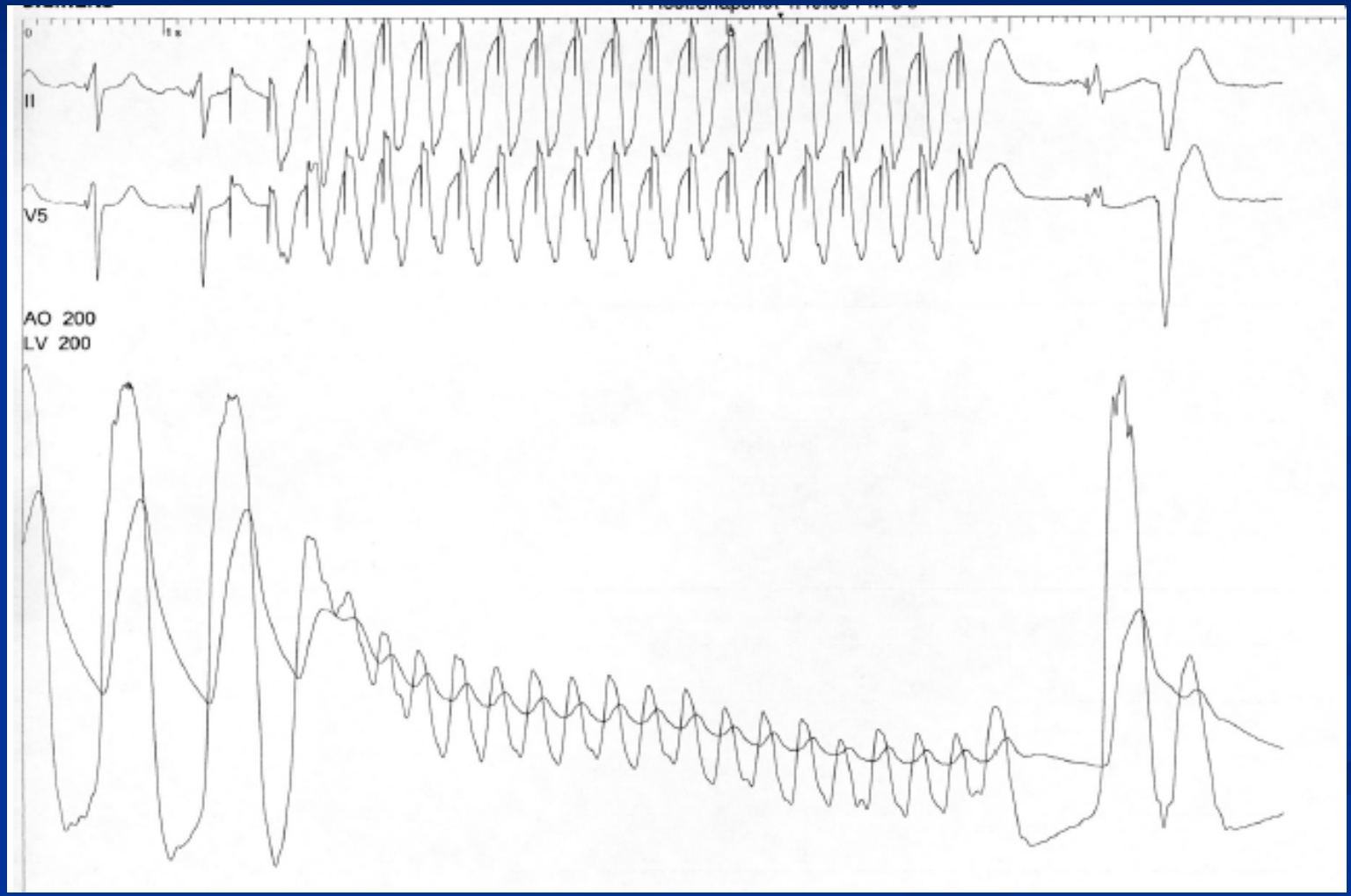
Stent Shape	Tricuspidy (n = 19)	Bicuspidy (n = 14)
Circular, n (%)	13 (68)	2 (14)
Elliptic, n (%)	2 (11)	11 (79)
Triangular, n (%)	4 (21)	1 (7)

Basal Septum Hypertrophy

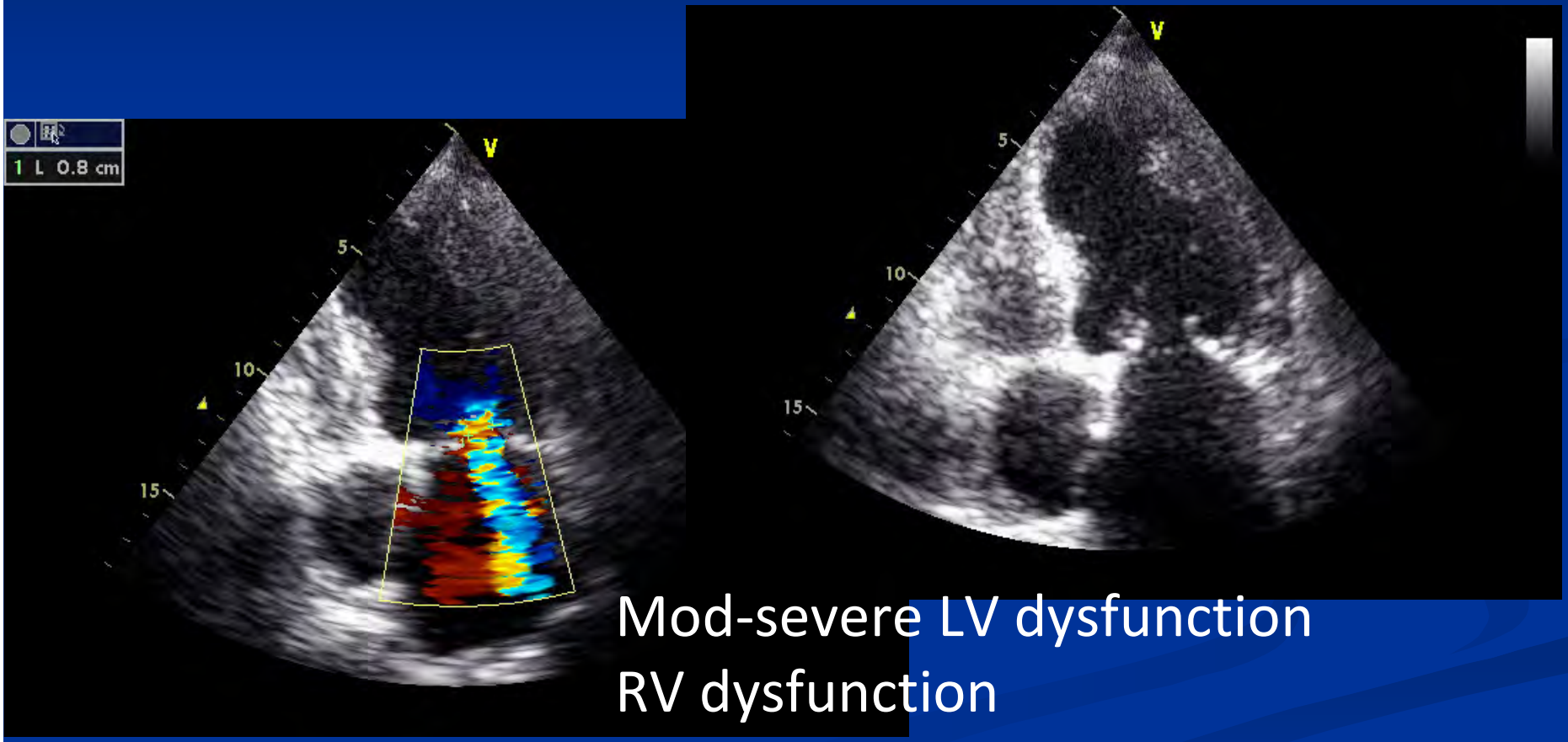




Rapid Pacing During Implantation

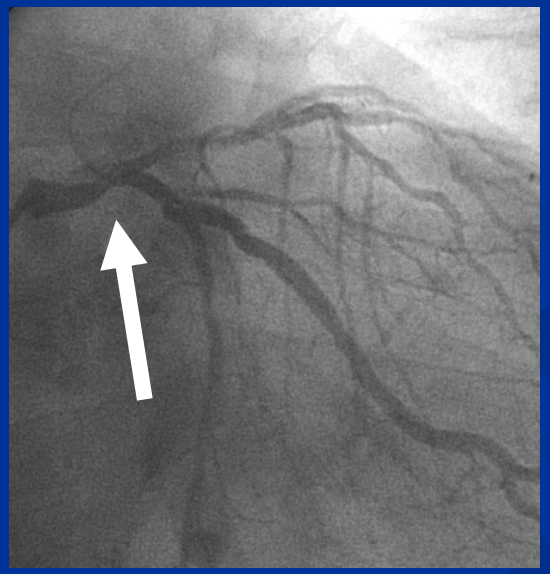


Is it safe to perform the rapid pacing in this patient?



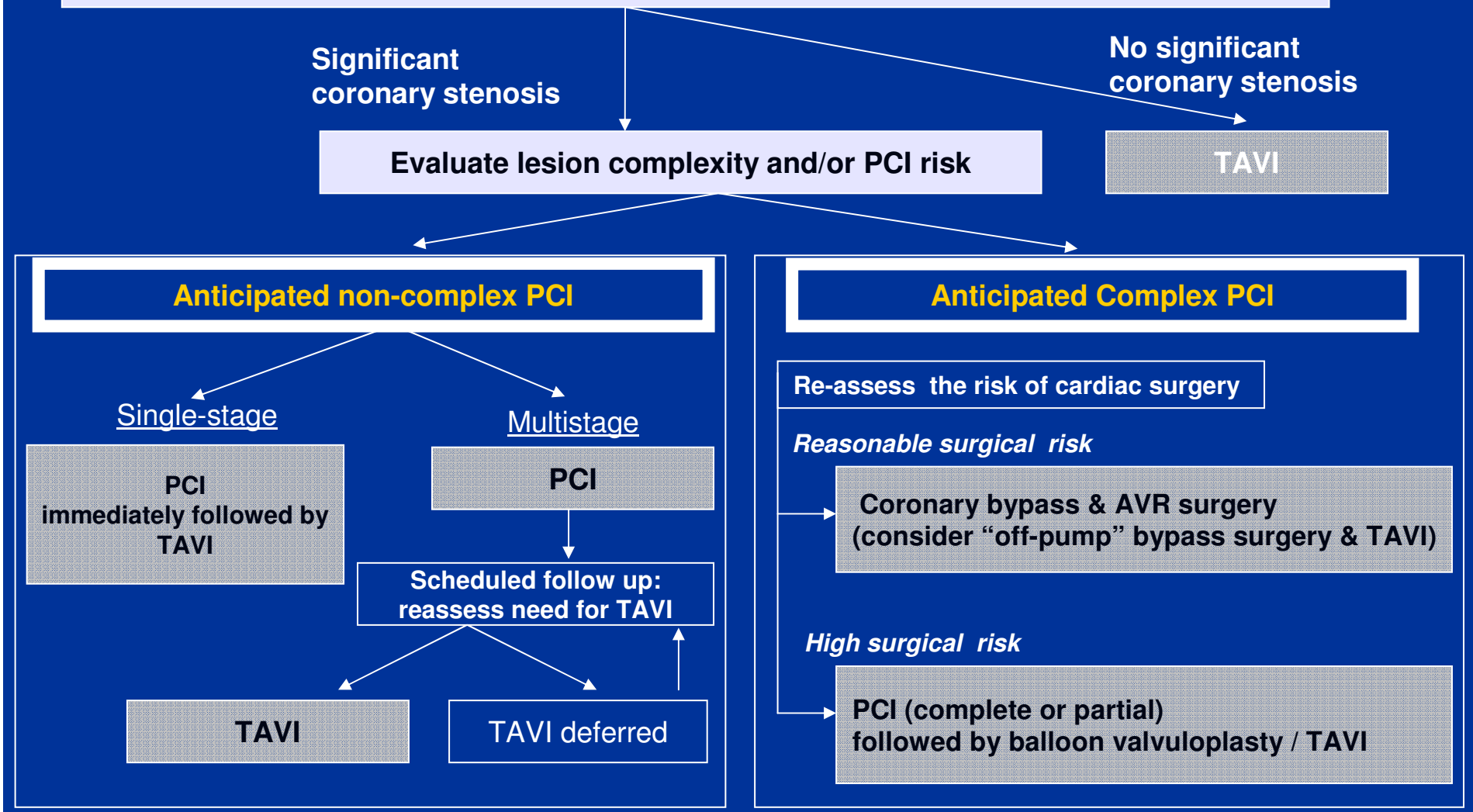
Mod-severe LV dysfunction
RV dysfunction
Mod-Severe MR
Severe Pulmonary HTN

Is it safe to perform the rapid pacing in this patient?



Three-Vessel Disease
Left Main Disease

Suggested PCI Strategy in TAVI Candidates



Dvir D. et al. *J Invasive Cardiol* 2009

TAVI experience in Israel

PAVI was included in the “health basket” in January 2010

Sapien PAVI: Israeli data

	Patients data (N=41) Procedures (N=42)*
Age (yrs)	82.6±5.3 (65-91)
Age >80 yrs (%)	76
Men/women (%)	40/60
Logistic EurosScore (%)	23.1±13.9
NYHC III/IV (%)	93
Diabetes mellitus (%)	37
Post sternotomy	37
Renal insufficiency (creat.≥1.4 mg%)	40
Pulmonary disease (%)	22

Sapien PAVI: Israeli data

	Patients data (N=41) Procedures (N=42)*
23 mm valve utilized	20
26 mm valve utilized	21
AVA (before cm^2)	0.57±0.13
AVA (after cm^2)	1.67±0.25
Peak/Mean gradient (before mm Hg)	89/52
Peak/Mean gradient (after mm Hg)	17/9

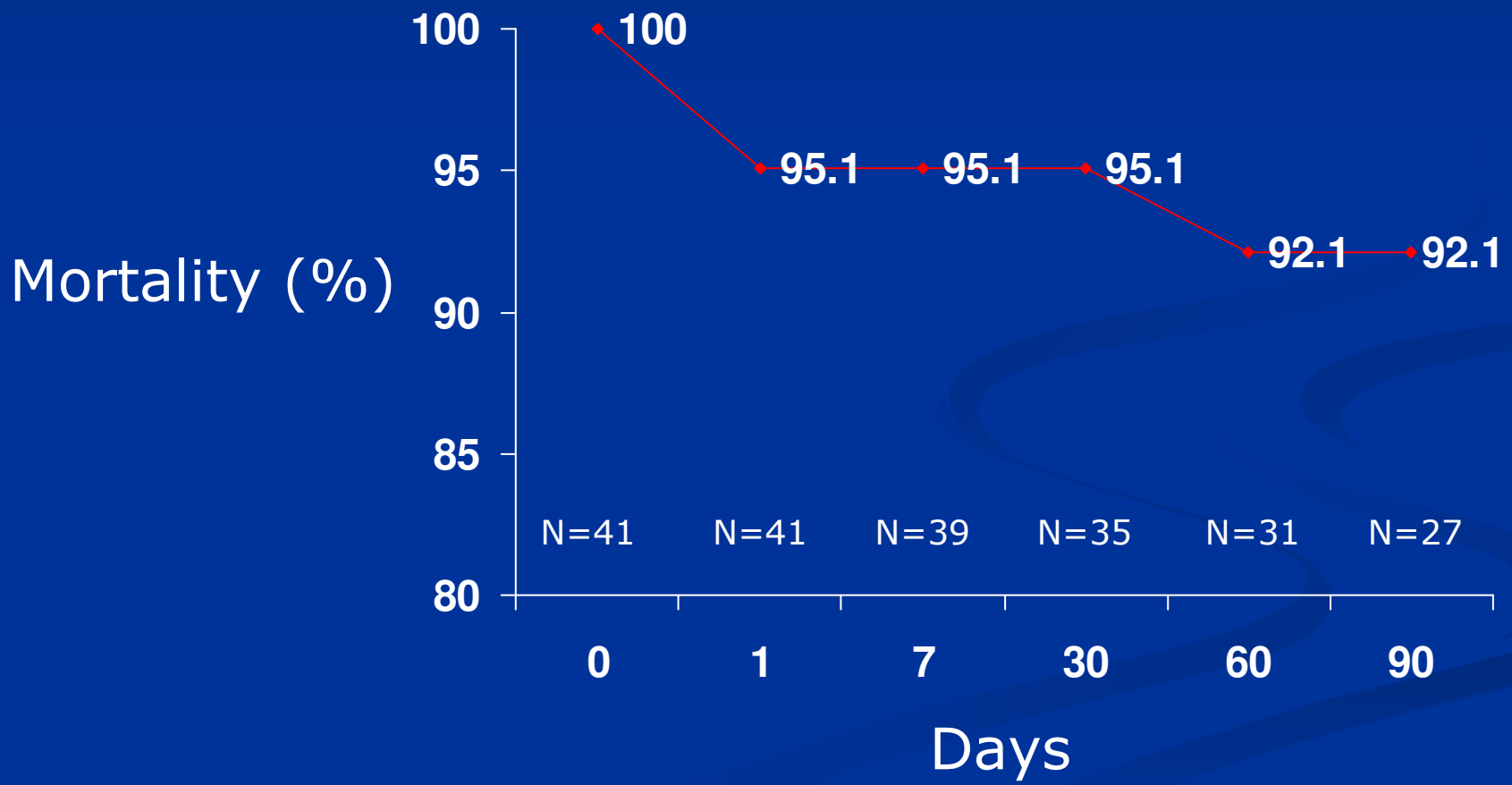
*in one case the procedure was converted from TF->TA

Sapien PAVI: Israeli data

System	Patients data (N=41) Procedures (N=42)*
Overall procedural success (%)	92.8% (39/42)
Trans-femoral procedural success (%)*	95.4% (21/22)
Trans-apical procedural success (%)**	85.0 (17/20)
Overall in-hosp. patients mortality (%)	4.9 (2/41)
Trans-femoral patients mortality (%)	0 (0/21)
Trans-apical patients mortality (%)	10.0 (2/20)
35 day patient survival (%)	92.1 (35/38)

*TF-in one case the procedure was converted from TF->TA
**TA-in two cases in-lab fatal complications occurred and one additional case was converted into surgical AVR

Sapien PAVI: Israeli survival



Mortality cases specified

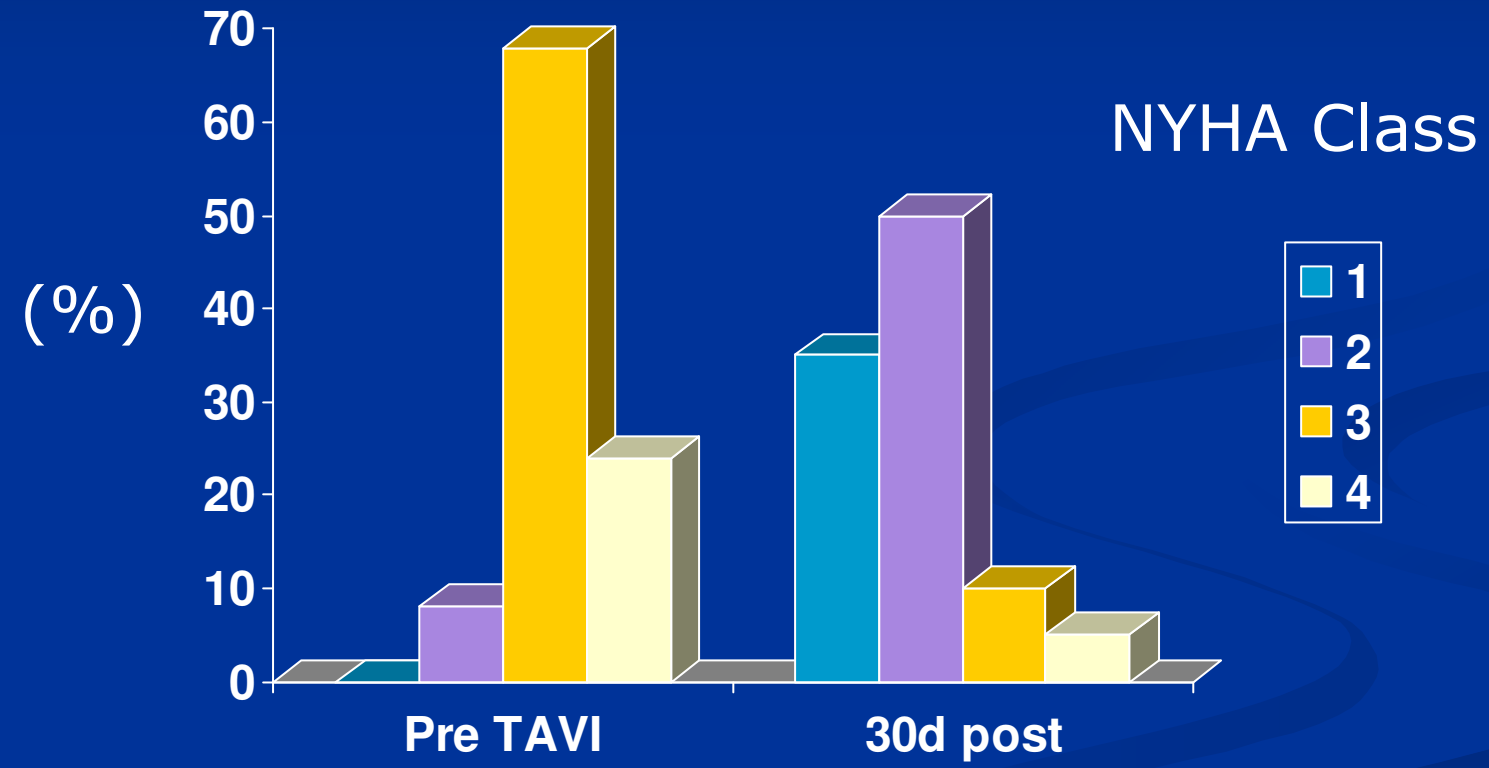
- Case #1: Trans-apical, stiff wire related perforation, in-lab tamponade and death
- Case #2: Suspected annular rupture and severe AI, in-lab shock and death
- Case #3: Trans-femoral, in-lab vascular complication, vascular surgical repair, prolonged hospitalization, stroke and death @day 32 post TAVI.

Sapien PAVI: Israeli complications

	Patients data (N=41) Procedures (N=42)*
Stroke (%)	4.9 (2/41)
-Major stroke (%)	2.4 (1/41)
-Minor stroke (%)	2.4 (1/41)
Myocardial infarction (%)	0 (0/41)
Perforation-tamponade (%)	4.9 (2/41)
-including PM related tamponade	2.4 (1/41)
Major vascular complications (%)	4.9 (2/41)
Valve migration (%)	2.4 (1/41)
Need for permanent pacemaker (%)	2.4 (1/41)

*median hospital stay=7 days (mean 13.7 days)

NYHA Class Response to TAVI



The Israeli CoreValve Registry

	N = 123
Age (years)	82.4 ± 5.9
Logistic EuroSCORE (%)	23.6 ± 13.1
Female	61%
NYHA	I-II: 3.2% III-IV: 96.8%
Aortic Valve Area (cm^2)	0.6 ± 0.1
Peak gradient (mm Hg)	81.3 ± 21.0
Mean gradient (mm Hg)	50.0 ± 12.9
P2P gradient (mm Hg)	70.5 ± 21.3
LVEF (%)	55.5 ± 9.2

The Israeli CoreValve Registry (n=123)

Death	4.4% (5)* (1<24h)
Aortic Dissection	0
Cardiac Tamponade	4.1% (5)
Cardiac Perforation	0.8% (1)
Access Site Complication	12.0% (15)
Major Bleeding	6.3% (5)
Conversion to Surgery	0
Myocardial Infarction	0
Major Arrhythmia	0.8% (1)
Aortic Regurg. 2/≥3	5%(4)/1.6% (2)
Pacemaker	30% (38)
Renal Failure	2.4% (3)
Stroke	1.6% (2) *
TIA	0.8% (1)

* hemorrhagic day 12

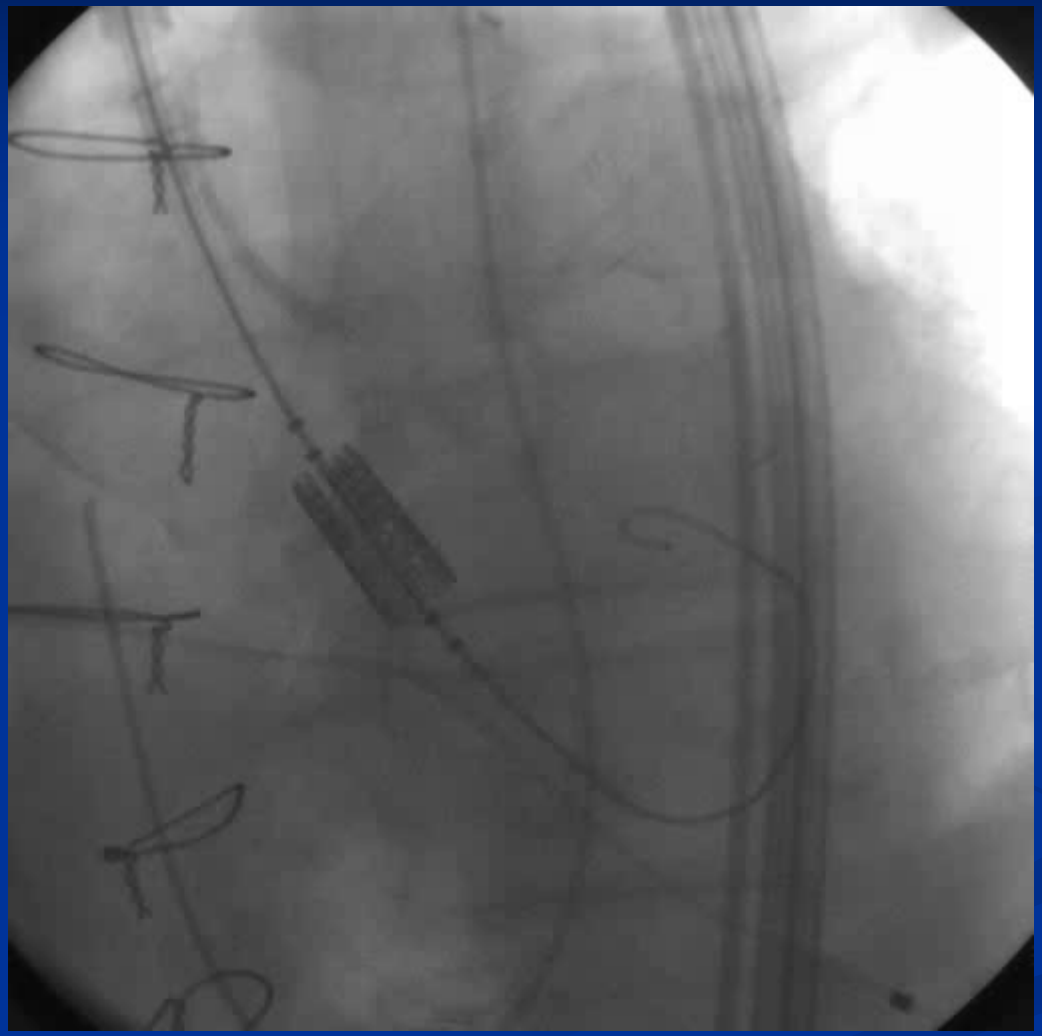
TAVI experience in Rabin Medical Center

The 1st patient 5/11/2008

- 87 year-old male
- Severe symptomatic AS –Functional Class III
- Very high risk d/t
  - previous cardiac surgery
  - porcelain aorta
  - pulmonary disease
- Calculated Euroscore- 20% predicted mortality.

The Moment of Truth…

Transfemoral Edwards 11/2008

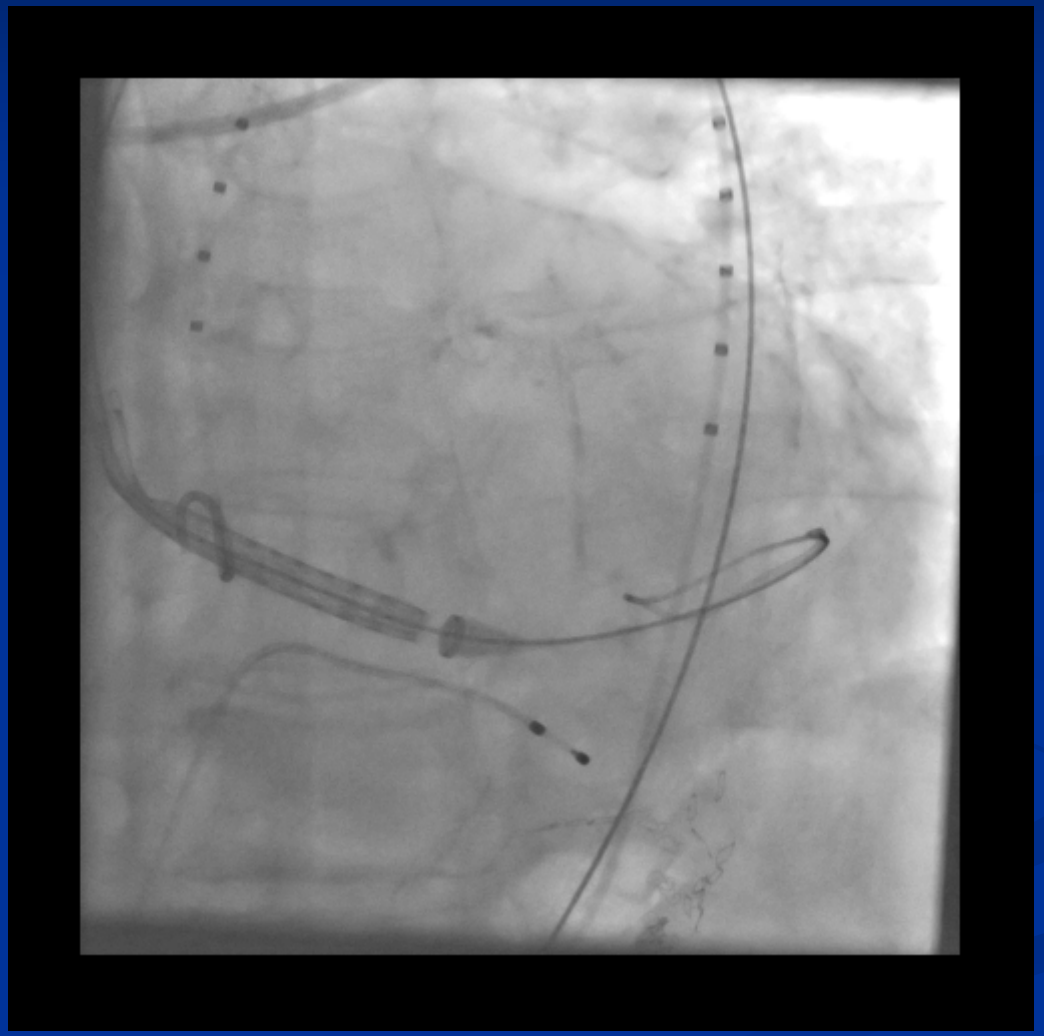


Our first patient;
4 months after the procedure

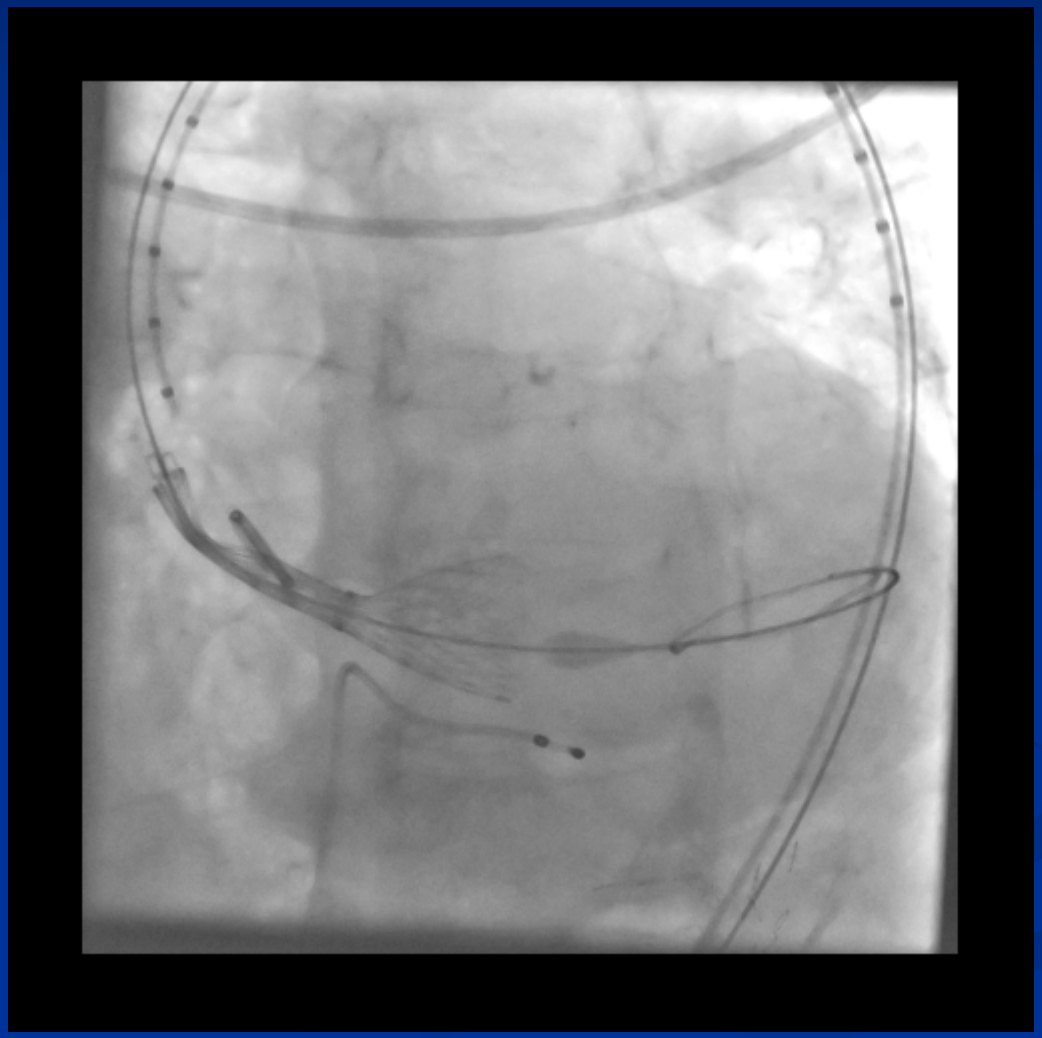
Transfemoral CoreValve 9/2009

- A 76-year-old woman
- Obesity.
- Chronic hemodilysis tx.
- Deteriorating functional capacity.

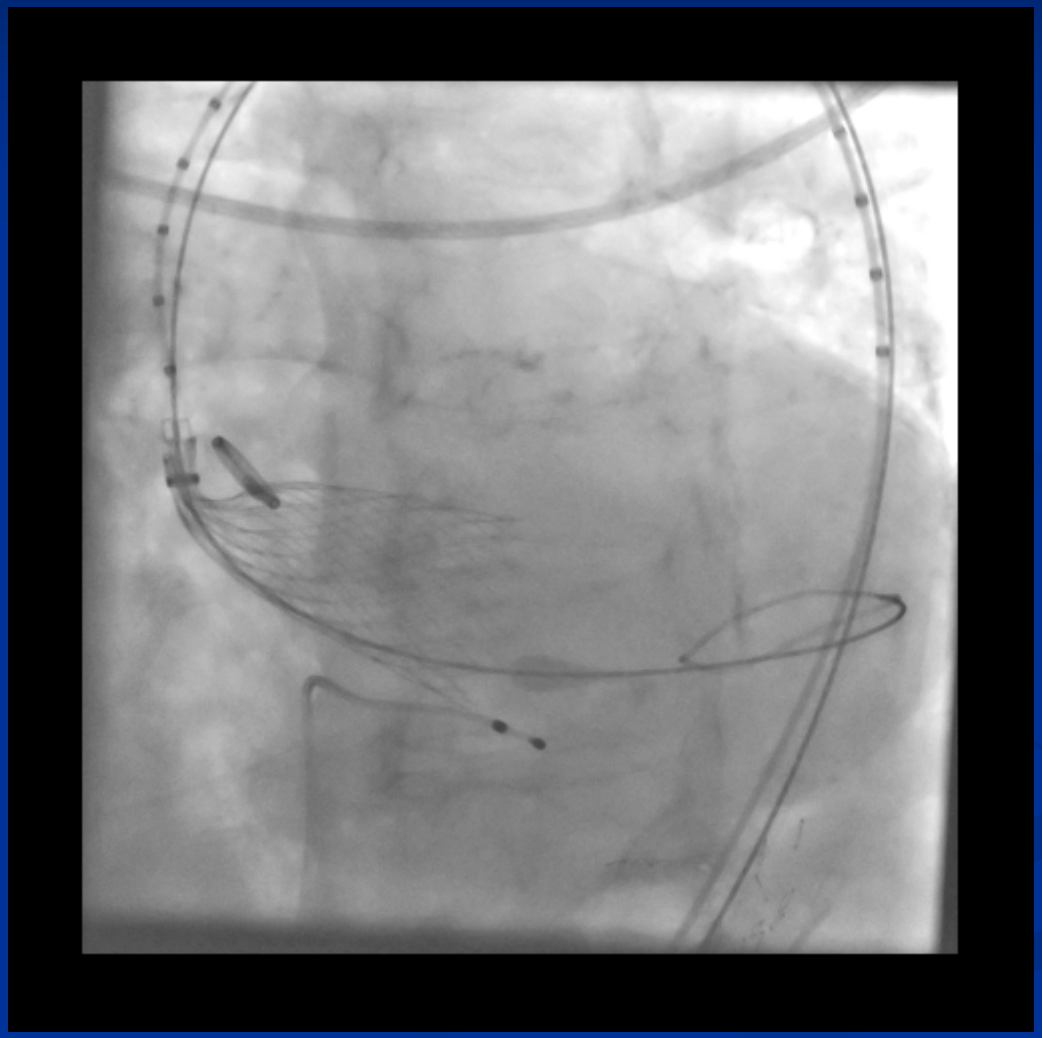
Transfemoral CoreValve 9/2009



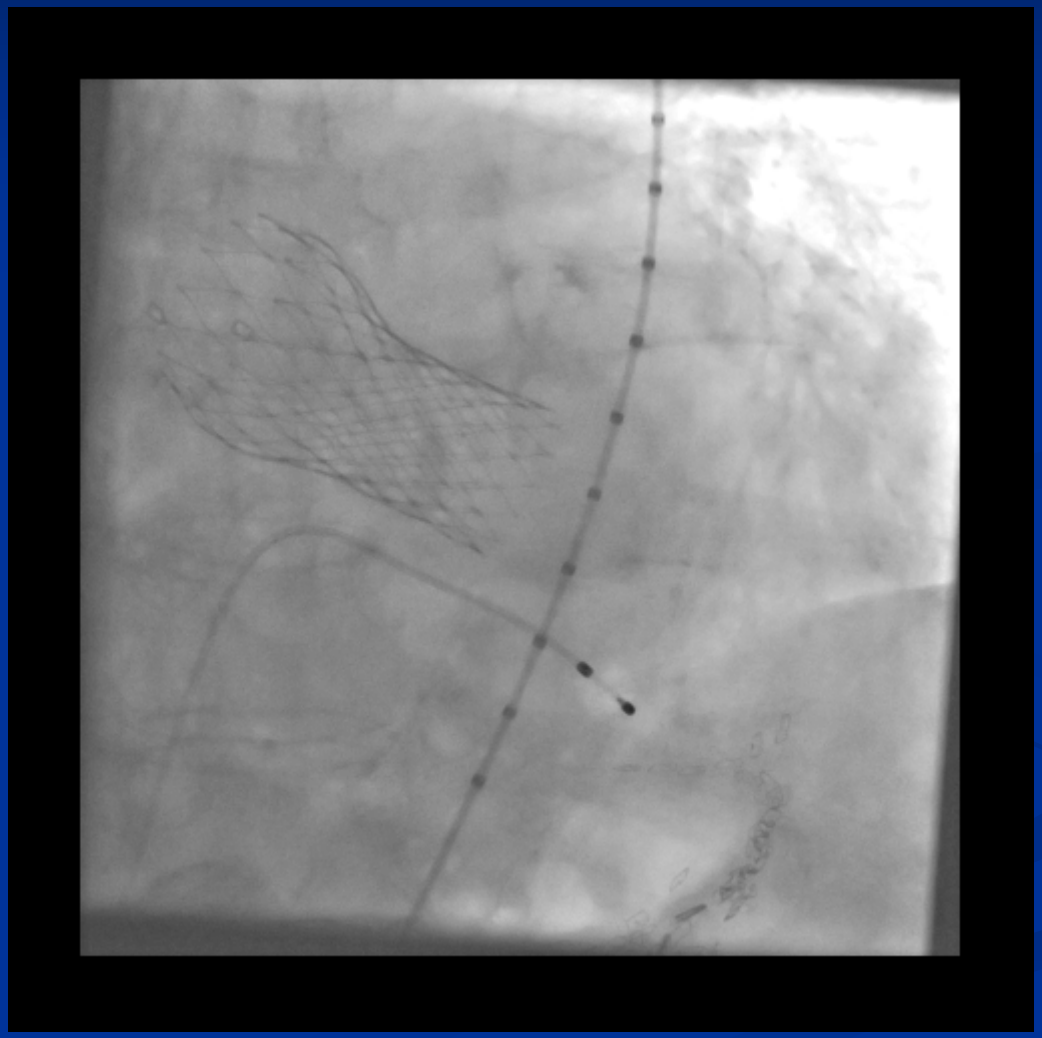
Transfemoral CoreValve 9/2009



Transfemoral CoreValve 9/2009



Transfemoral CoreValve 9/2009

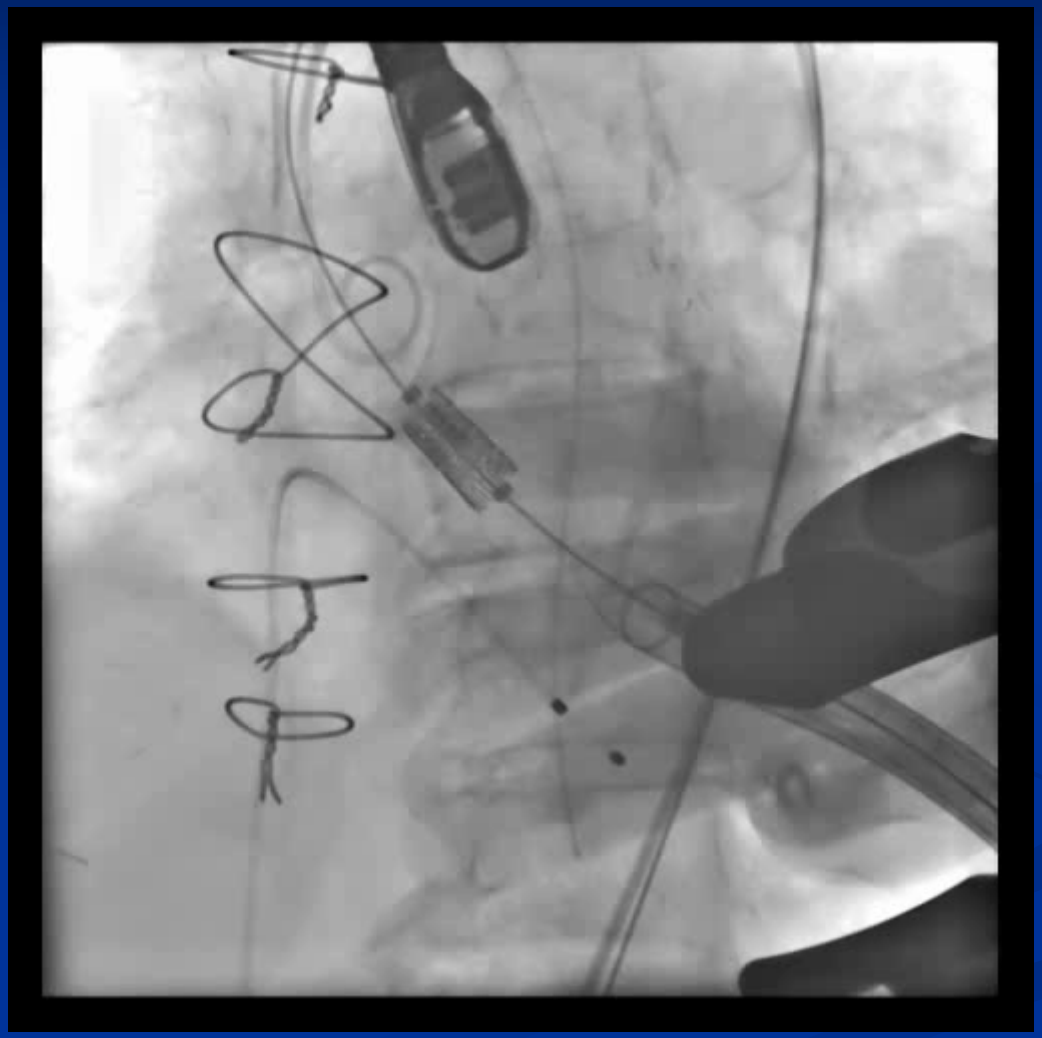


Transapical Edwards 12/2009

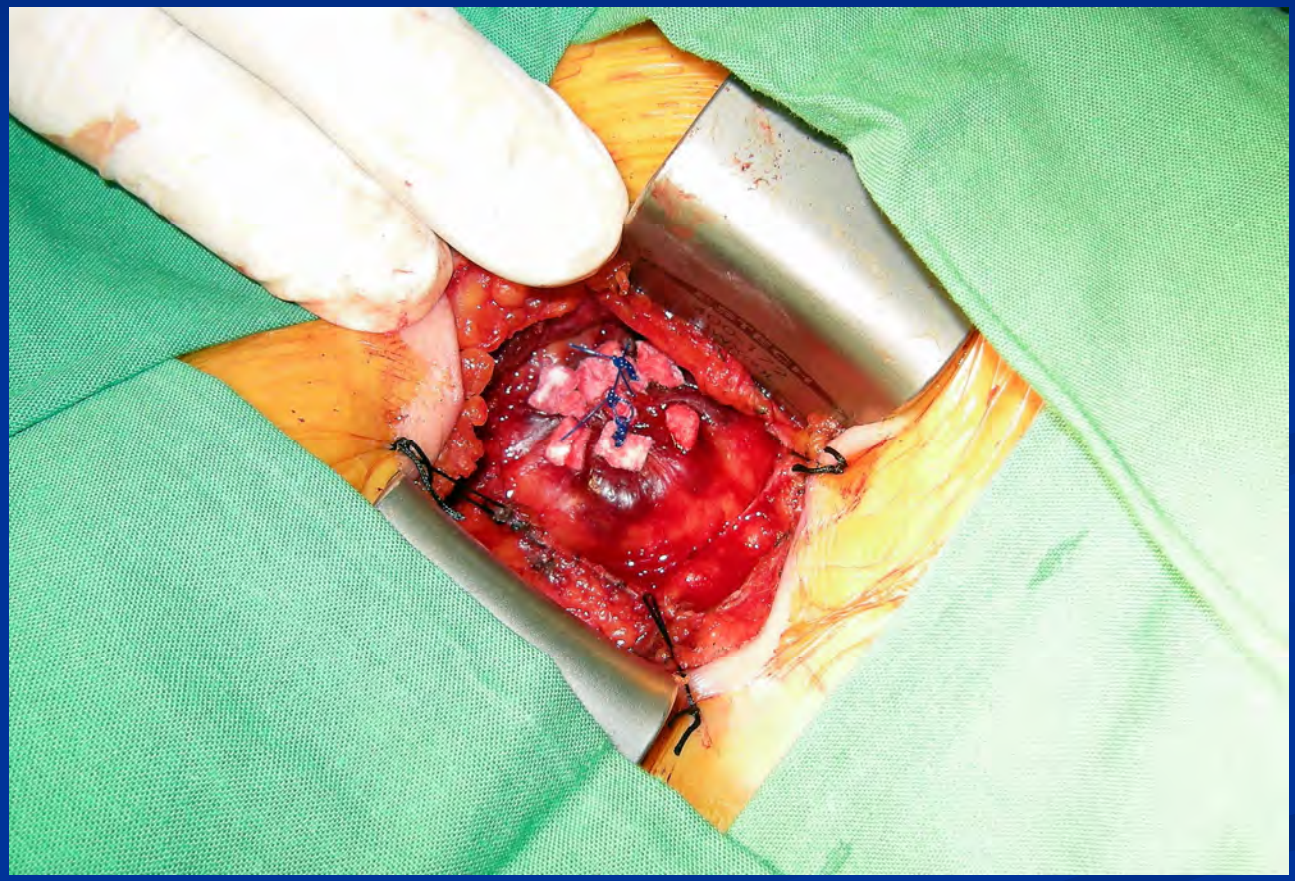
- 89 year old woman
- Many comorbidities:
  - Ischemic heart disease, s/p CABG
  - Bilateral carotid stenosis
  - Peripheral vascular disease
- Logistic EuroSCORE 45.2%

Transapical Edwards 12/2009

Transapical Edwards 12/2009



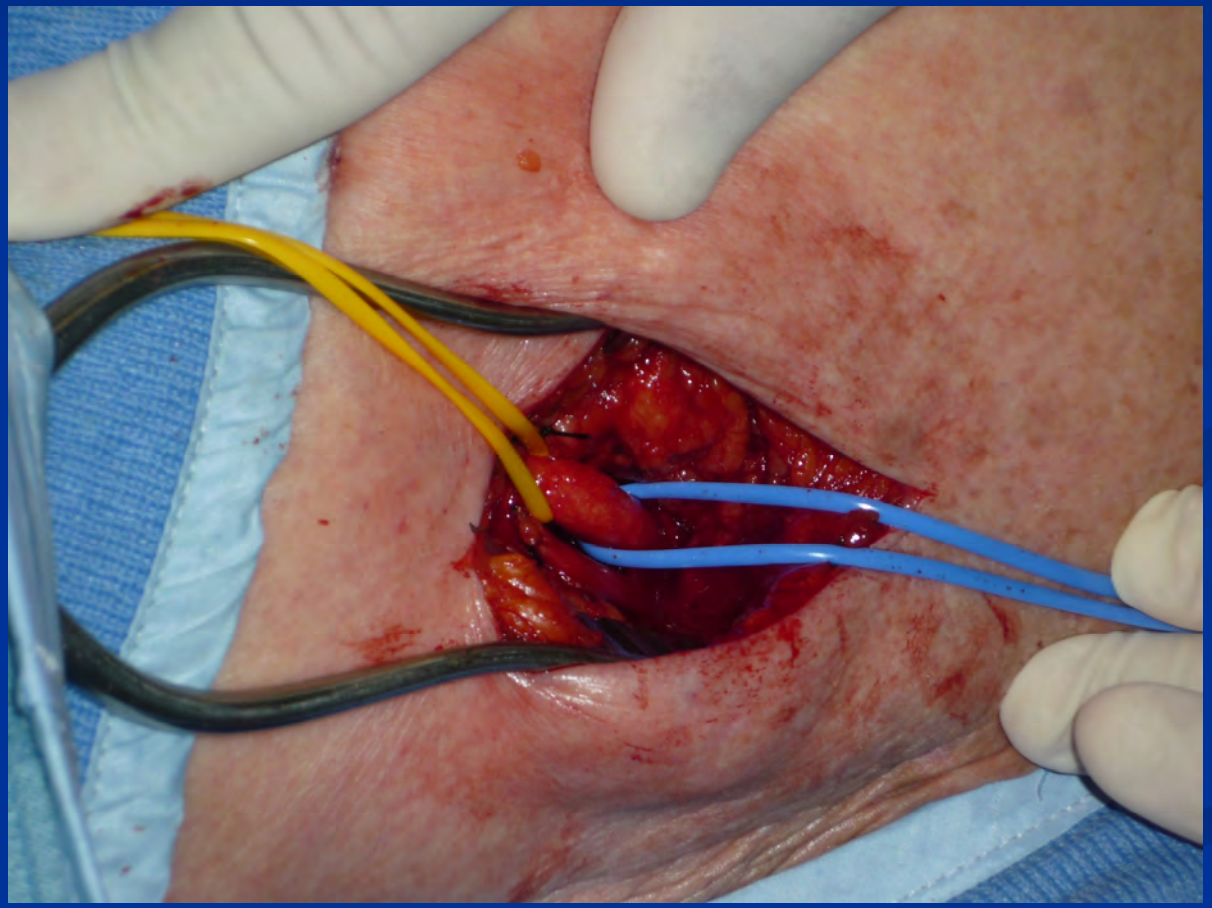
Transapical Edwards 12/2009



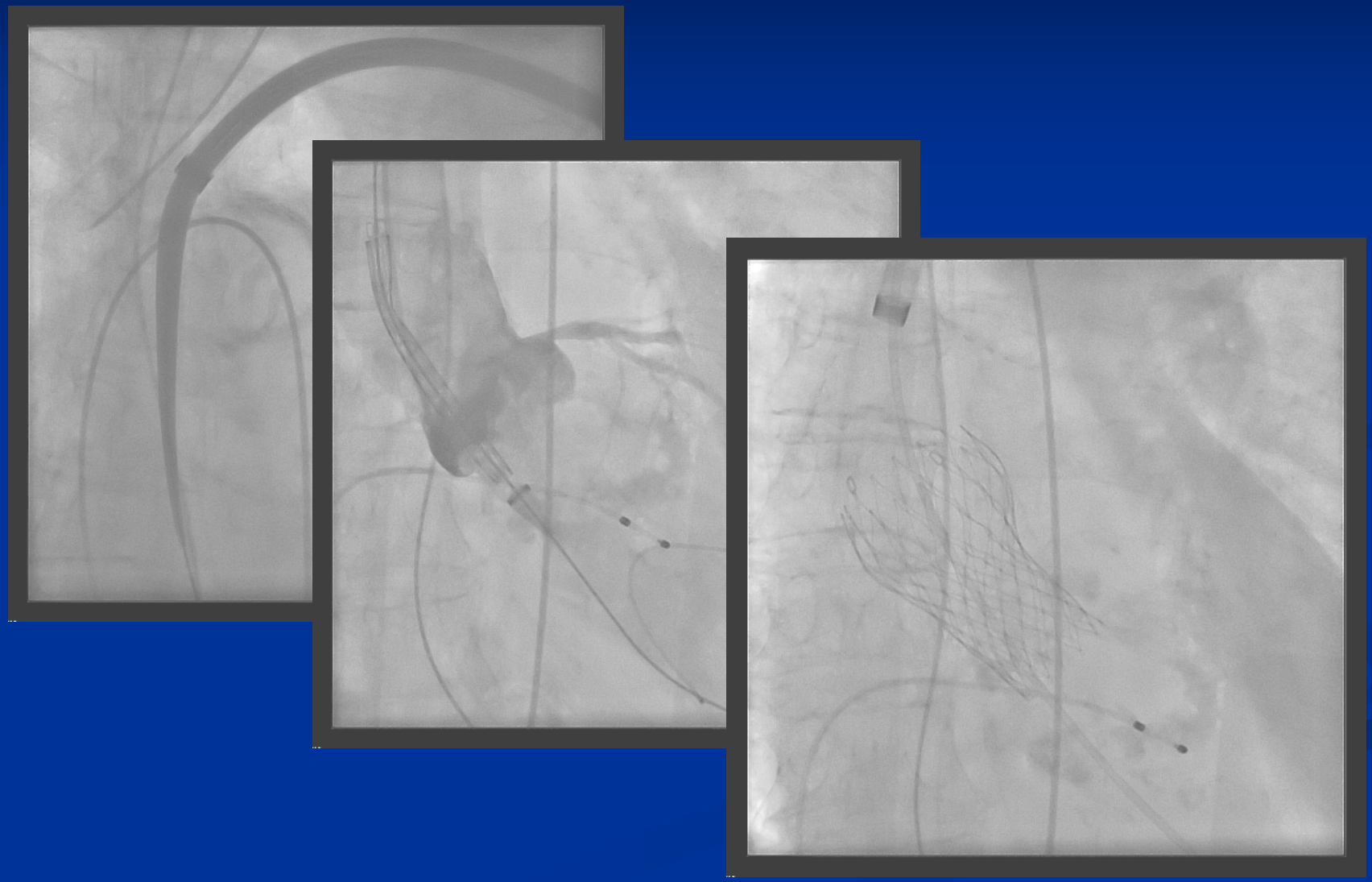
Transaxillary CoreValve 3/2010

- 90 year-old woman
- Severe LV dysfunction
- Critical state
- Log EuroSCORE 47.5%

Transaxillary CoreValve 3/2010



Transaxillary CoreValve 3/2010



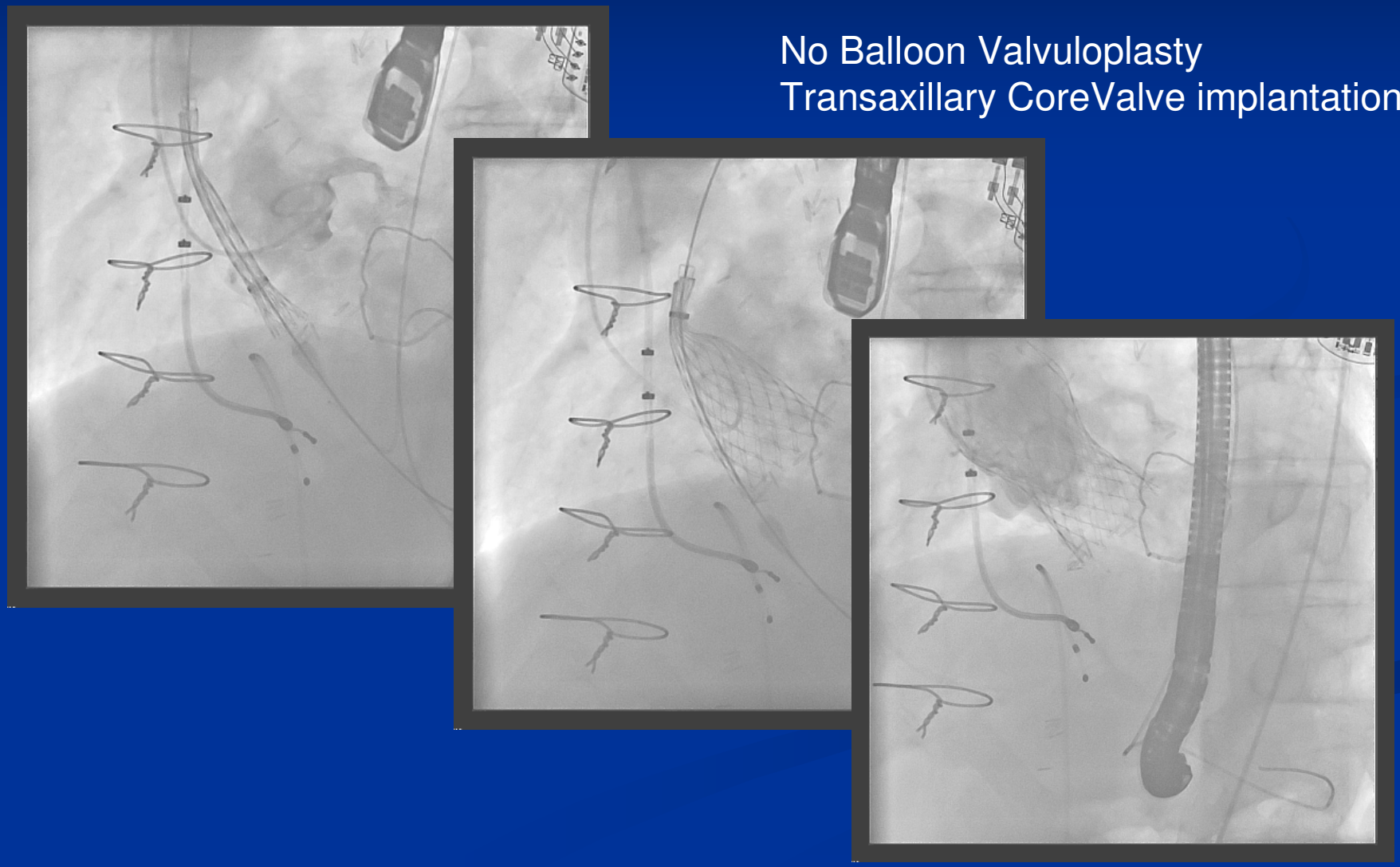
“Valve in Valve” 5/2010

first in Israel

- 81 year-old man
- s/p biologic AVR- Toronto stentless valve 29mm
- Severe aortic stenosis of the prosthetic valve

“Valve in Valve” 5/2010

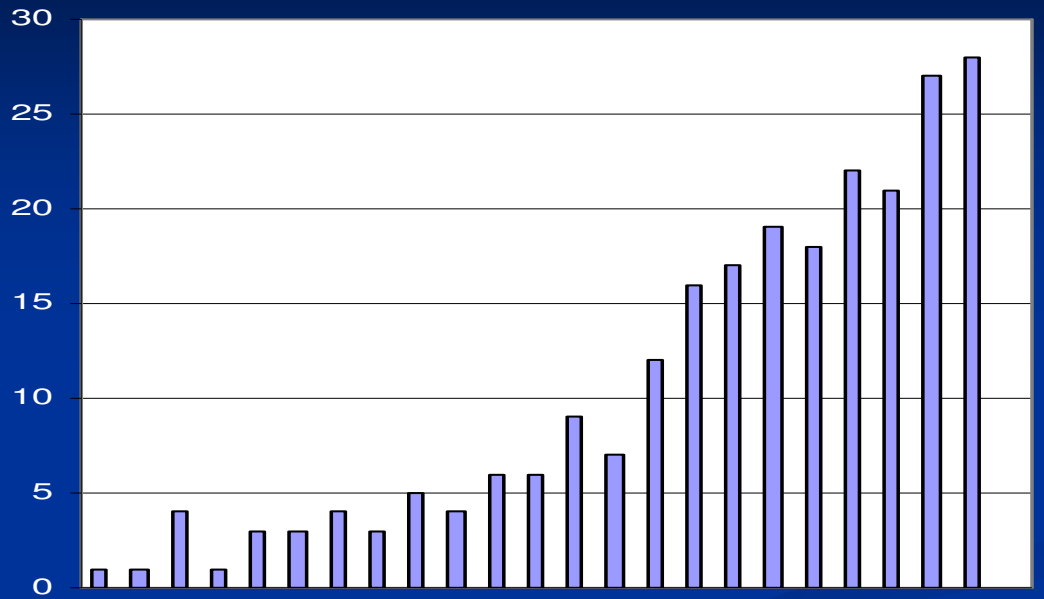
first in Israel



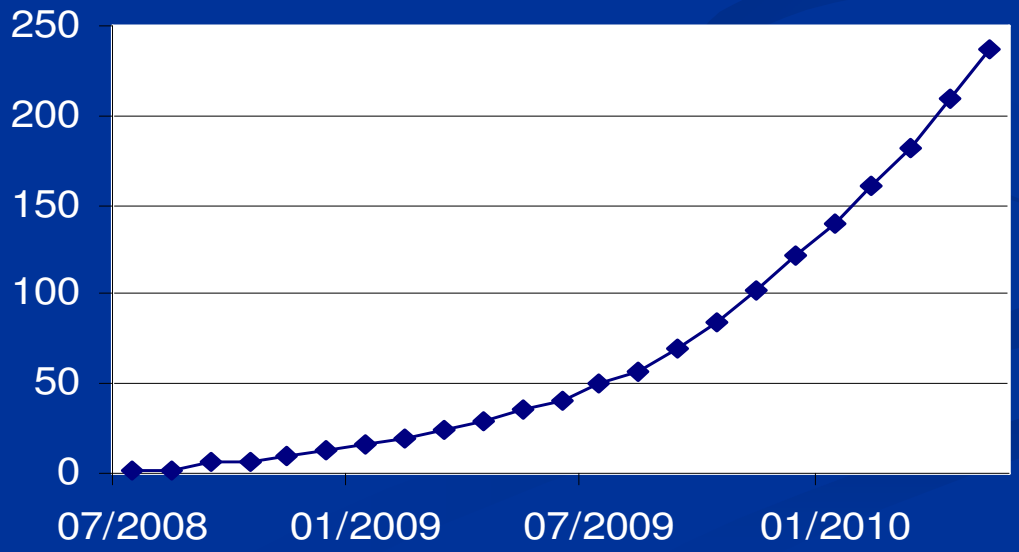
No Balloon Valvuloplasty
Transaxillary CoreValve implantation

Screening Recruitment Rate

New patients per month



Cumulative # of patients



Treatment assignment

High-risk Severe AS Patients (n= 246)

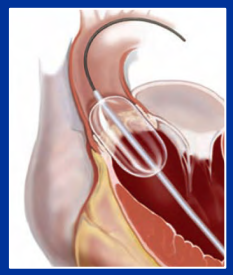
Treatment Assigned (n= 178)

Under Active Screening (n= 68)

Conservative treatment (n= 70)

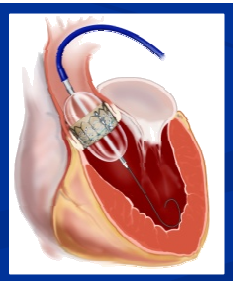
Aortic-Valve Replacement (n= 31)

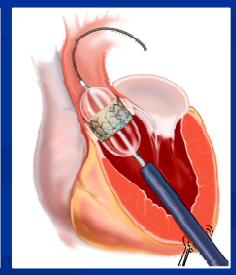
Balloon Valvuloplasty (n= 32)



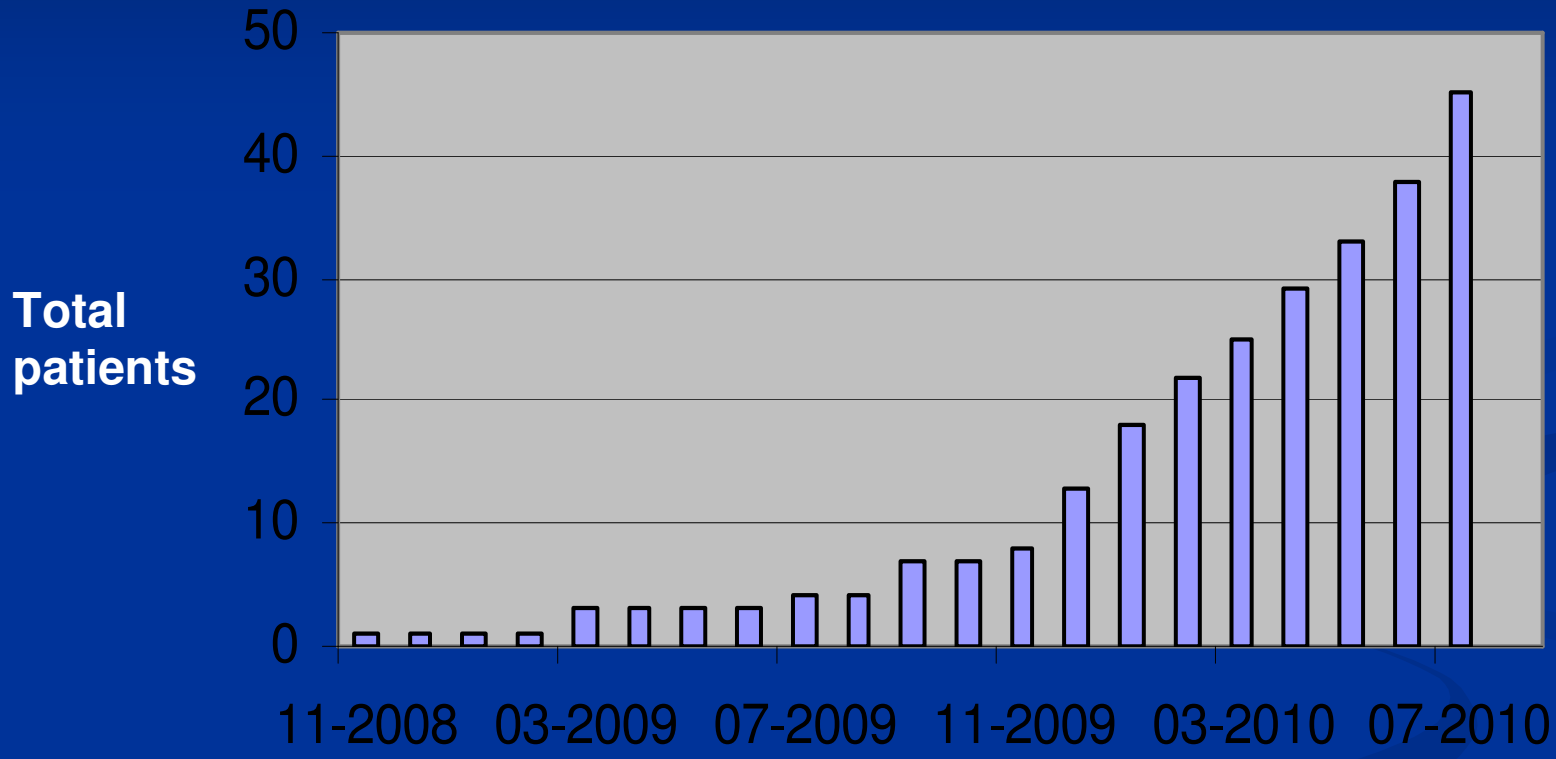
Transcatheter Aortic-Valve Implantation (n= 45)

TF/TAX CoreValve n= 29	TF Edwards n= 7	TA Edwards n= 9



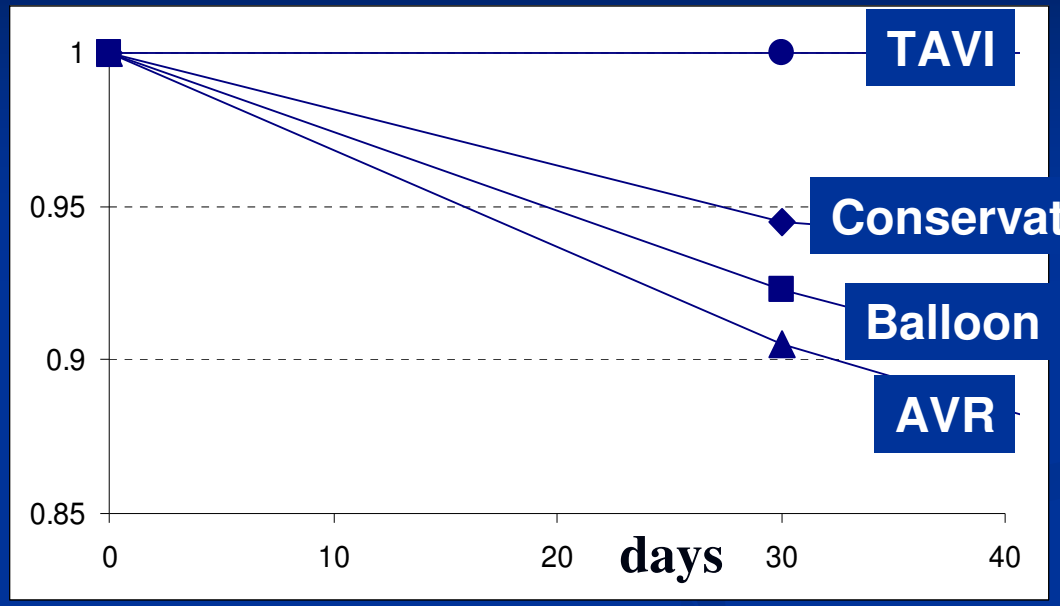


Cumulative TAVI Procedures



Survival Analysis- 30 days

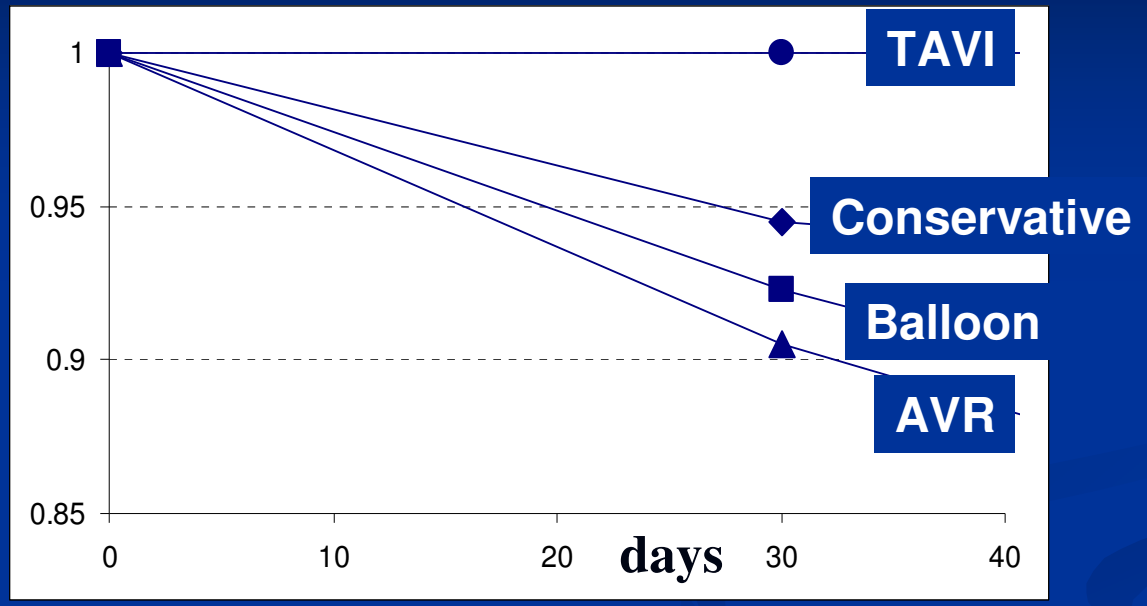
% survival



# at risk	0 days	30 days
TAVI	29	25
Conservative	61	55
Balloon	29	26
AVR	23	21

Survival Analysis- 30 days

% survival



Deaths 30 days:

Conservative tx: sepsis, unknown, pulmonary edema & multiorgan failure.

Balloon: pulmonary edema, sepsis.

AVR: tamponade?, unknown.

Clinical Profile

Variable	TAVI (n=45)
Age (years)	82.1±6.4
Male	33% (12)
STS score	7.4±5.8
Logistic EuroSCORE	22.8±10.4
New York Heart Association Class III / IV	100% (36)

Clinical Profile

Variable	TAVI (n=45)
Diabetes mellitus	25% (9)
Hypertension	92% (33)
Hyperlipidemia	89% (32)
Coronary artery disease	62% (22)
Smoker	11% (4)
COPD	17% (6)
Renal failure	44% (16)
Prior CVA/TIA	17% (6)
Arrhythmia	33% (12)
PVD	31% (11)
Prior CABG	39% (14)
Prior PCI	53% (19)

Echocardiographic Data

Variable	TAVI (n=45)
Ejection fraction (%)	44.7±14
Pulmonary artery systolic pressure (mmHg)	38.3±13.8
Aortic valve area (cm^2)	0.55±0.11
Maximum velocity across aortic valve (m/sec)	4.1±0.8
Mean gradients across aortic valve (mmHg)	45.5±23.4
Peak gradients across aortic valve (mmHg)	71.7±34.2

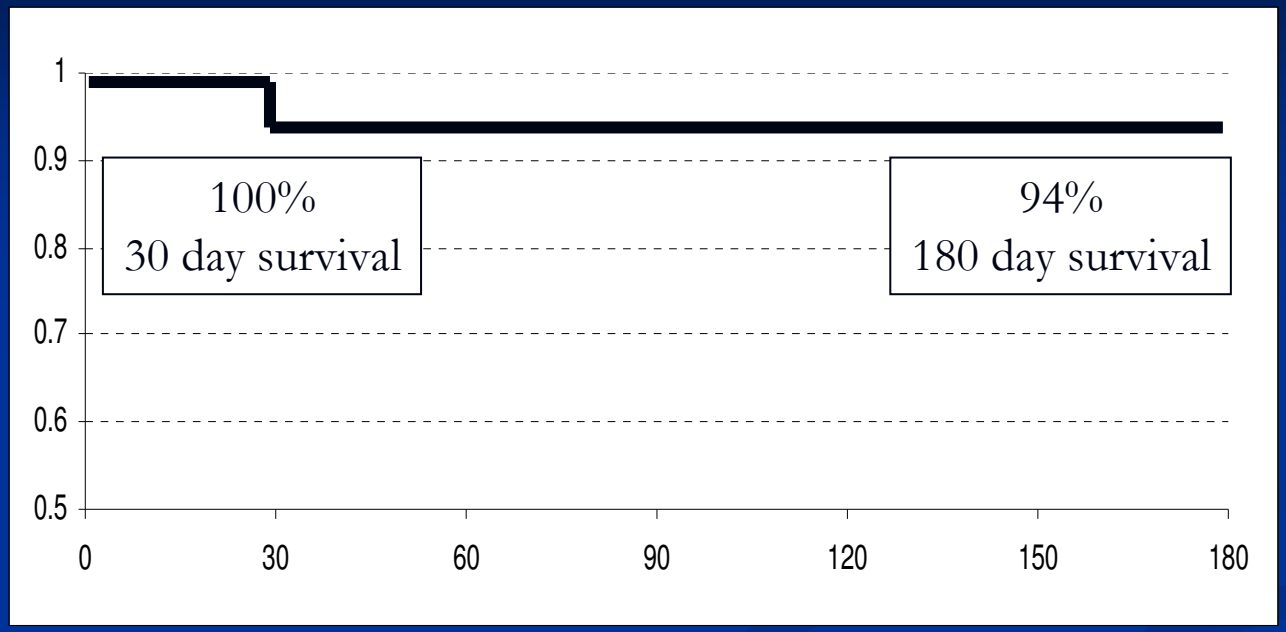
Change in AV Gradients

Variable	TAVI (n=45)
Before treatment	
Mean gradients across aortic valve (mmHg)	45..5±23.4
Peak gradients across aortic valve (mmHg)	71.7±34.2
After treatment	
Mean gradients across aortic valve (mmHg)	7.8±2.3
Peak gradients across aortic valve (mmHg)	15.6±5.5

Early Complications after TAVI- 30 days (n=45)

Death	**0%**
Vascular-minor	13.3% (6)
Vascular-major / Tamponade	2.2% (1)
Valve misplacement	0%
Perm Pacemaker implantation	15.6% (24% in CoreValve / 0% in Edwards)
VT / VF	2.2% (1) (8 days post procedure)
Blood transfusion	40% (18)
MI	0%
CHF	6.7% (3)
Acute Renal Failure	2.2% (1)
Significant AR (≥2)	2.2% (1)
CVA	4.4% (2)
Pulmonary Embolism	2.2% (1)
Surgical wound infection	2.2% (1)
Length of hospital stay	mean 6 days

TAVI- Survival Analysis



# at risk	0 days	30 days	180 days	360 days
TAVI	45	38	18	4

* one patient died at day 35 from sepsis. No signs of endocarditis including on TEE evaluation.

SUMMARY

- Treatment options for symptomatic aortic-stenosis patient:
  - Medical tx only.
  - Surgical AVR- the “treatment of choice”
  - AV balloon valvuloplasty- as a “bridge” to AVR / TAVI.
  - TAVI (transfemoral / transaxilary / transapical)

SUMMARY

- TAVI is an emerging technique with a rapid increase in world-wide experience, approaching 20,000 cases.
- Current indications include only high-risk severe symptomatic aortic stenosis patients.
- Patient selection is critical.
- Preliminary studies show that TAVI is both feasible and effective in the short and medium term.

Thank You !