2011 Cath Lab Symposium
Aug 27, 2011

AORTIC AND MITRAL VALVE DISEASE
HEMODYNAMICS AND CLINICAL ASPECTS

- Basics
- Mitral stenosis and PMBV
- Aortic stenosis and PABV
- TAVI
- HOCM and ASA (case presentation)

Luis F. Tami, MD

Cath Lab Director

Memorial Regional Hospital

Pressure Units in Cath Lab

PRESSURE measurements: force/area

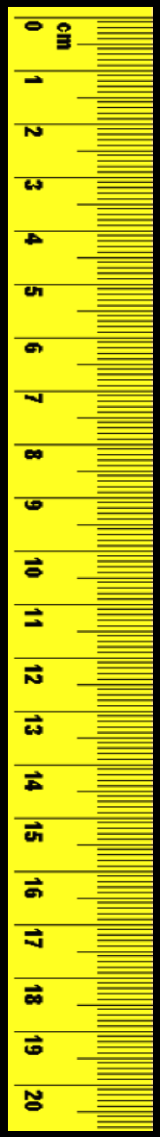
- International Units: Newton/m2 (pascal or pa)
- In USA: “pounds per square inch” = psi
- At sea level: 1 ATM (760 mmHg)
- Equivalence: 1 ATM = 14.7 psi

THEN:

1 psi is 51.7 mmHg

Then 120/80 mmHg is 2.32/1.55 psi

Relation of different pressure measurements used in the Cath Lab



- 900 psi
- 600 psi
- 300 psi
- 0 psi

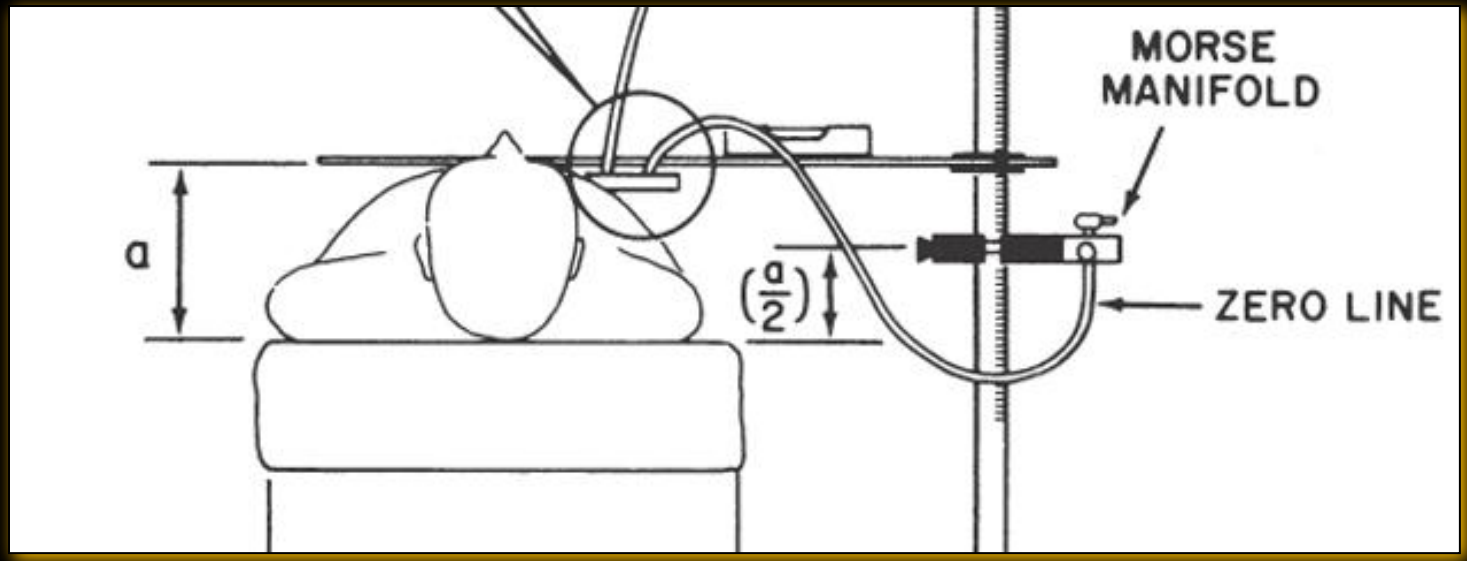
LV GRAM

10-14 ATM in pressure
(147-206 psi)

- 120/80 mmHg = 2.32/1.55 psi

ZERO LEVEL

Mid-Axillary line is reference level



Placing the transducer 4 cm below the zero level will increase measured pressure by about 3 mmHg

Pulmonary Artery Wedge Pressure

- Wedge pressure represent the pressure at the pulmonary capillary level / pulmonary veins (usually representing LA pressure)

- A true Wedge Pressure is measured ONLY when blood flow stops

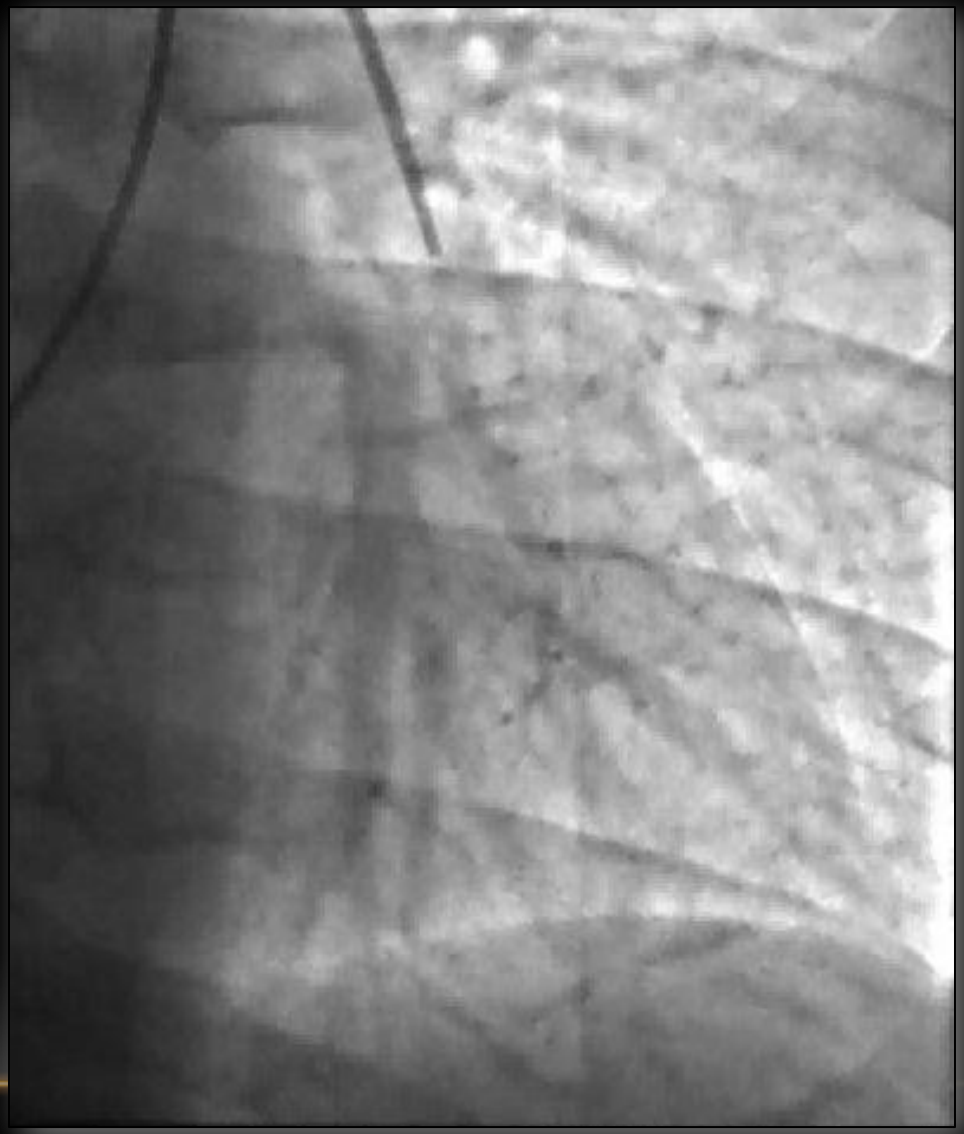
- A Wedge pressure is confirmed if:

  - Characteristic waveform is present and mean is lower than mean PA

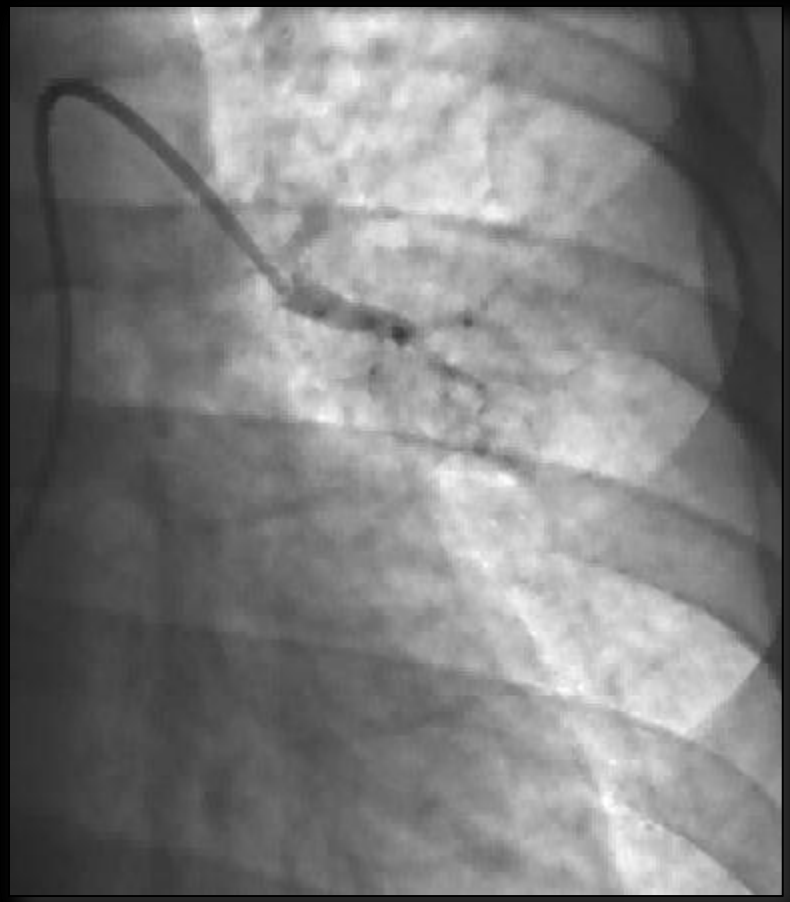
  - 02 Sat is greater than 95%

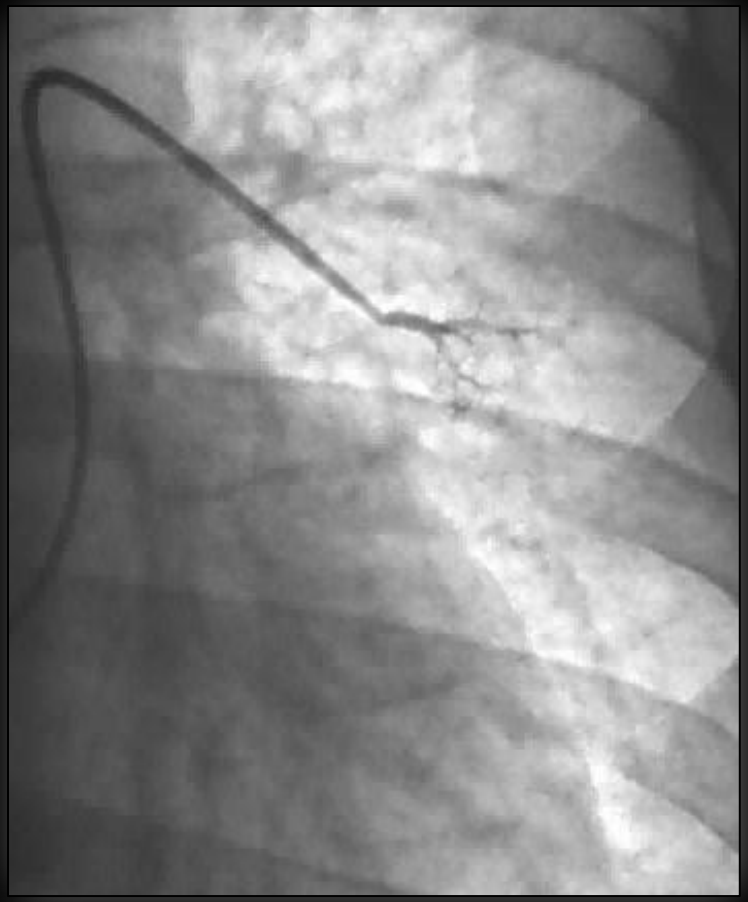
  - Angiographic confirmation of a wedge position with no flow

No real wedge. Still some flow around the balloon.

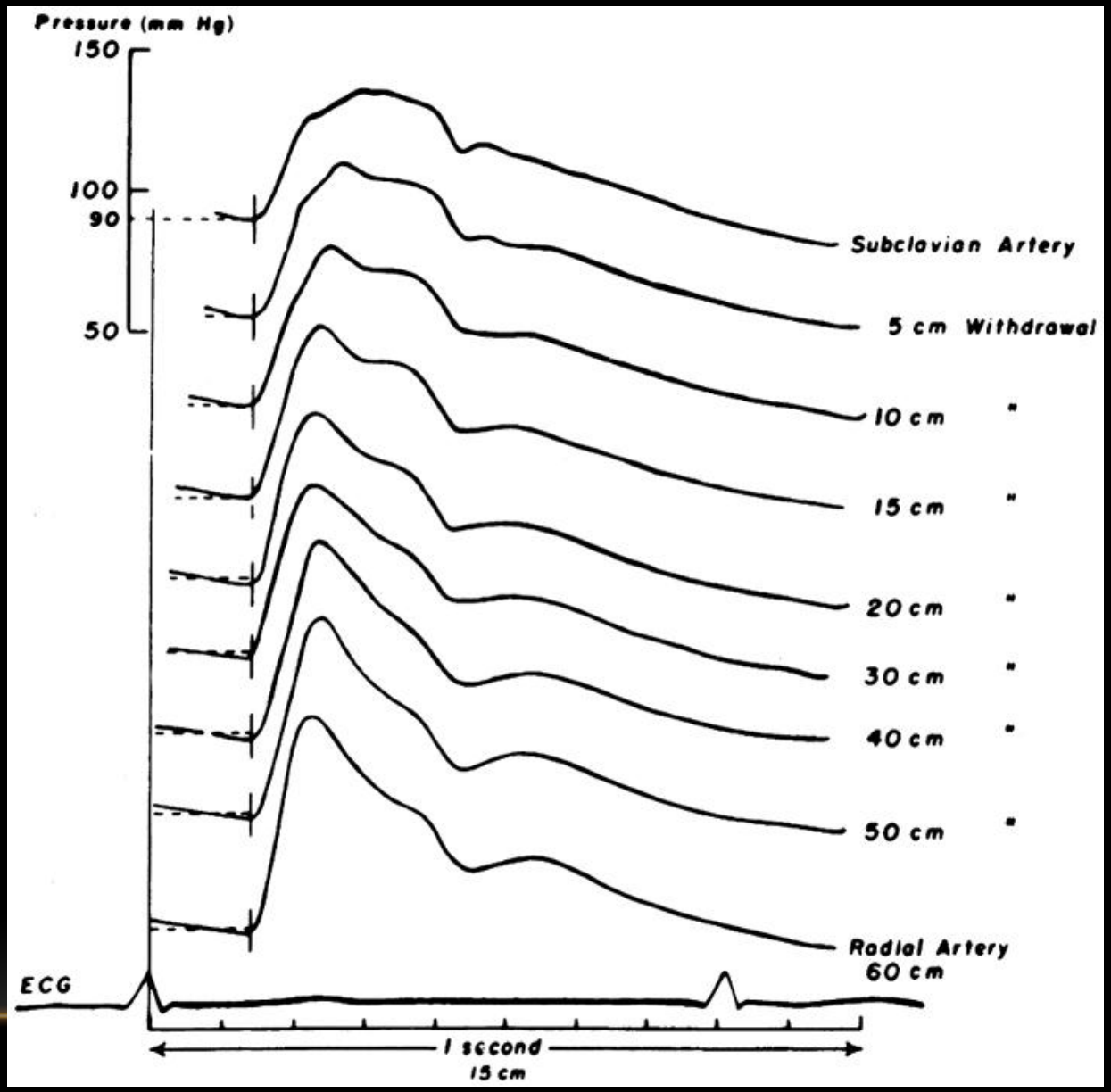


Real Wedge: either with balloon or catheter itself





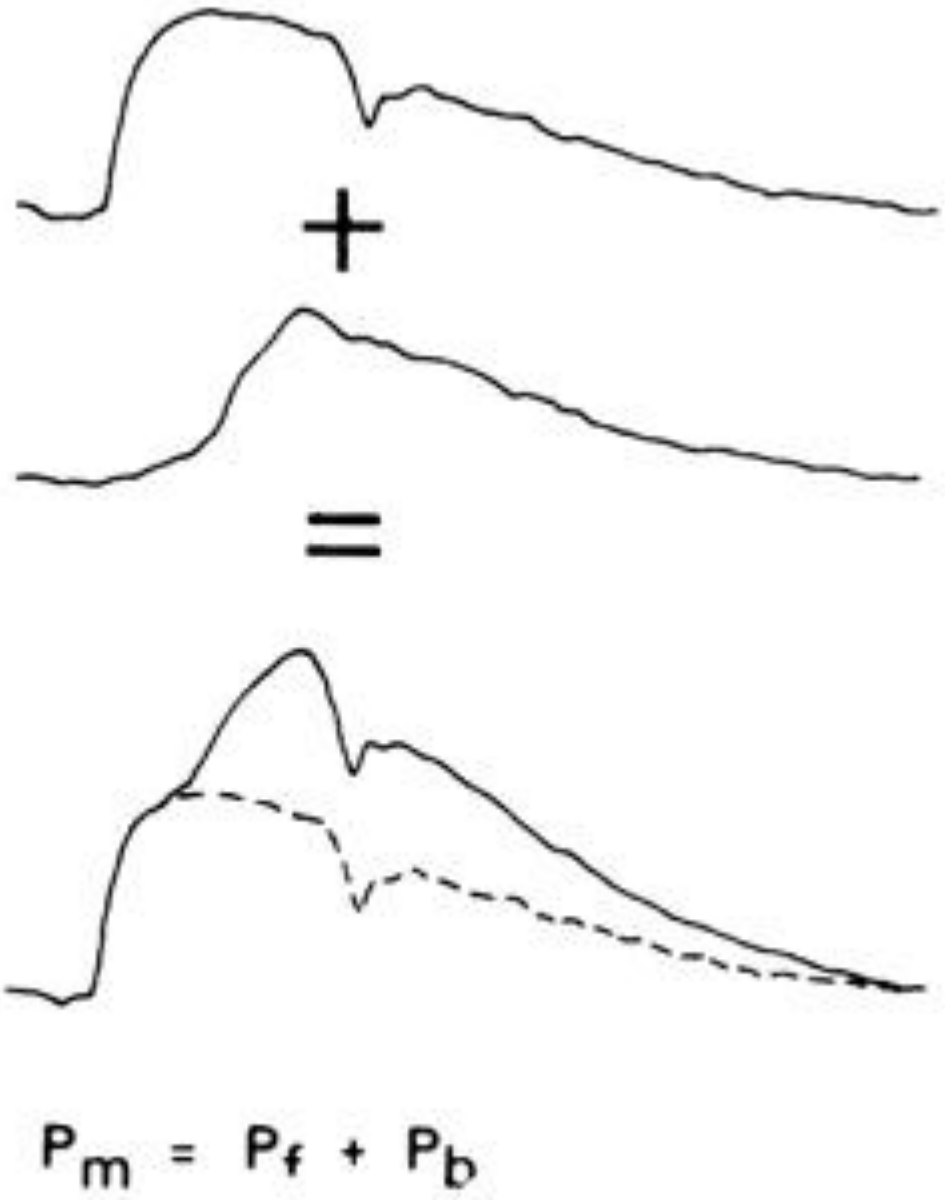
Arterial Pressure Waveform from central to peripheral artery in a Healthy 30-year old man



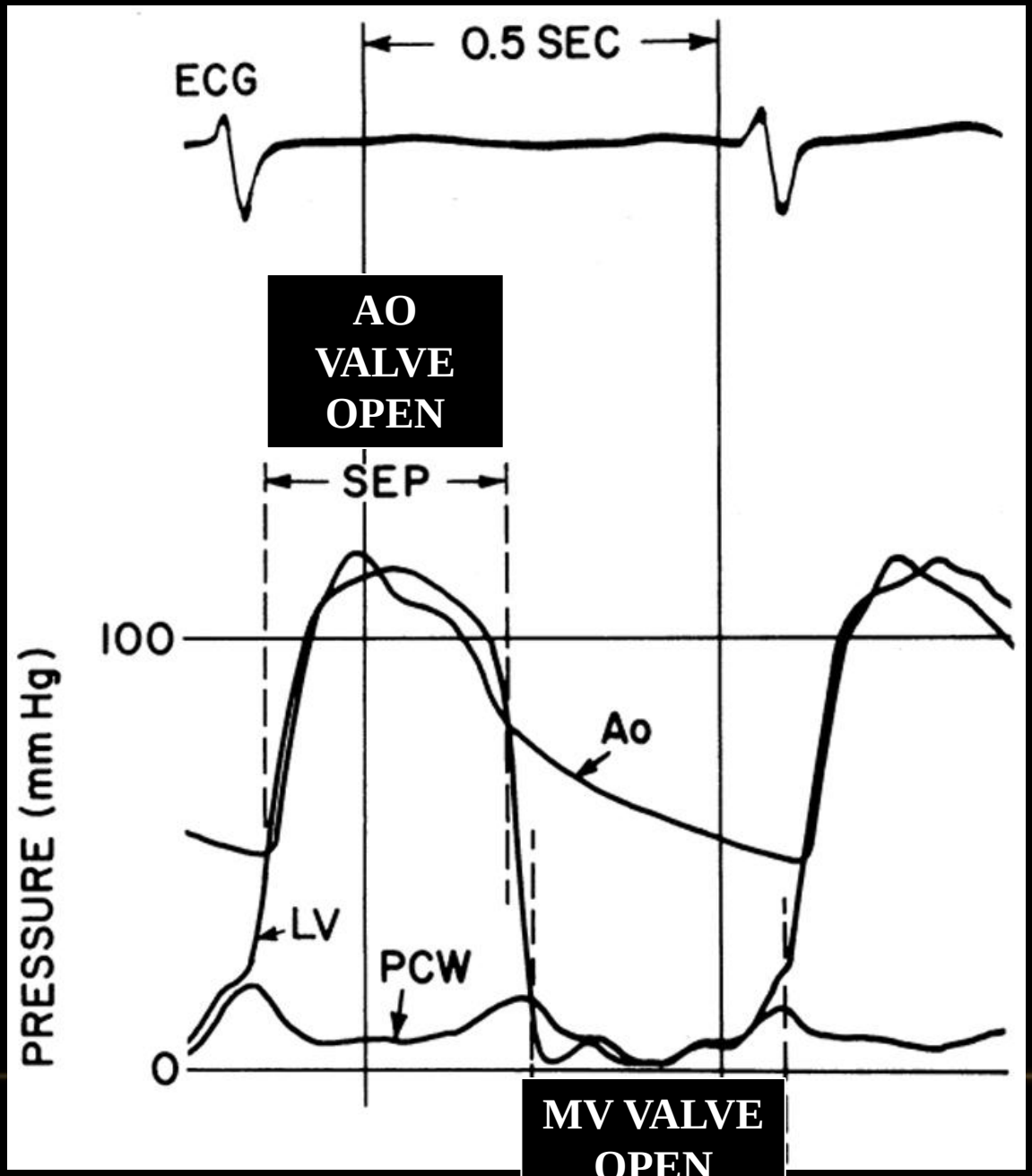
CENTRAL AORTA

REFLECTED WAVEFORM

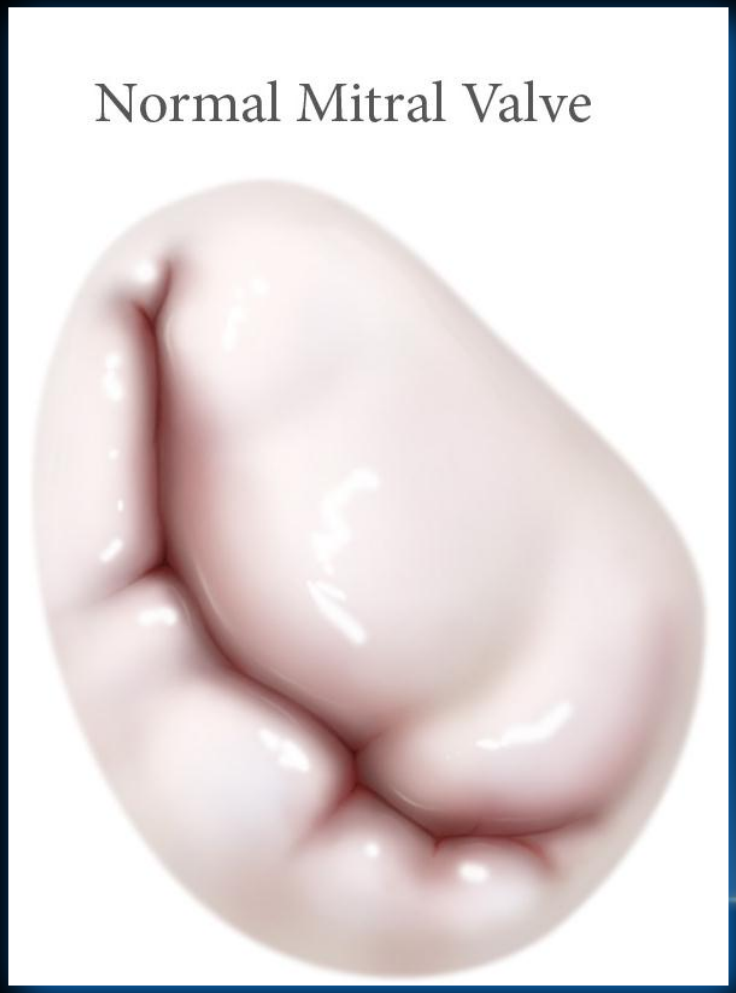
PERIPHERAL WAVEFORM



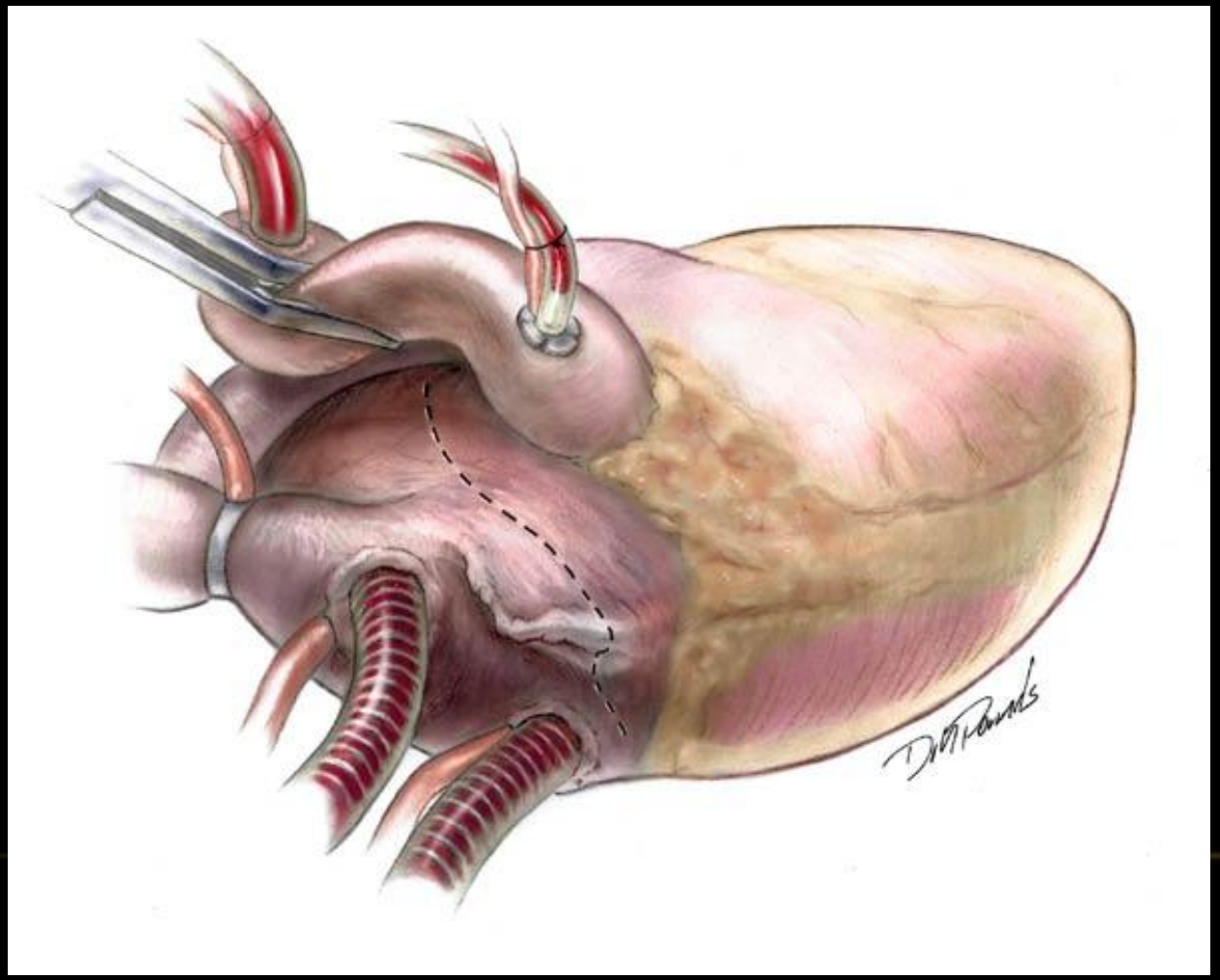
$$P_m = P_f + P_b$$


0.5 SEC
ECG
AO
VALVE
OPEN
SEP
100
PRESSURE (mm Hg)
Ao
LV
PCW
0
MV VALVE
OPEN

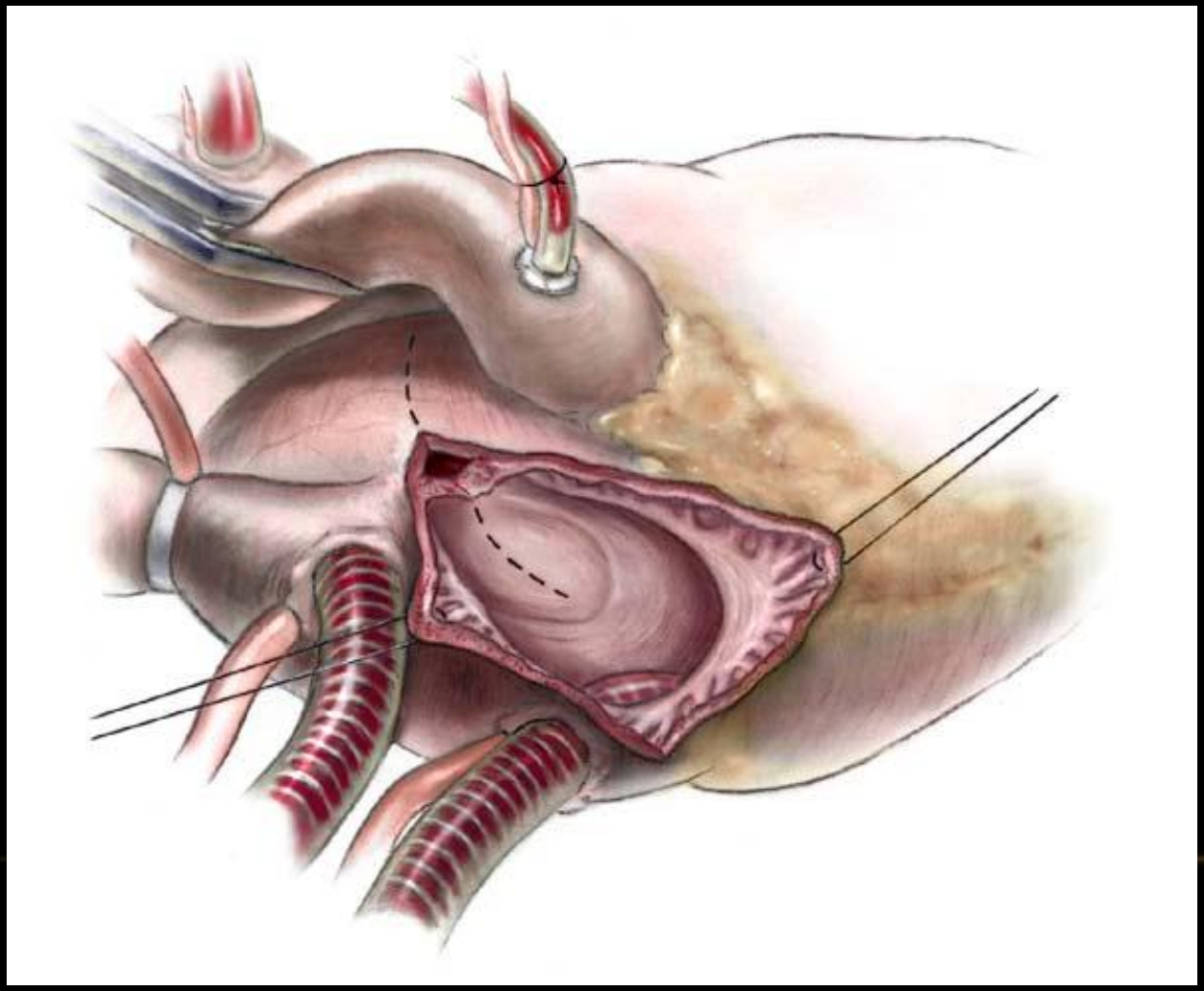
MITRAL STENOSIS: RHEUMATIC



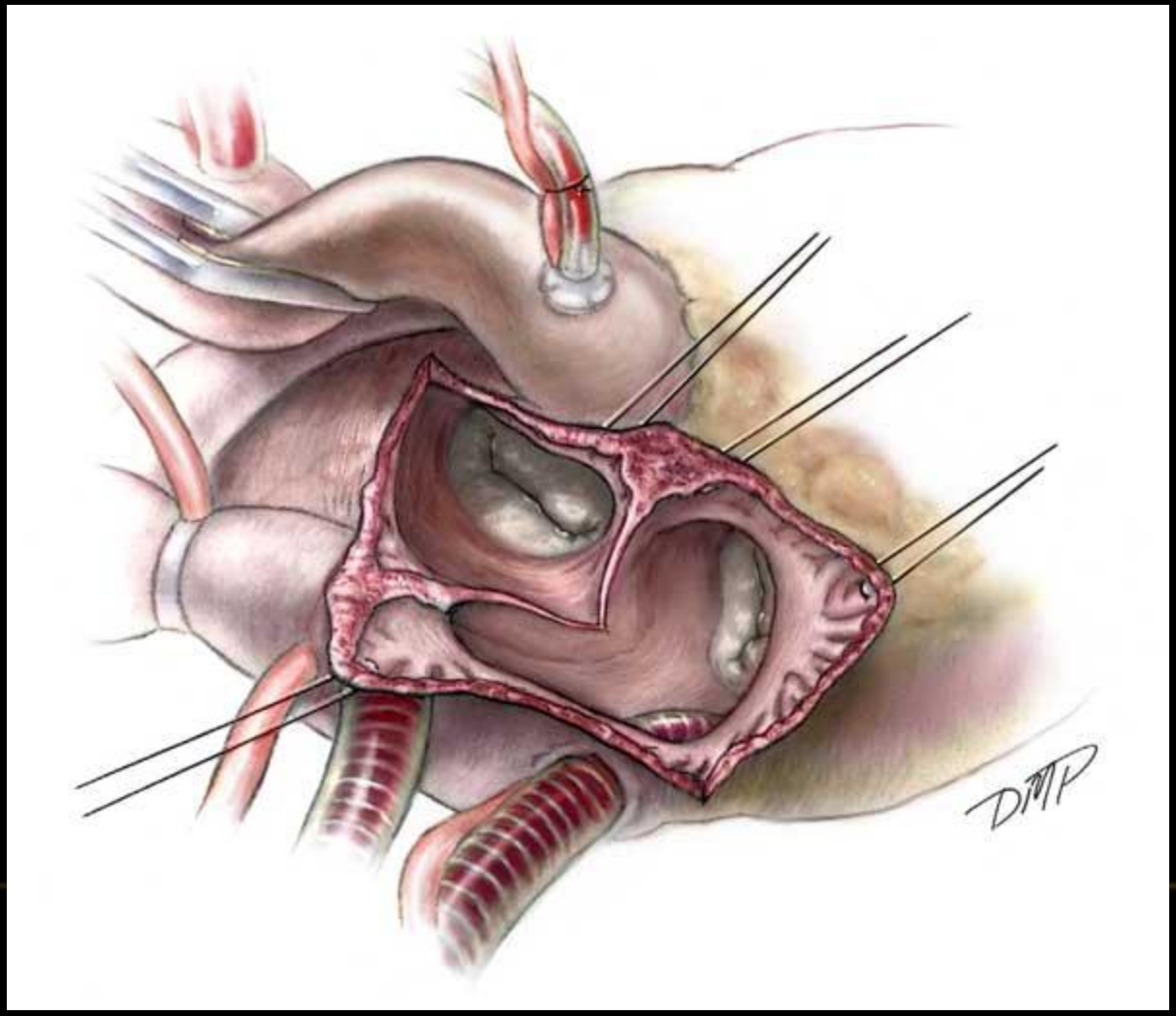
- CARDIOPULMONARY BYPASS
- INCISION AT RA



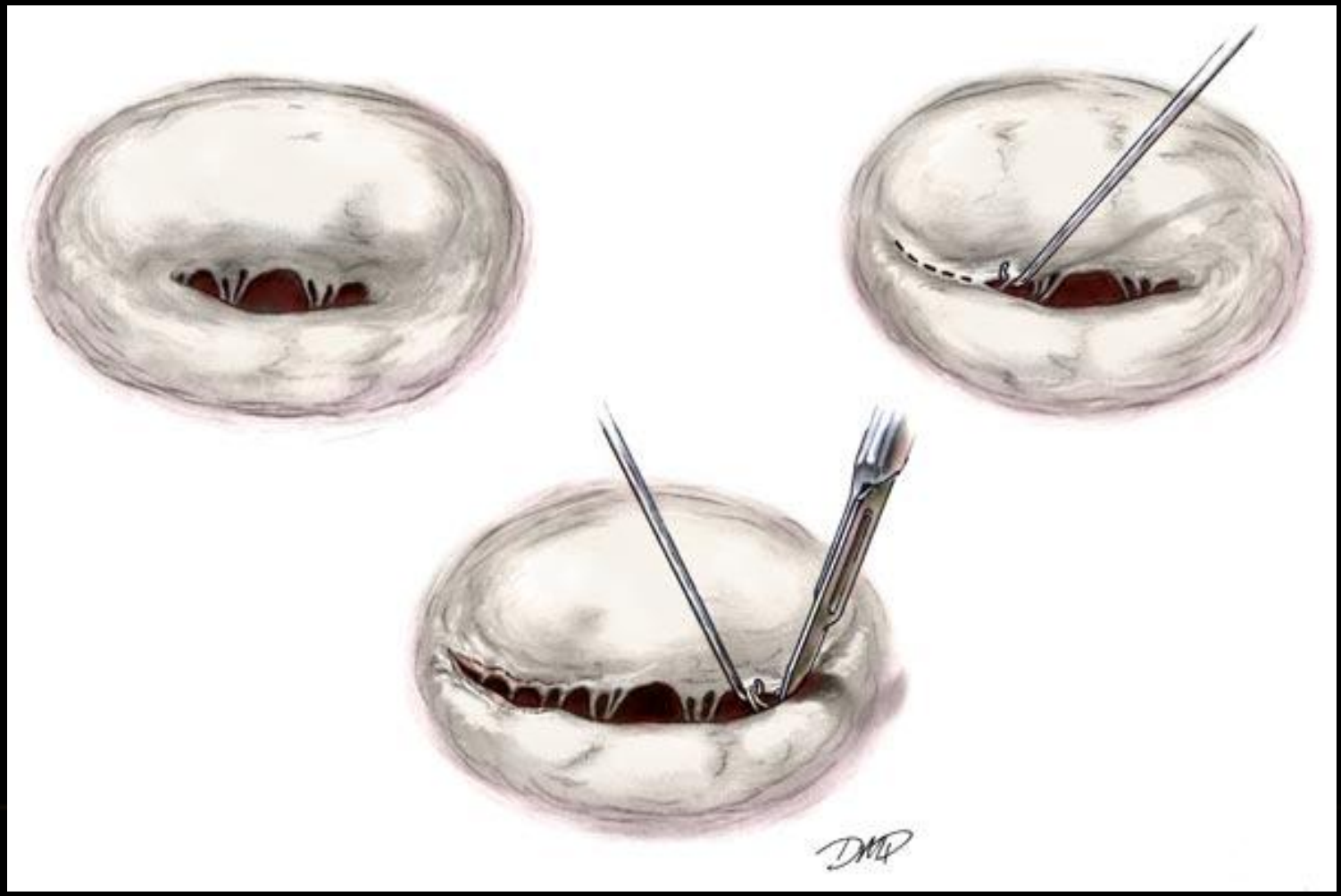
INCISION LA AND IAS TO EXPOSE MV



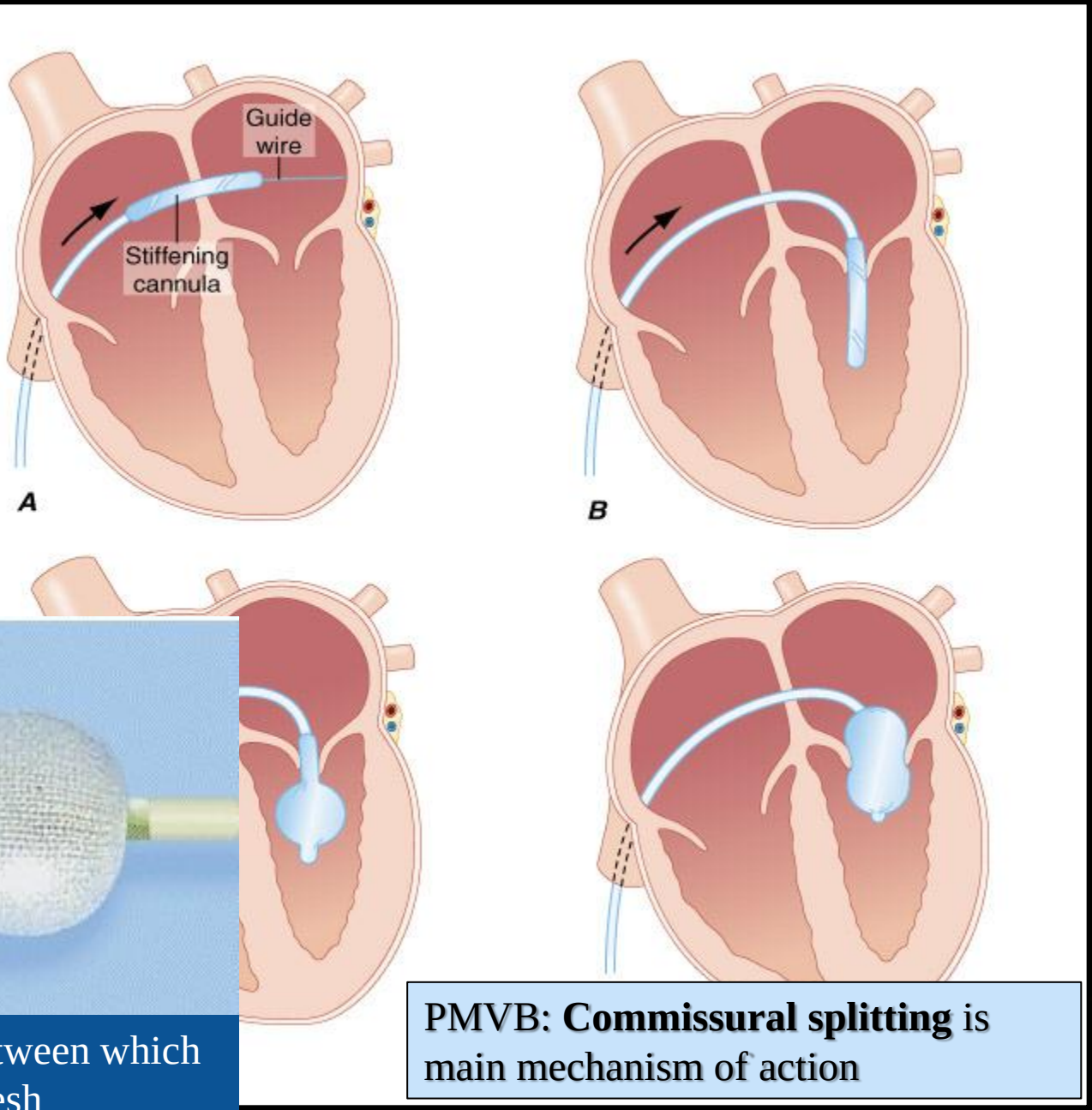
MV EXPOSED FROM ABOVE



MITRAL COMMISSUROTOMY

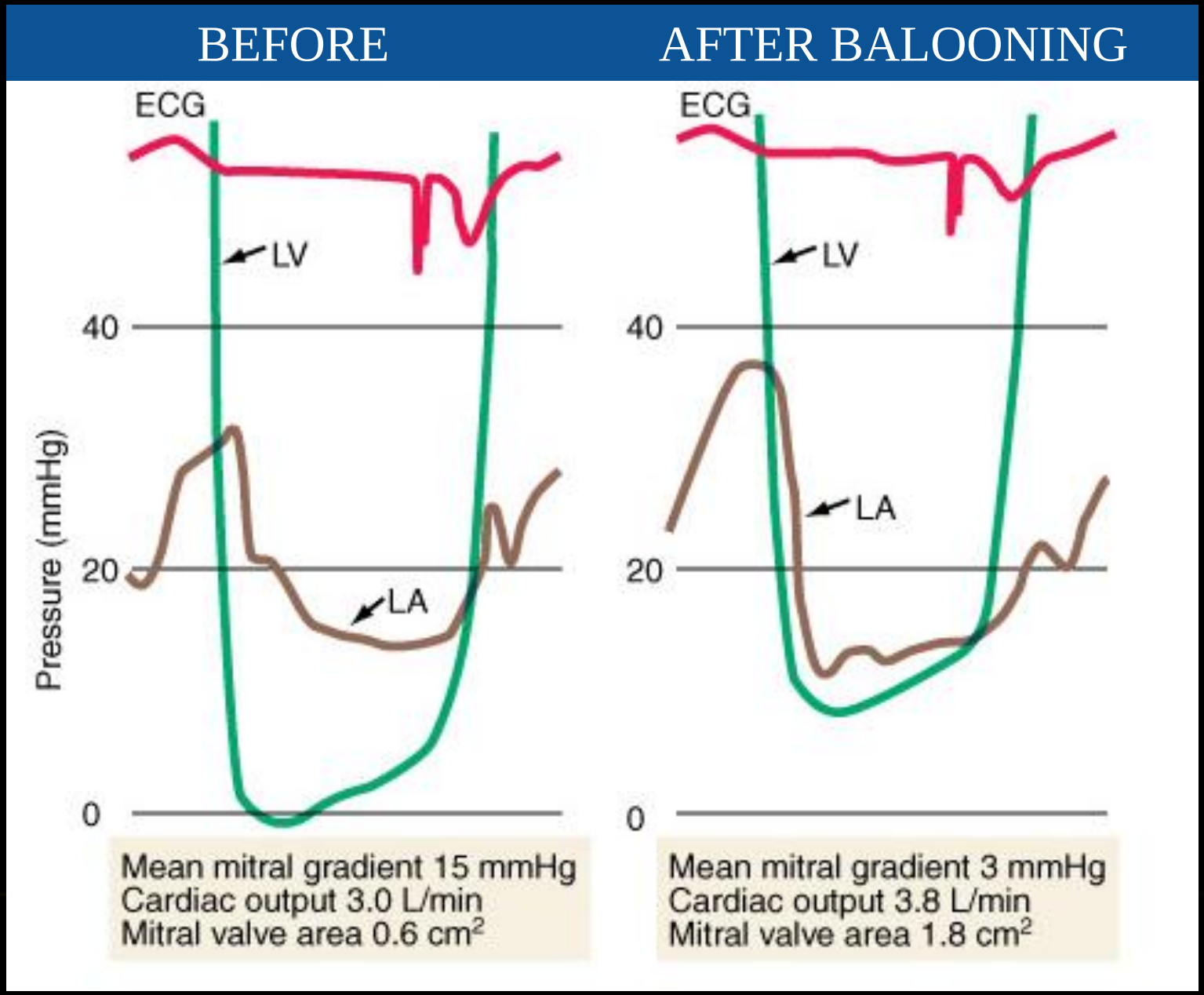


PMBV: INOUE BALLOON

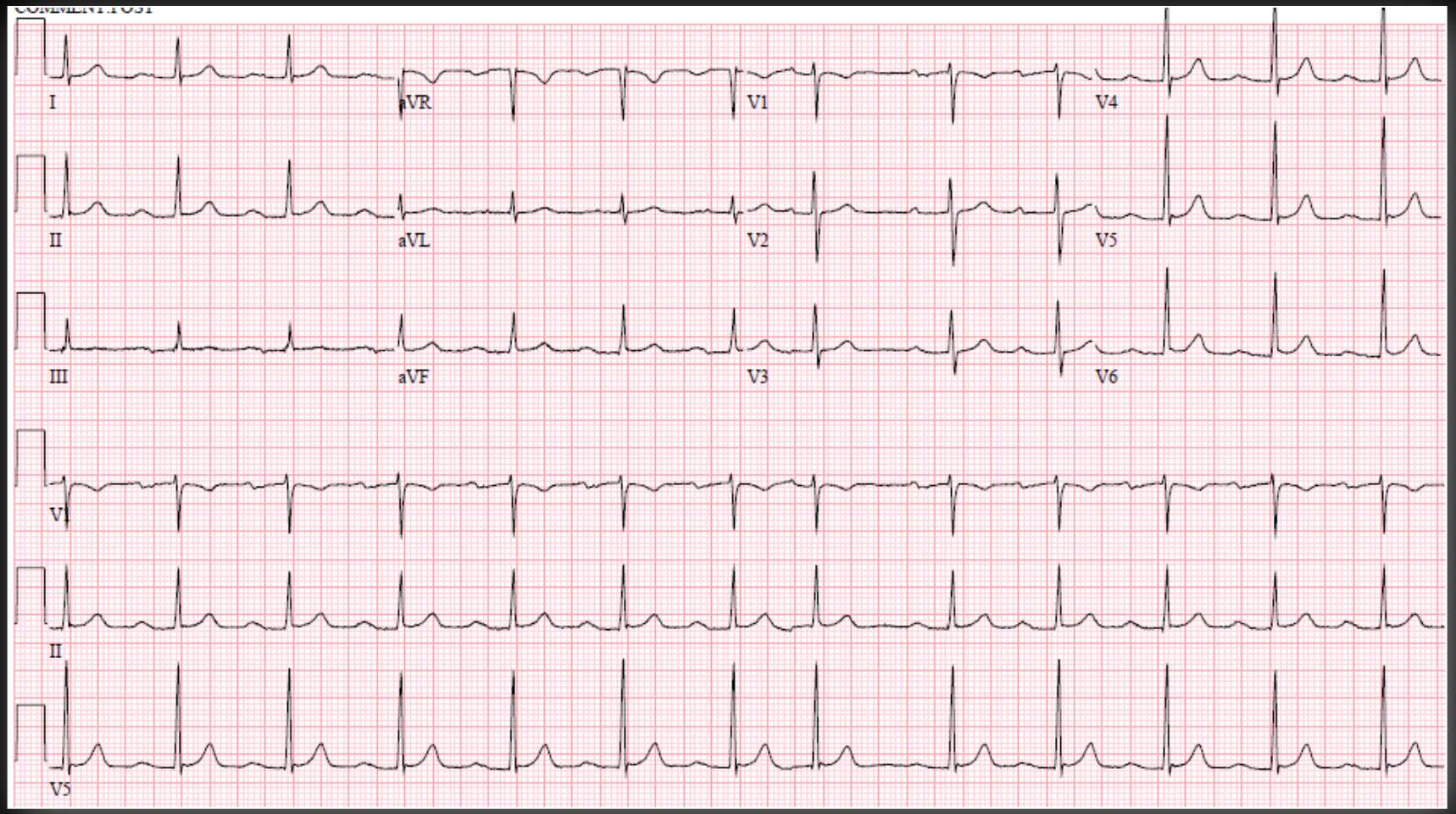


Two latex layers, between which is polyester micromesh

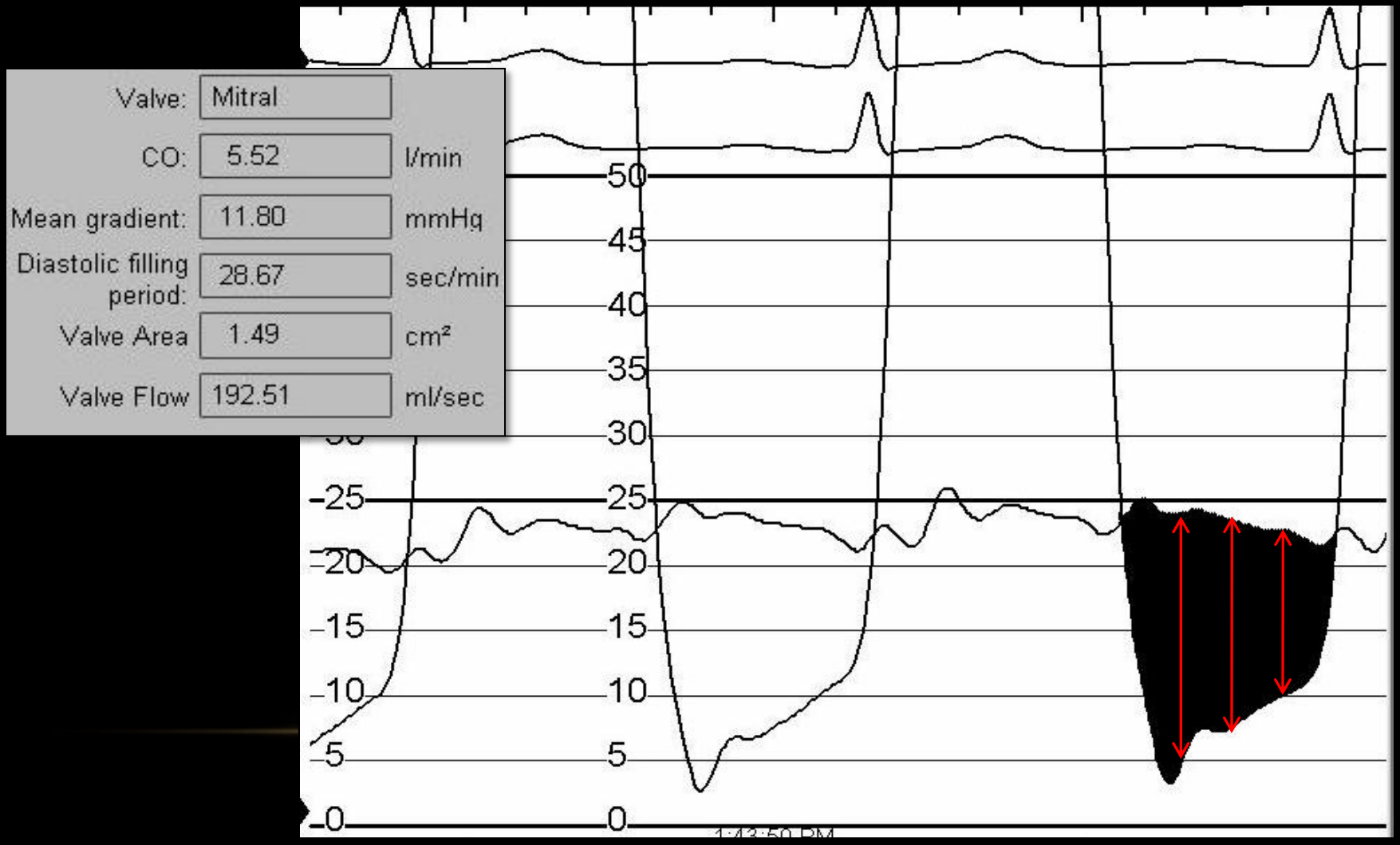
PMVB: **Commissural splitting** is main mechanism of action


BEFORE
AFTER BALOONING
ECG
LV
LA
40
20
0
Pressure (mmHg)
Mean mitral gradient 15 mmHg
Cardiac output 3.0 L/min
Mitral valve area 0.6 cm2
ECG
LV
LA
40
20
0
Mean mitral gradient 3 mmHg
Cardiac output 3.8 L/min
Mitral valve area 1.8 cm2

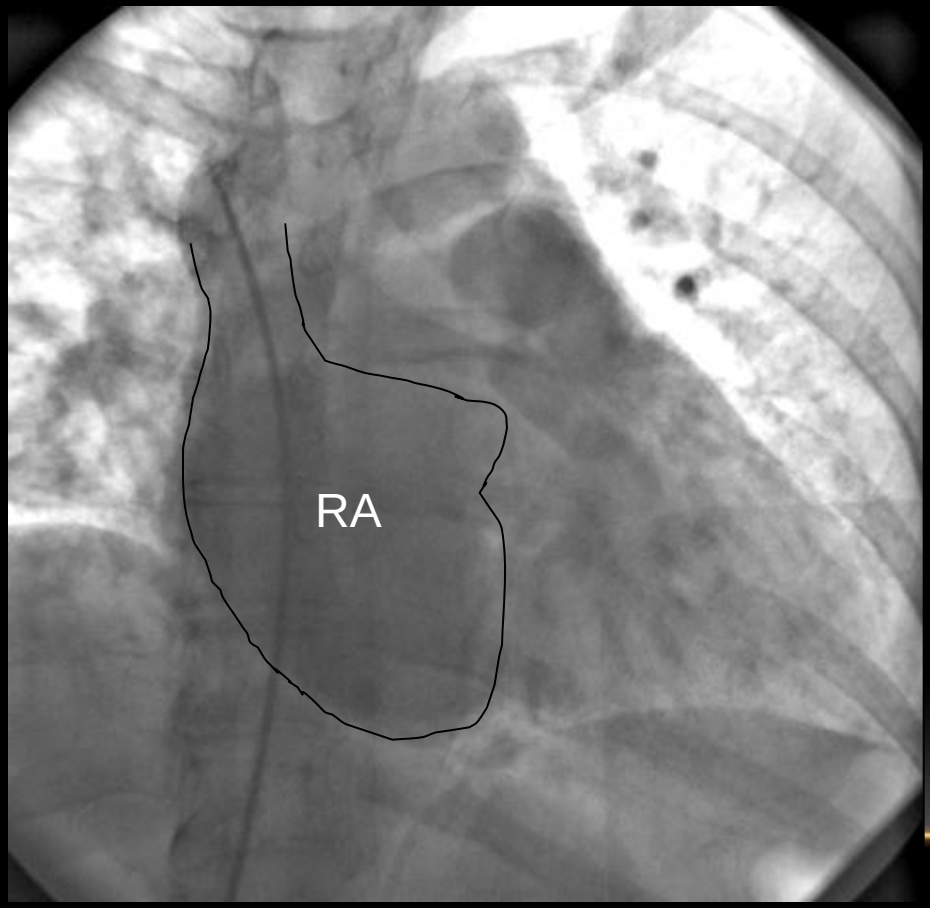
57 yr old female with h/o rheumatic fever at age 12 in Jamaica c/o DOE class III NYHA despite BB. Had open commissurotomy in her 30s.
TTE c/w MS and AVA 1.4, mild MR and PAP 50-60 mmHg.
TEE done. Wilkins score < 8.

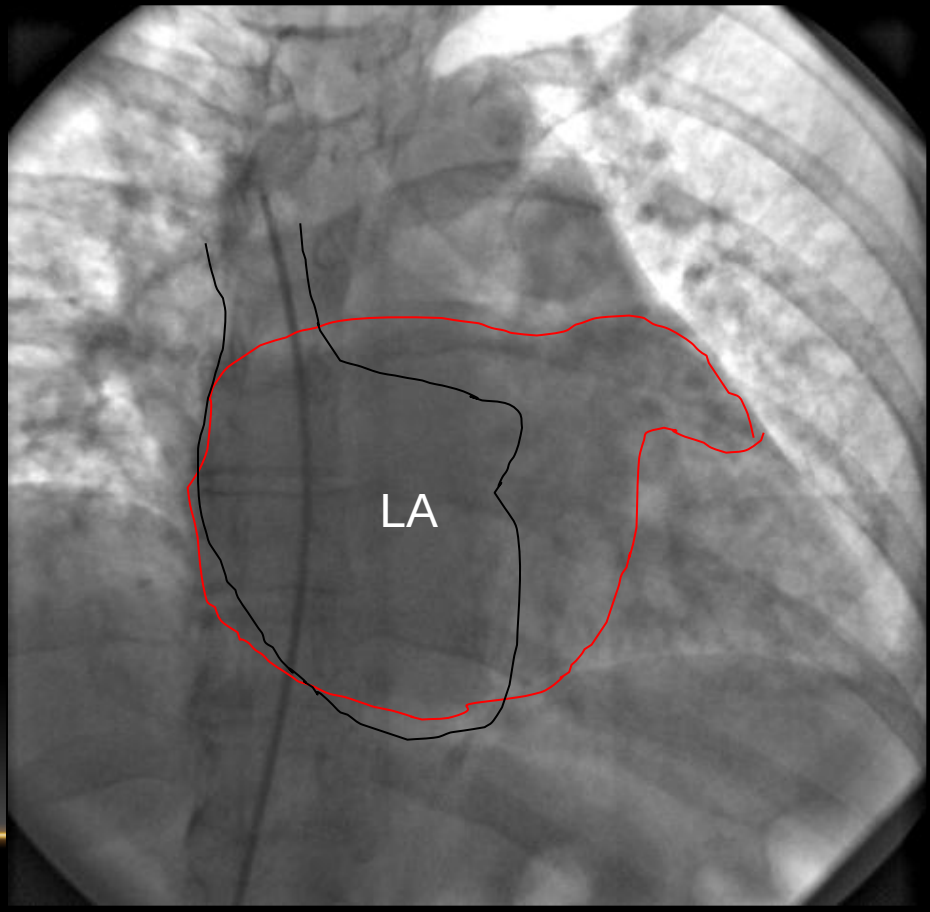


MITRAL STENOSIS

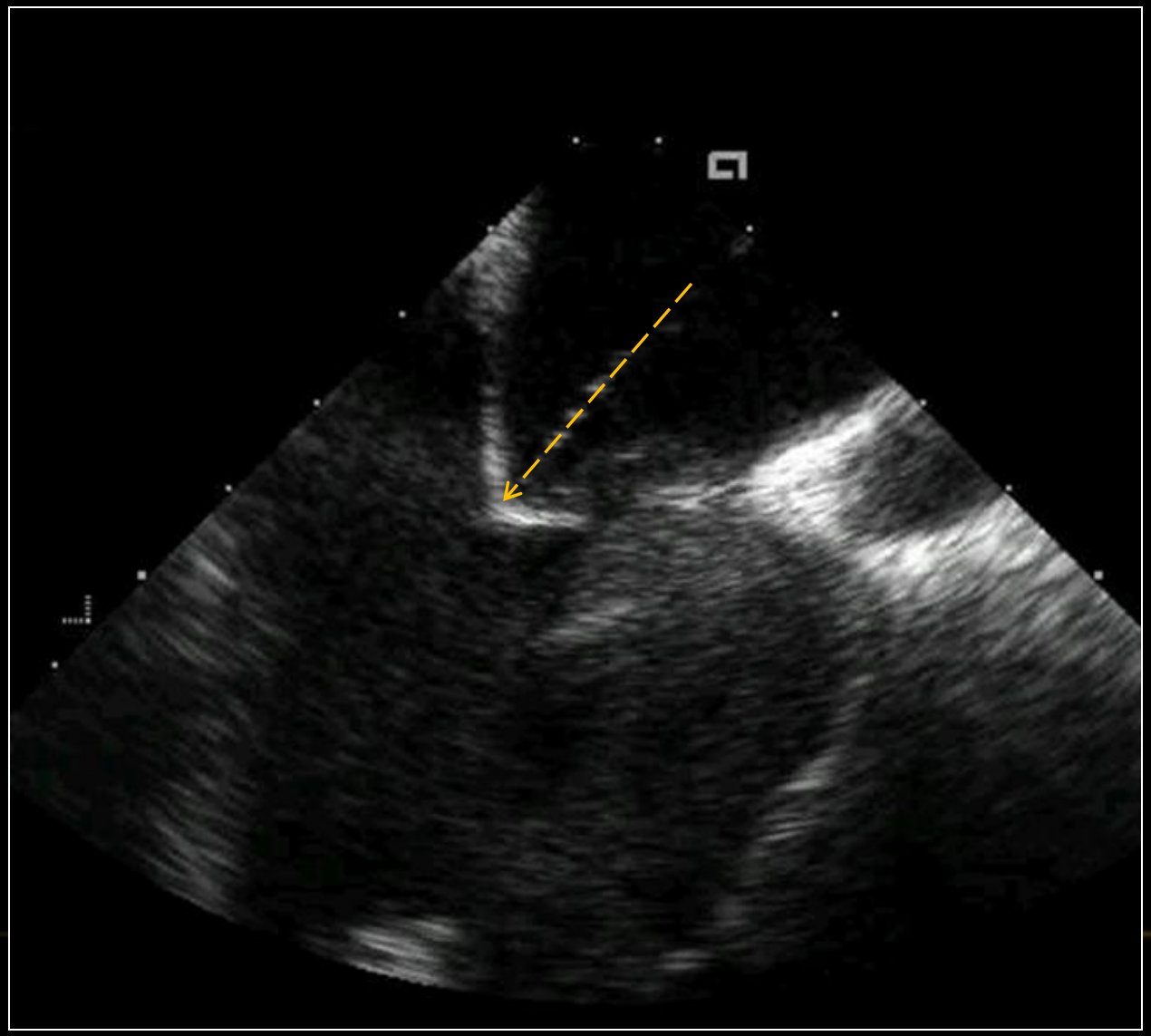


RA AND LA SILHOUETTES

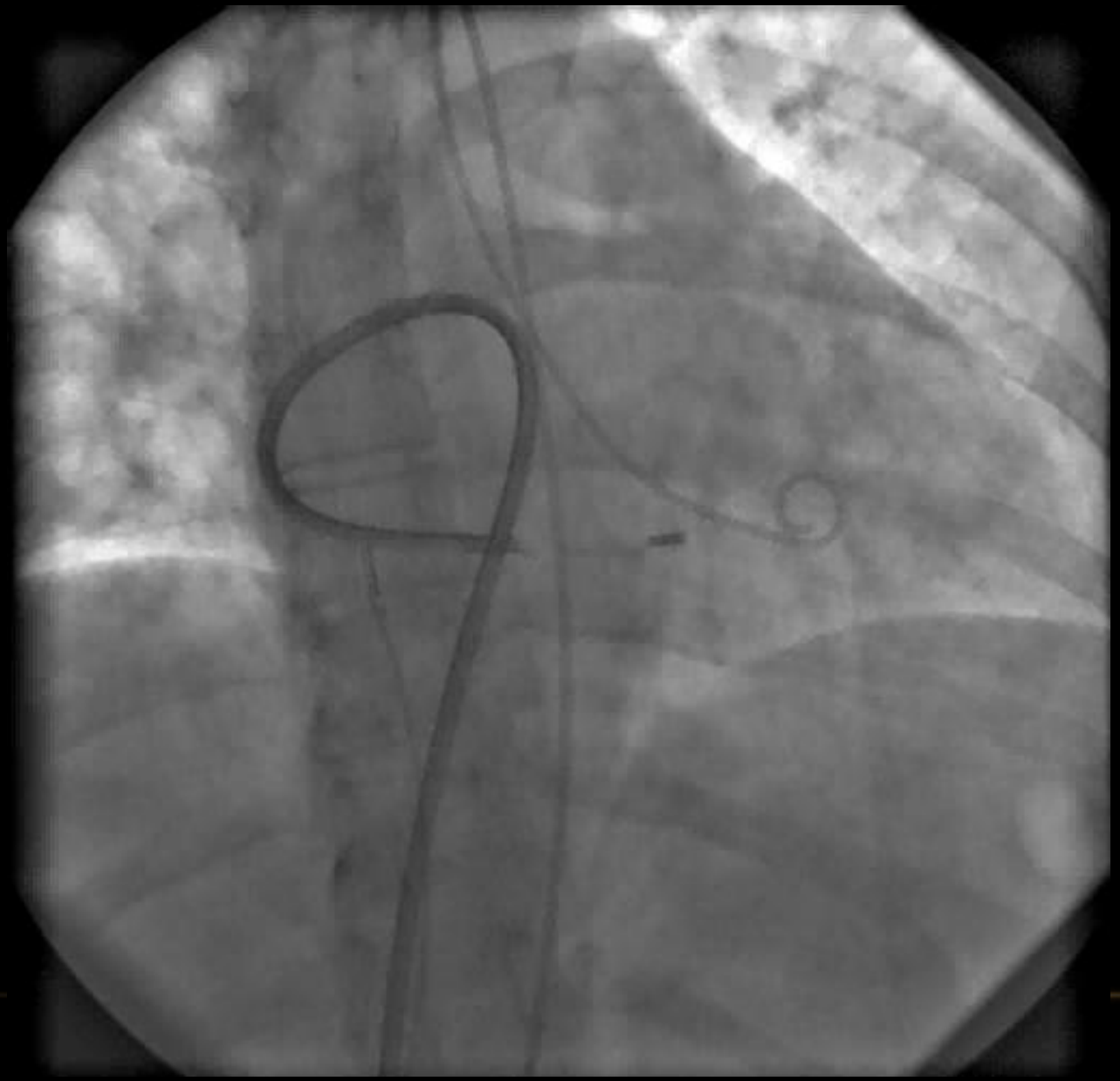




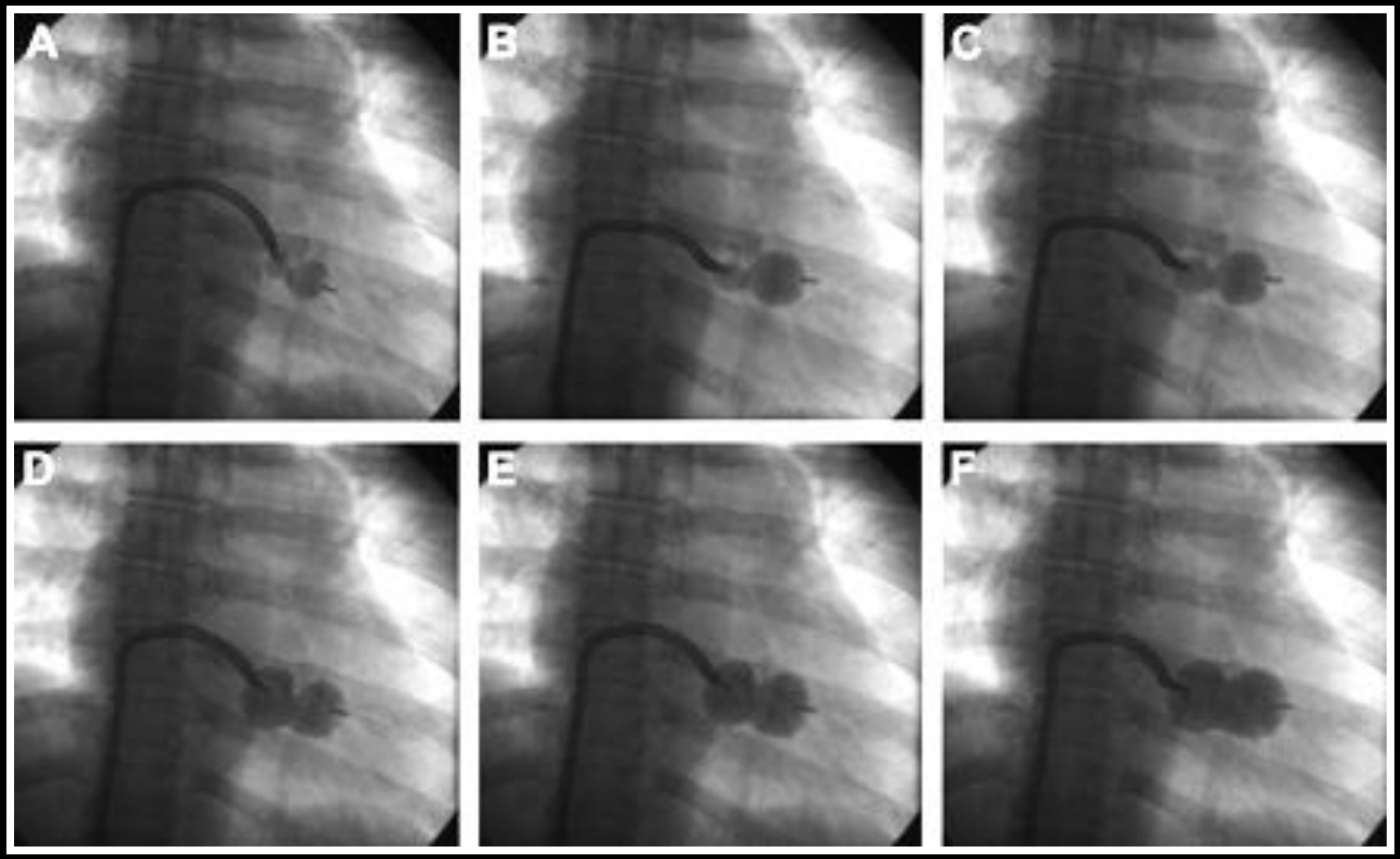
ICE: Transeptal Puncture



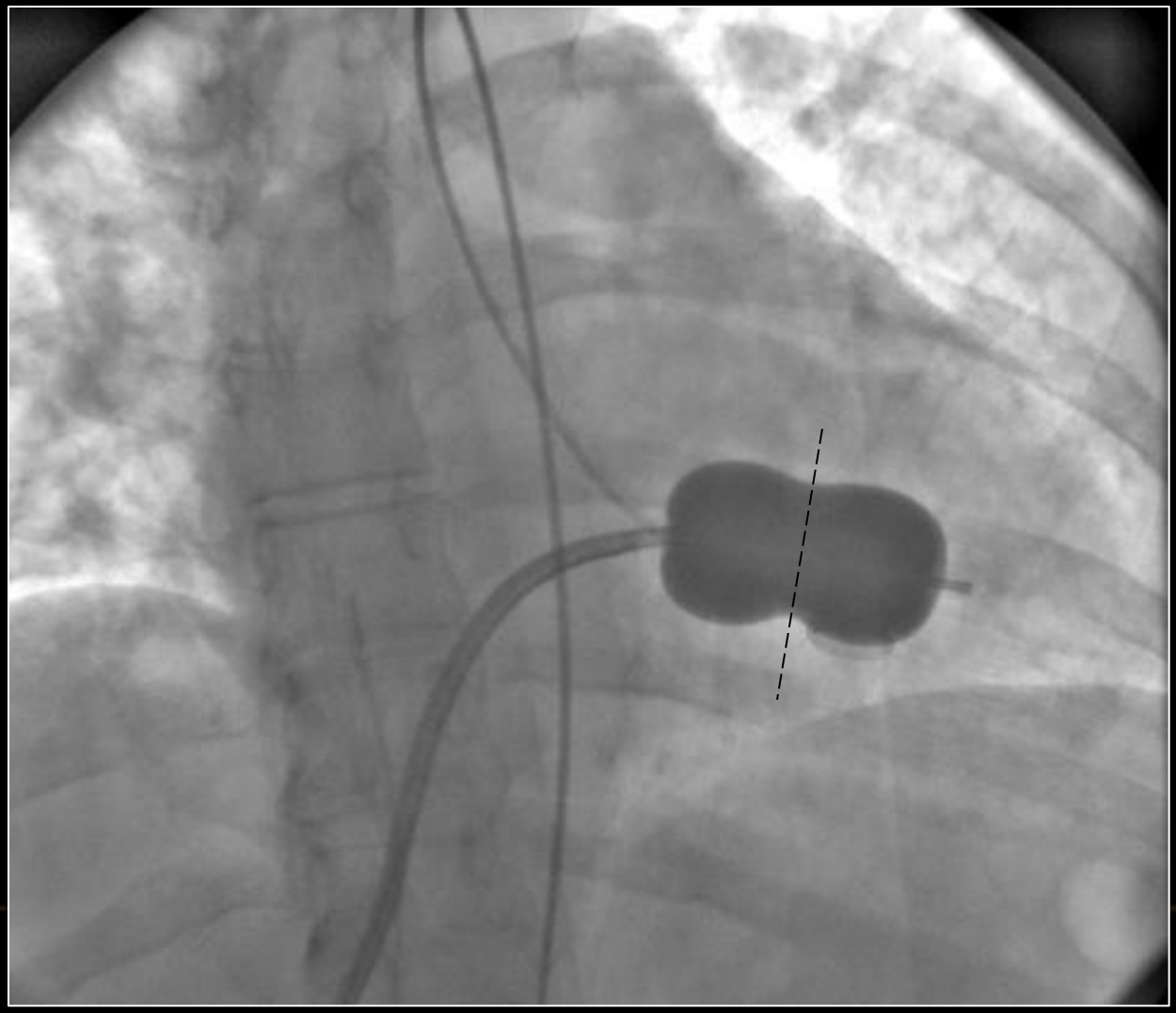
SEPTAL DILATATTION (14F DILATOR)



INOUE BALLOON INFLATION

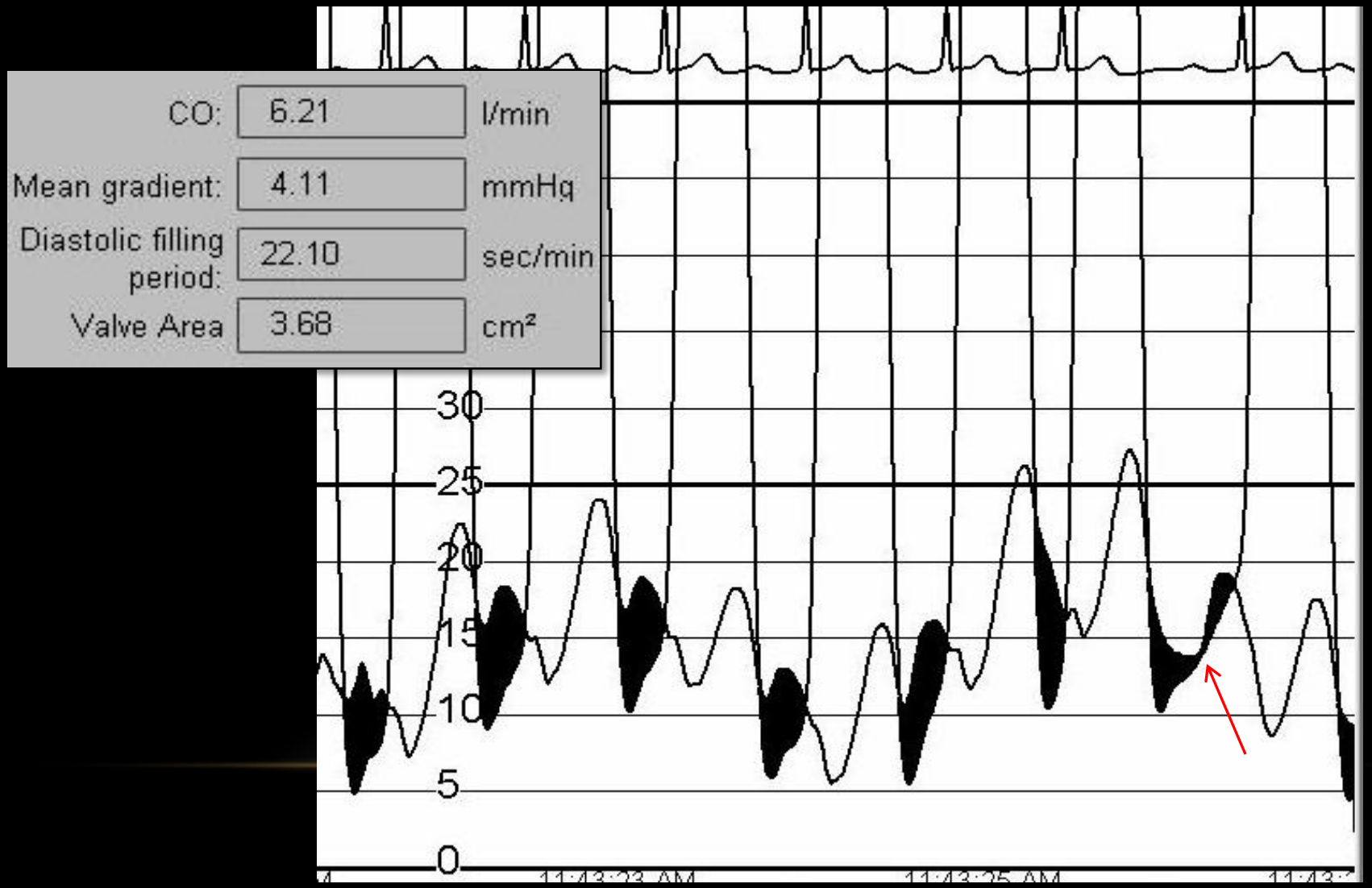


INOUE BALLOON

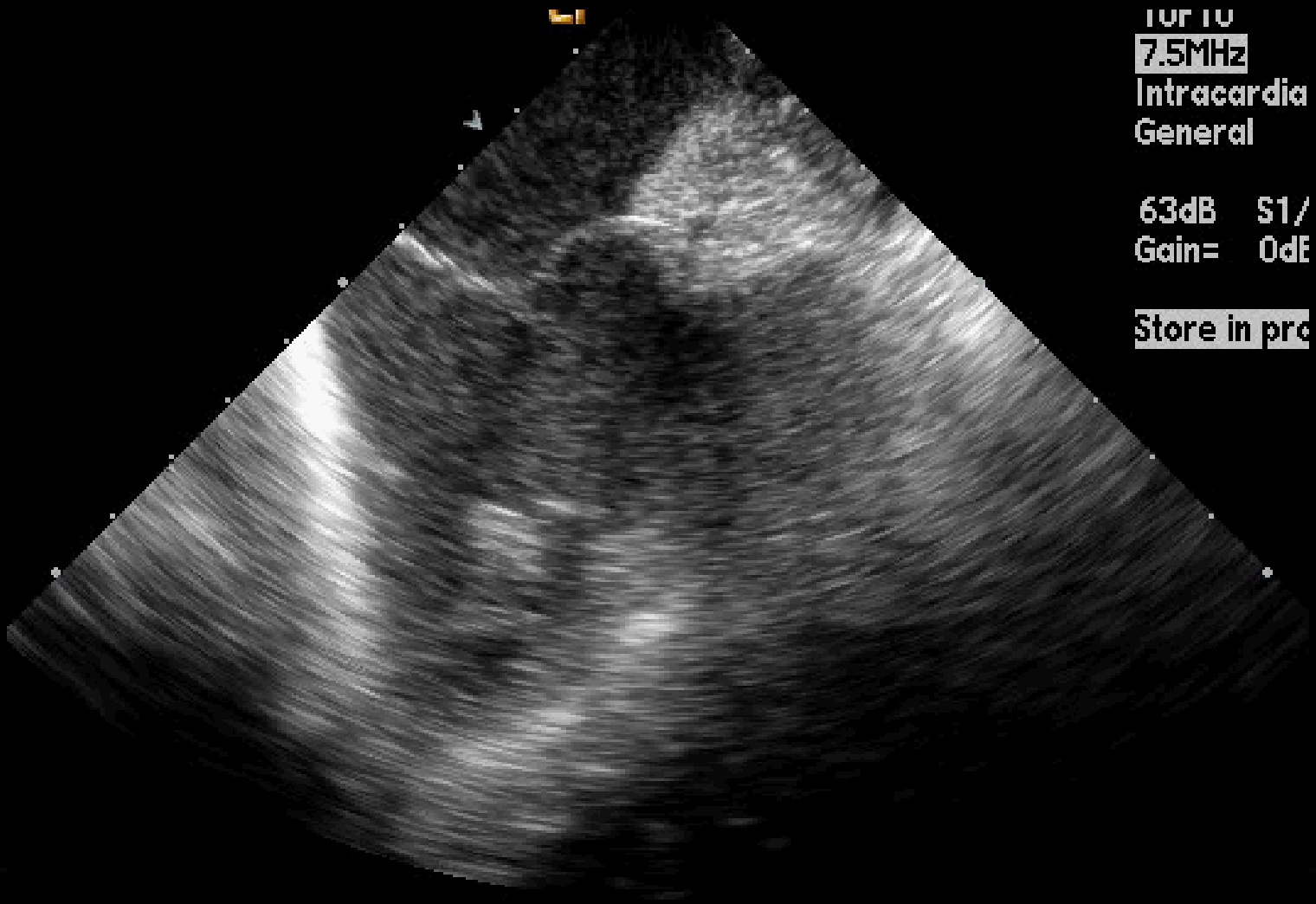


AFTER FIRST INFLATION 24 MM

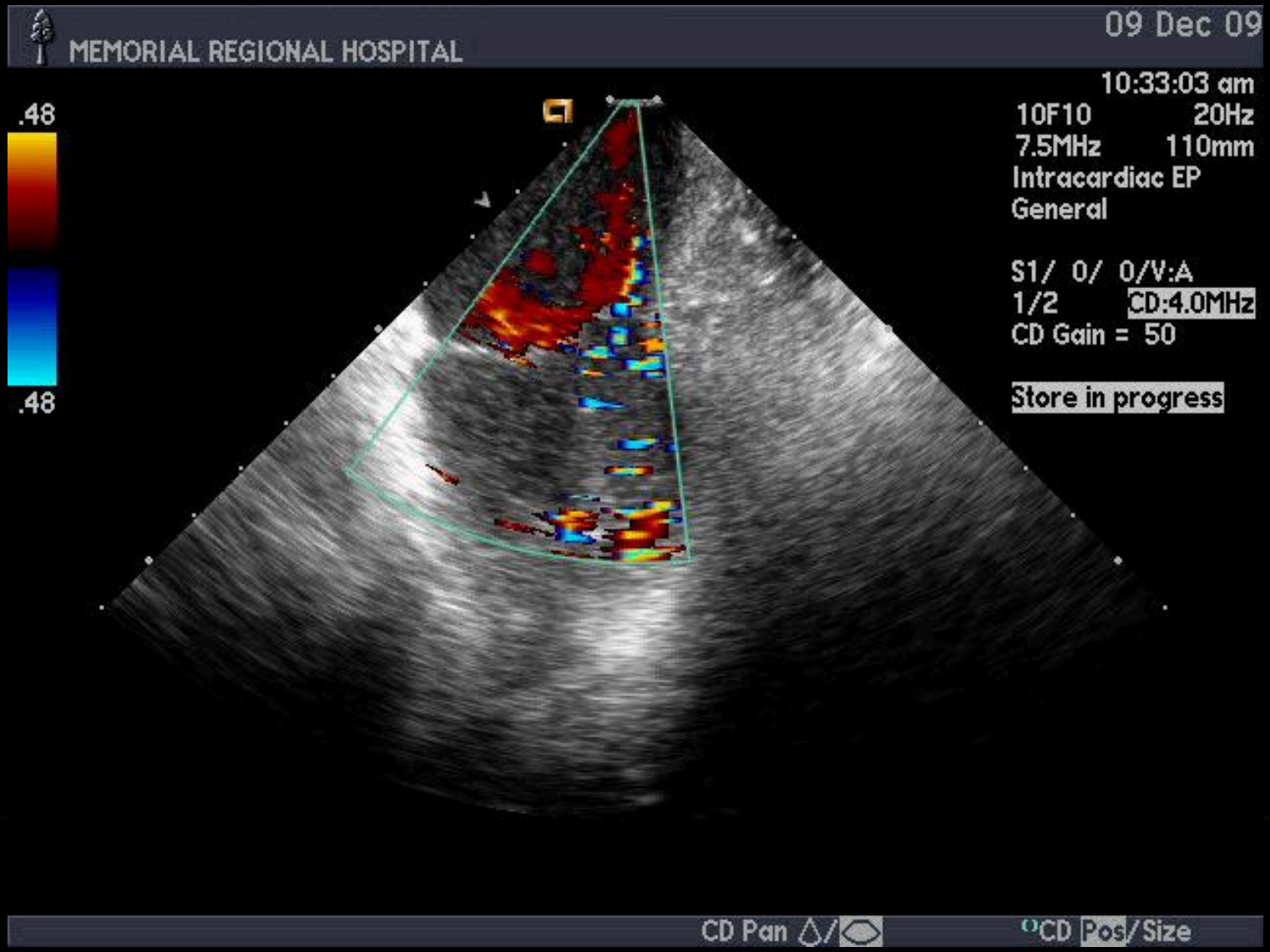
FINAL
AFTER SECOND INFLATION 25 MM



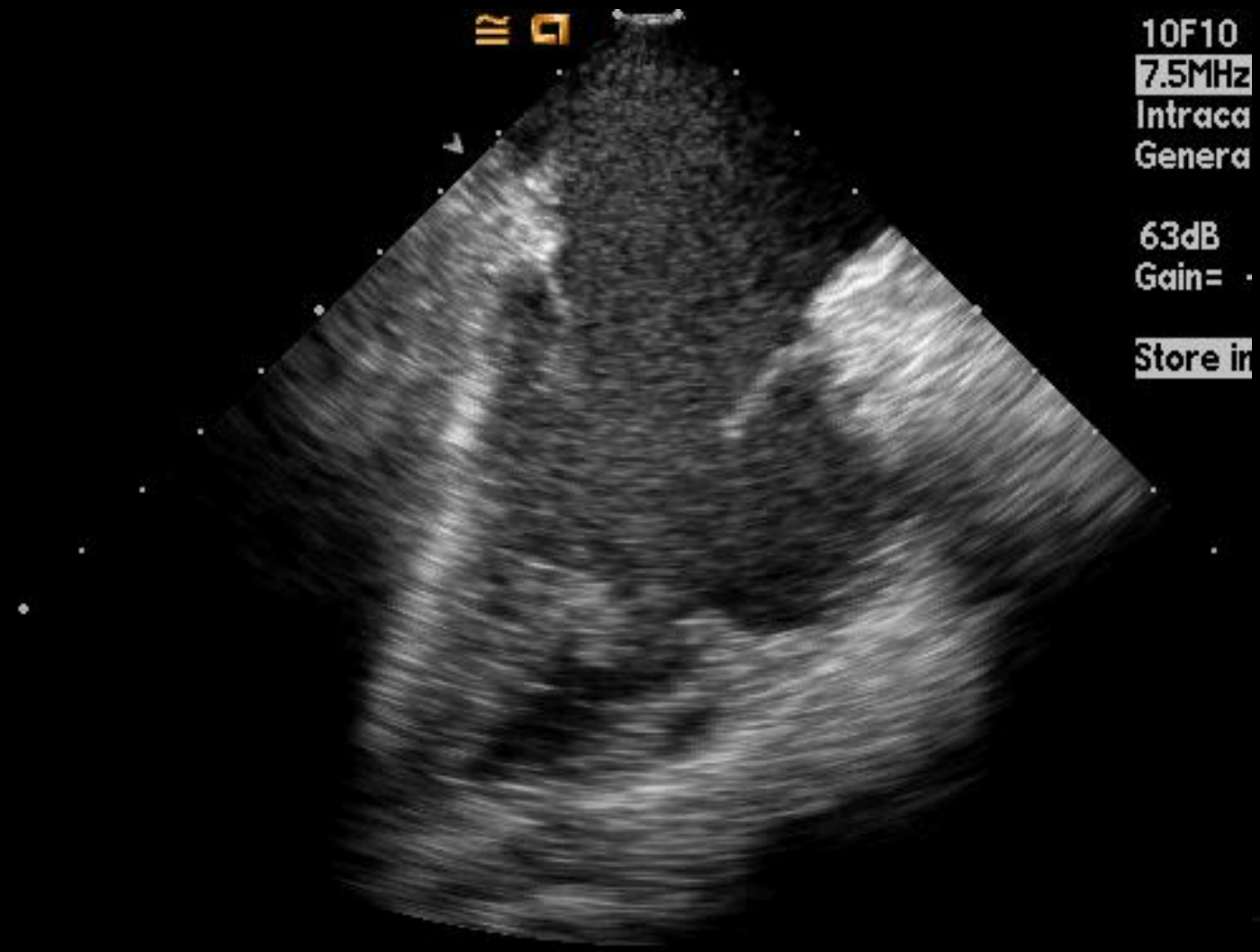
FINAL

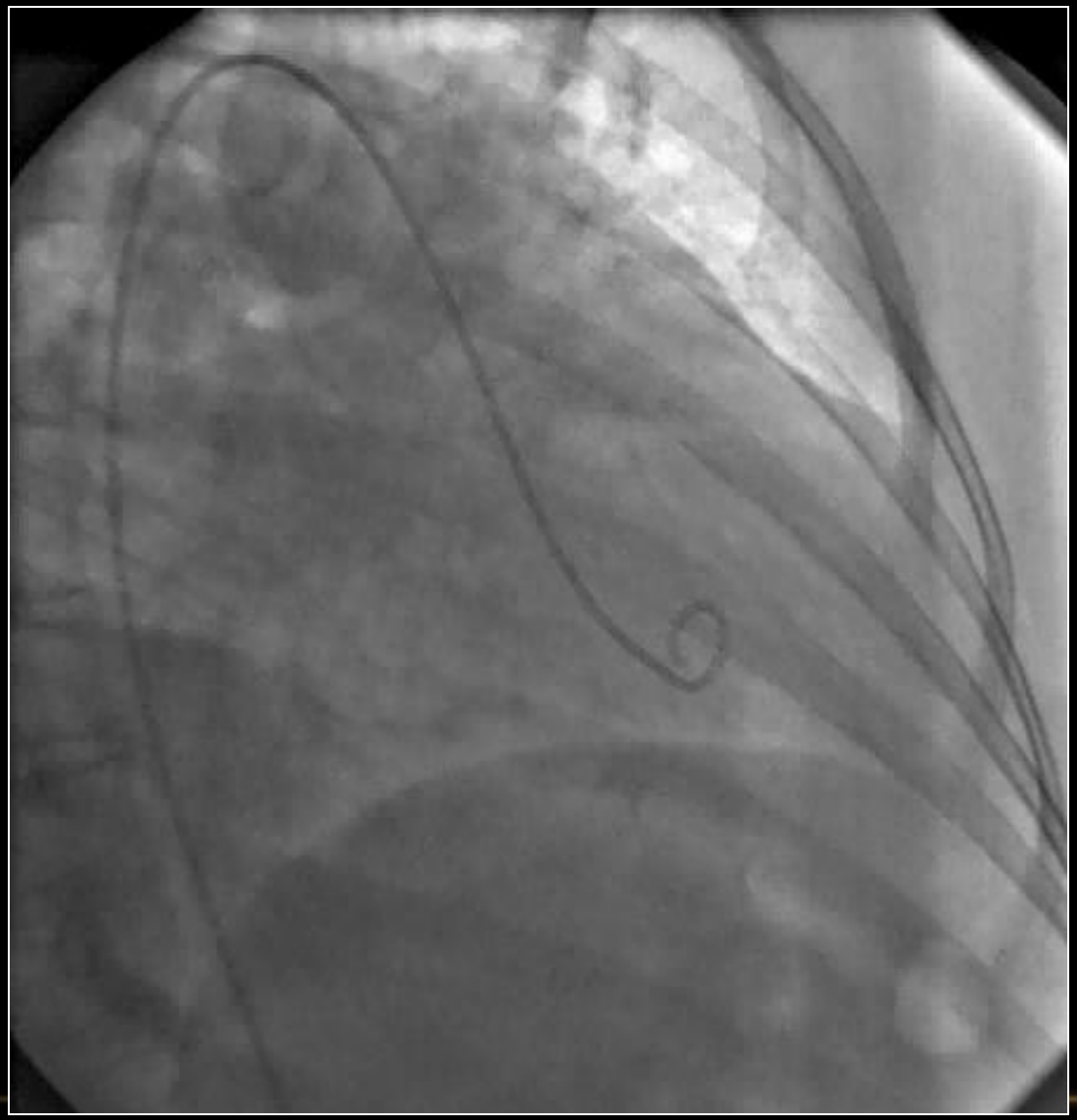


MILD MR AFTER PROCEDURE

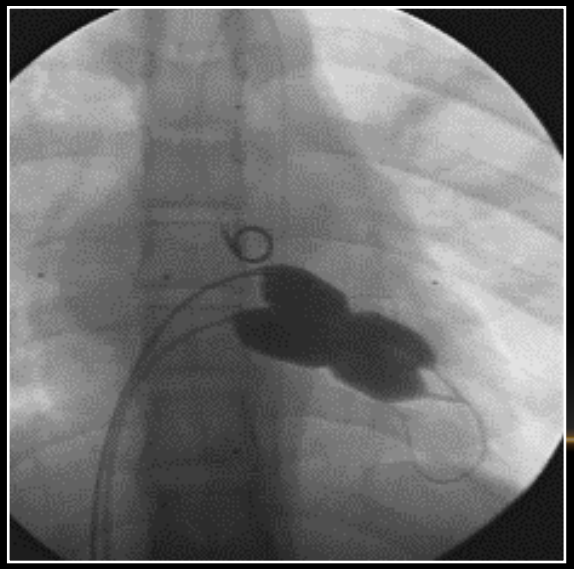


FINAL MV OPENING

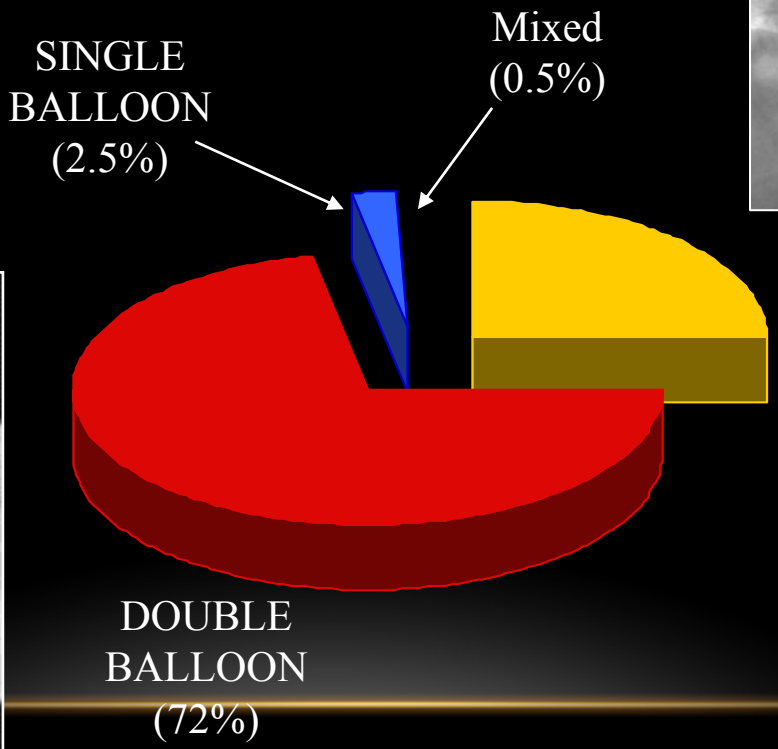


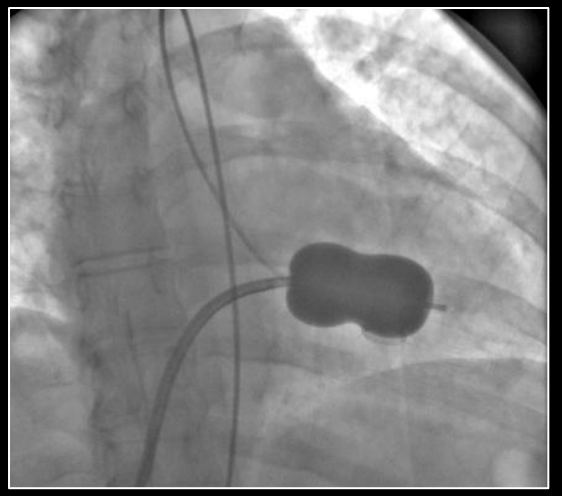


Mitral Balloon Valvuloplasty



PMV Technique





Palacios IF, et al. Circulation 2002; 105: 1465-1471.

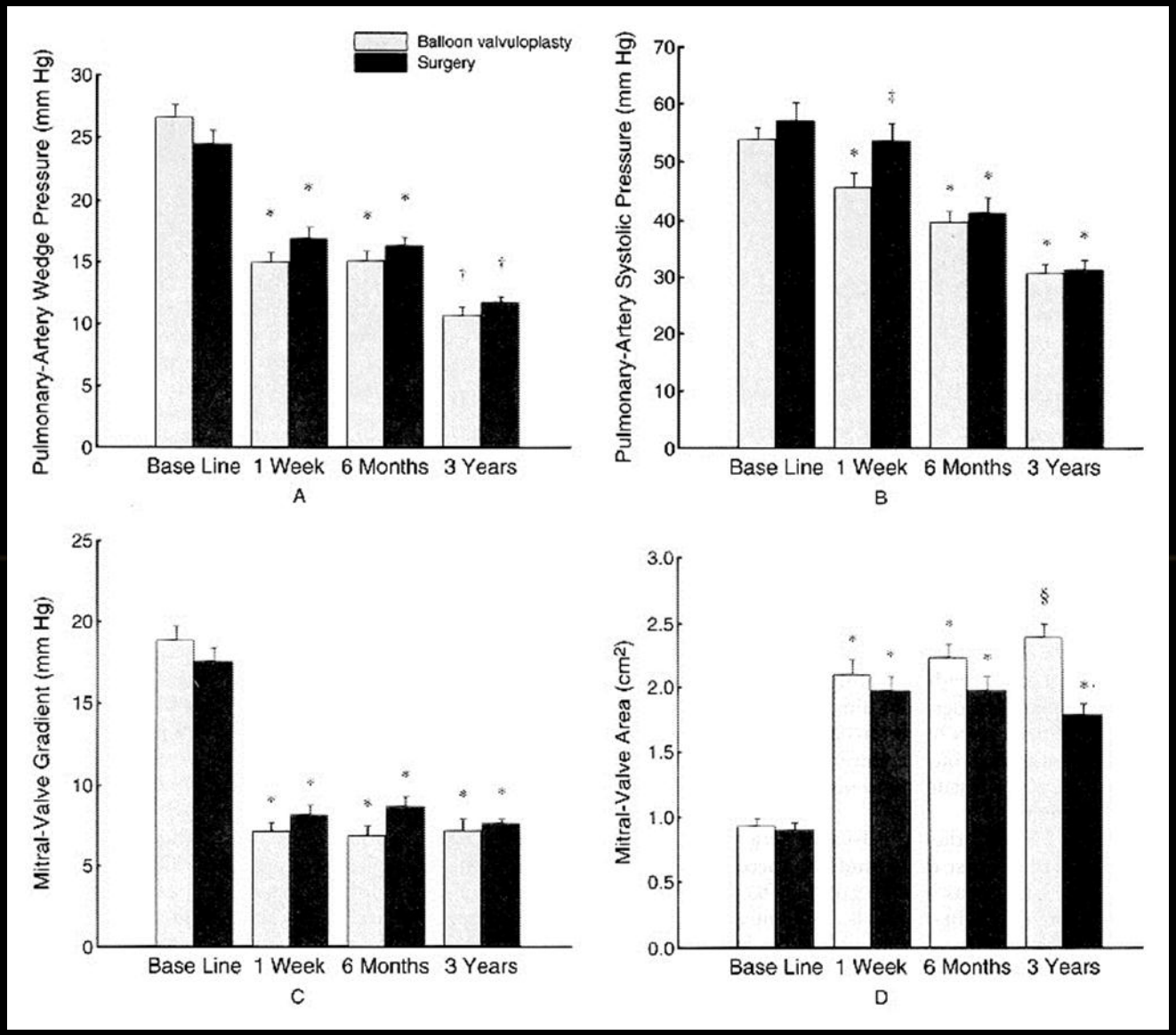
Mitral Balloon Valvuloplasty

COMPLICATIONS

• Procedure Mortality	0.6%
• In-Hospital Mortality	1.9%
• Severe (4 +) MR	2.7%
• Emergency MVR	1.4%
• Tamponade	0.8%
• Stroke	1.2%

Palacios IF, et al. Circulation 2002; 105: 1465-1471.

PMBV Vs Open Surgical Commissurotomy (n=60 patients)



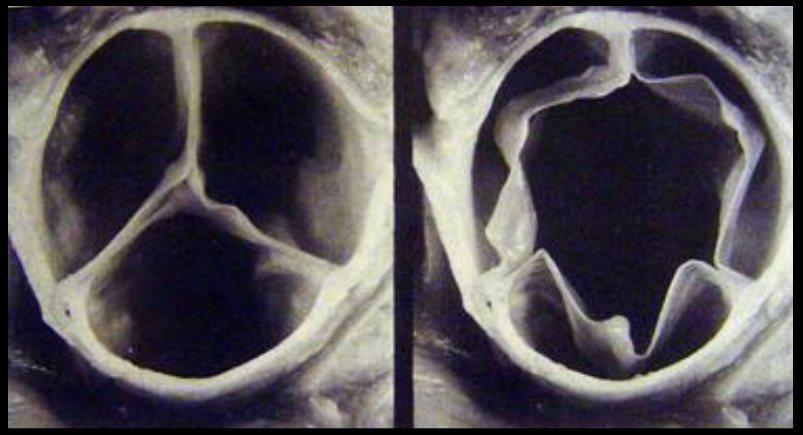
Reyes V et al. N Engl J Med 1994;331:961-967

The NEW ENGLAND JOURNAL of MEDICINE

2006 AHA/ACC GUIDELINES

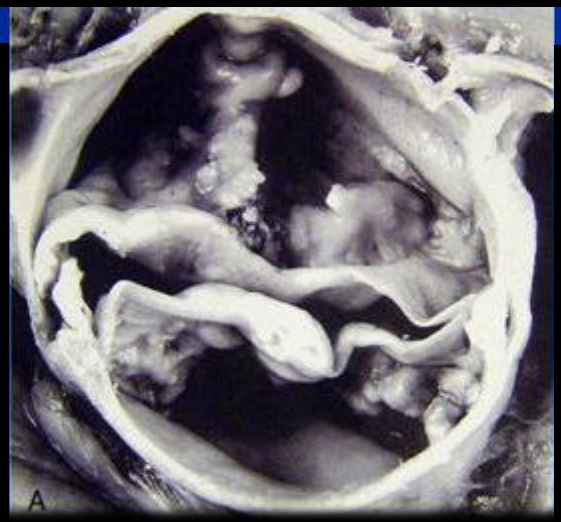
“ In centers with skilled, experienced operators, percutaneous balloon valvotomy should be considered the *INITIAL PROCEDURE OF CHOICE* for symptomatic patients with moderate to severe mitral stenosis who have a favorable valve morphology in the absence of significant MR or LA thrombus”.

Aortic Stenosis Pathology



Normal

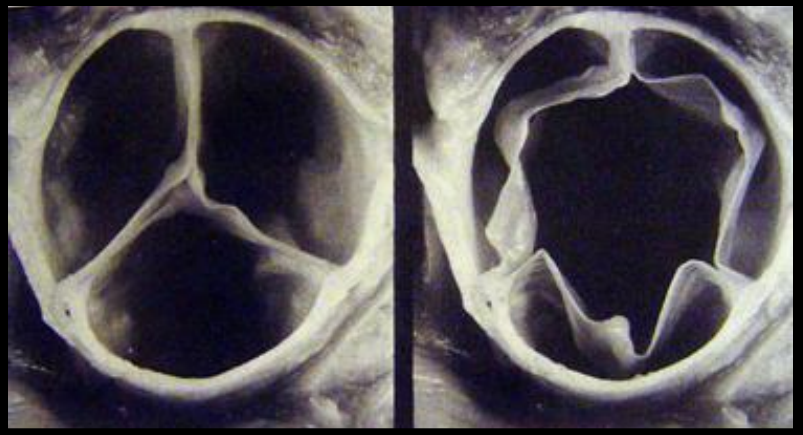
Degenerative Calcified



Bicuspid

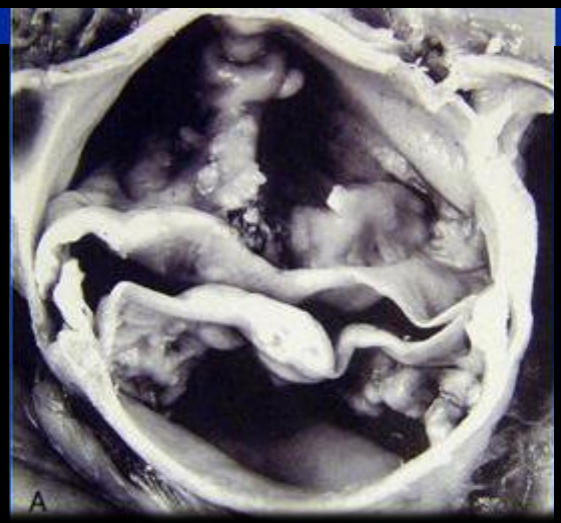
Rheumatic

Aortic Stenosis Currently



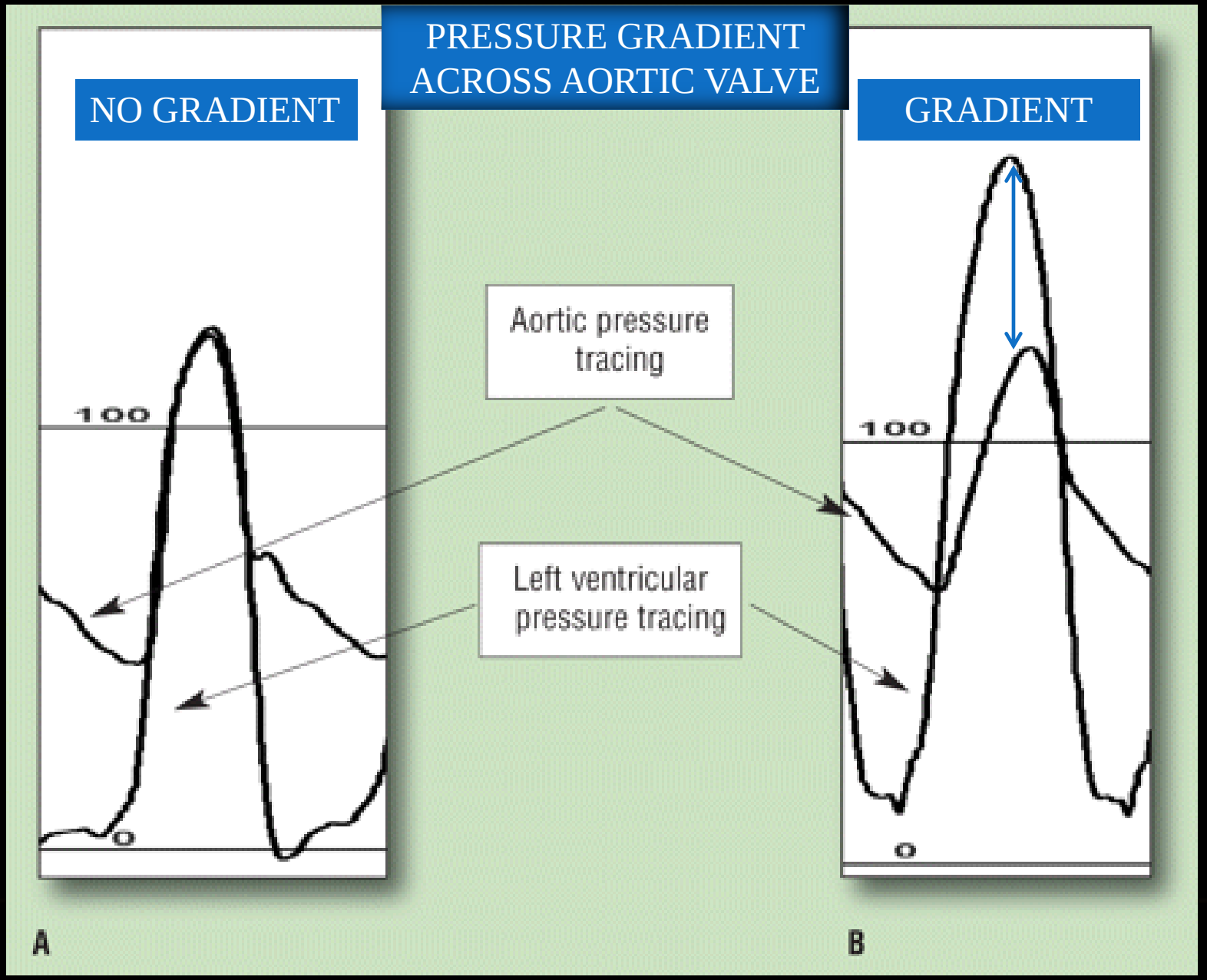
Normal

Degenerative Calcified

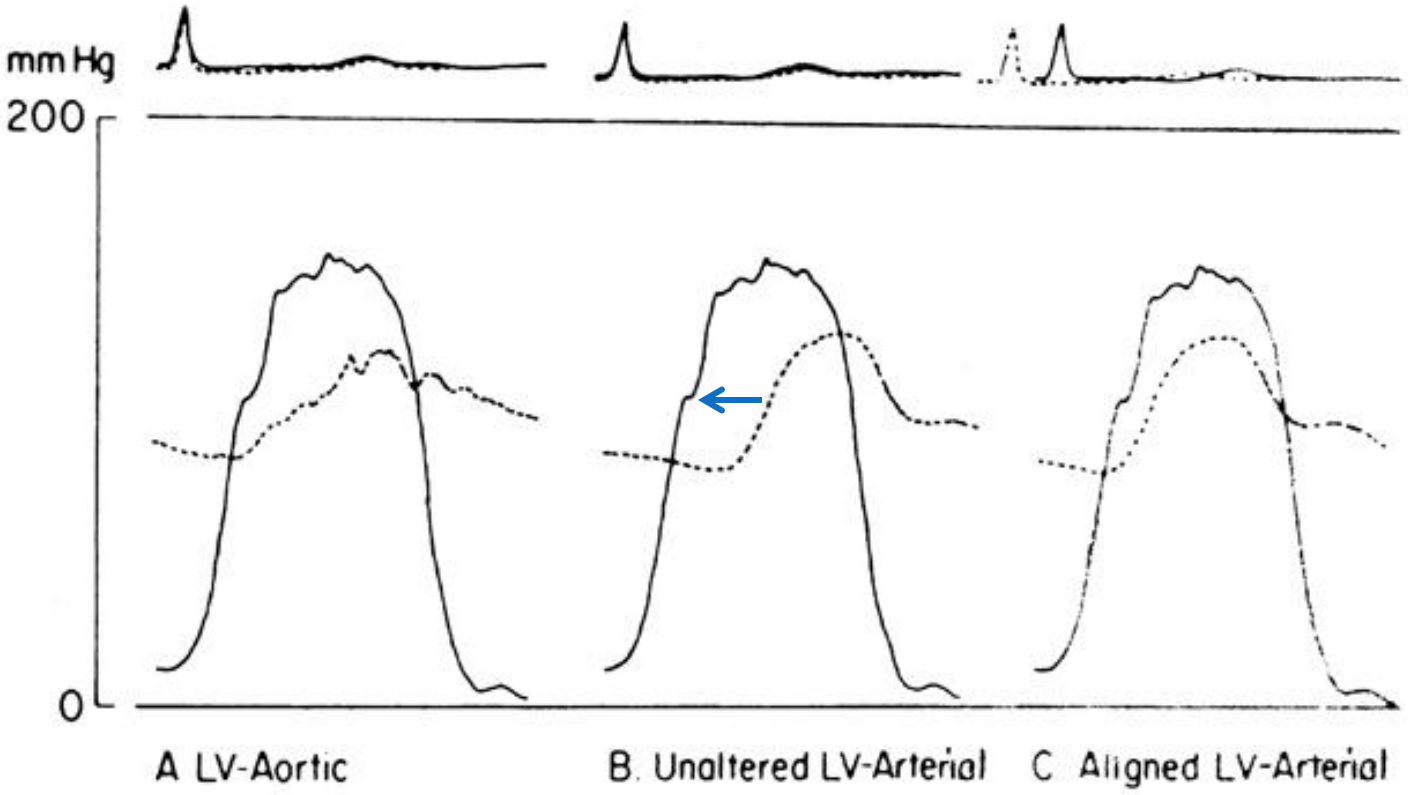


Bicuspid

Rheumatic


PRESSURE GRADIENT ACROSS AORTIC VALVE
NO GRADIENT
GRADIENT
Aortic pressure tracing
Left ventricular pressure tracing
100
0
100
0
A
B

Severe Aortic Stenosis Pressure Tracing



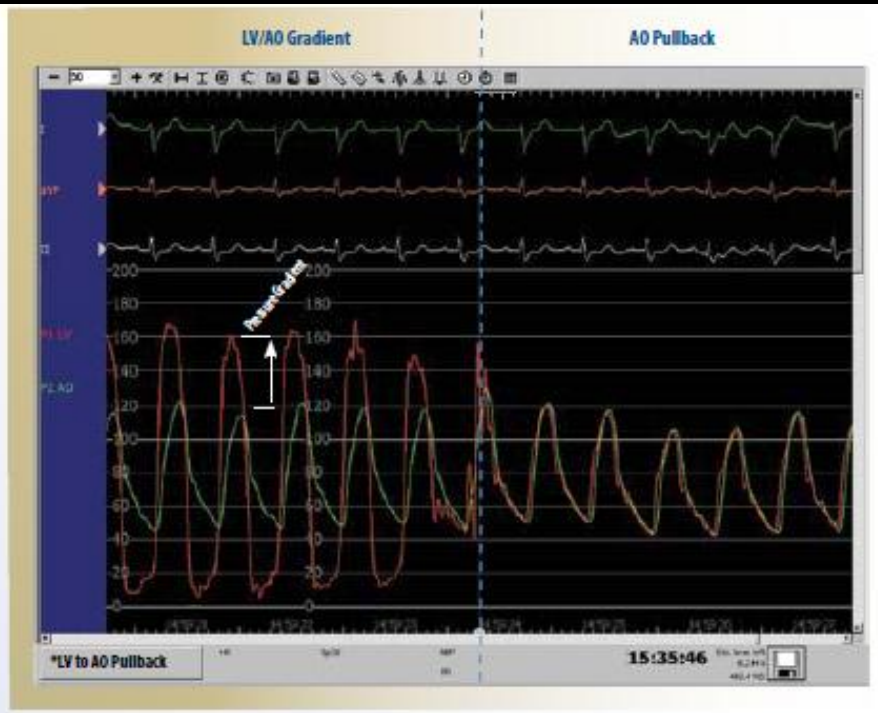
Gradient (mm Hg)	31	37	22
Area (cm^2)	1.07	1.01	1.24


200
180
160
140
120
100
80
60
40
20
0
200
180
160
40
20
00
80
60
40
20
0


C
C
200
200
180
180
160
60
140
40
120
120
100
100
80
80
60
60
40
40
20
20
0
0

Langston Dual Lumen Catheter

Available since 2005



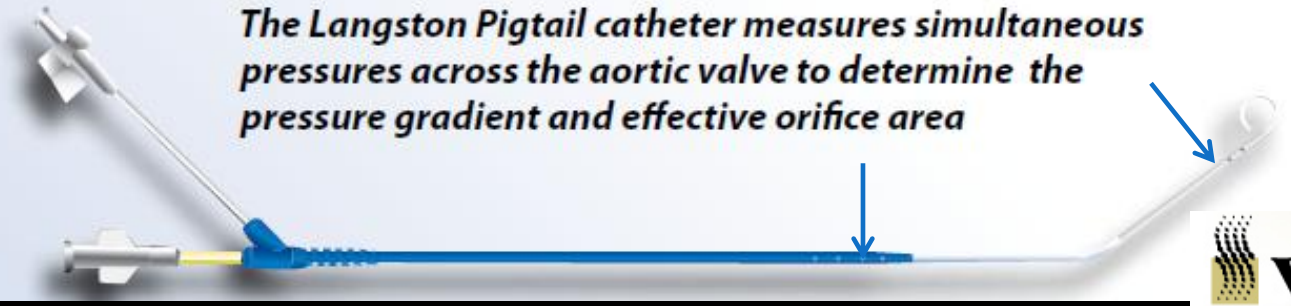
Langston dual lumen catheters deliver simultaneous pressure measurements accurately and precisely through two independent lumens.

Sensor Lines

Pigtail inner lumen pressure measurement

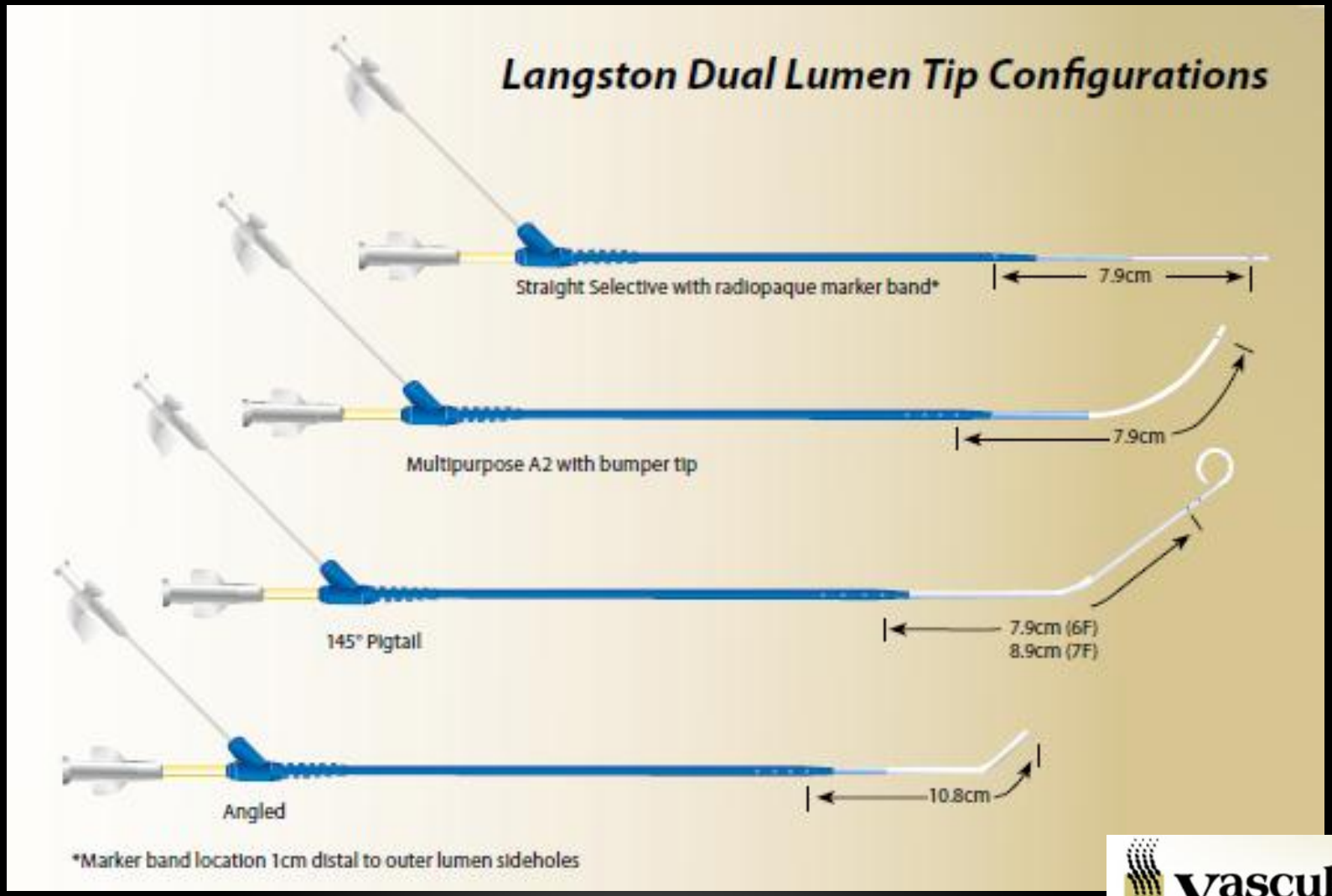
Outer coaxial lumen pressure measurement

* Patient deployment with Langston pigtail catheter



The Langston Pigtail catheter measures simultaneous pressures across the aortic valve to determine the pressure gradient and effective orifice area

Vascular SOLUTIONS
Bringing Solutions to Vascular Medicine



Vascular SOLUTIONS
Bringing Solutions to Vascular Medicine

Aortic Stenosis Severity

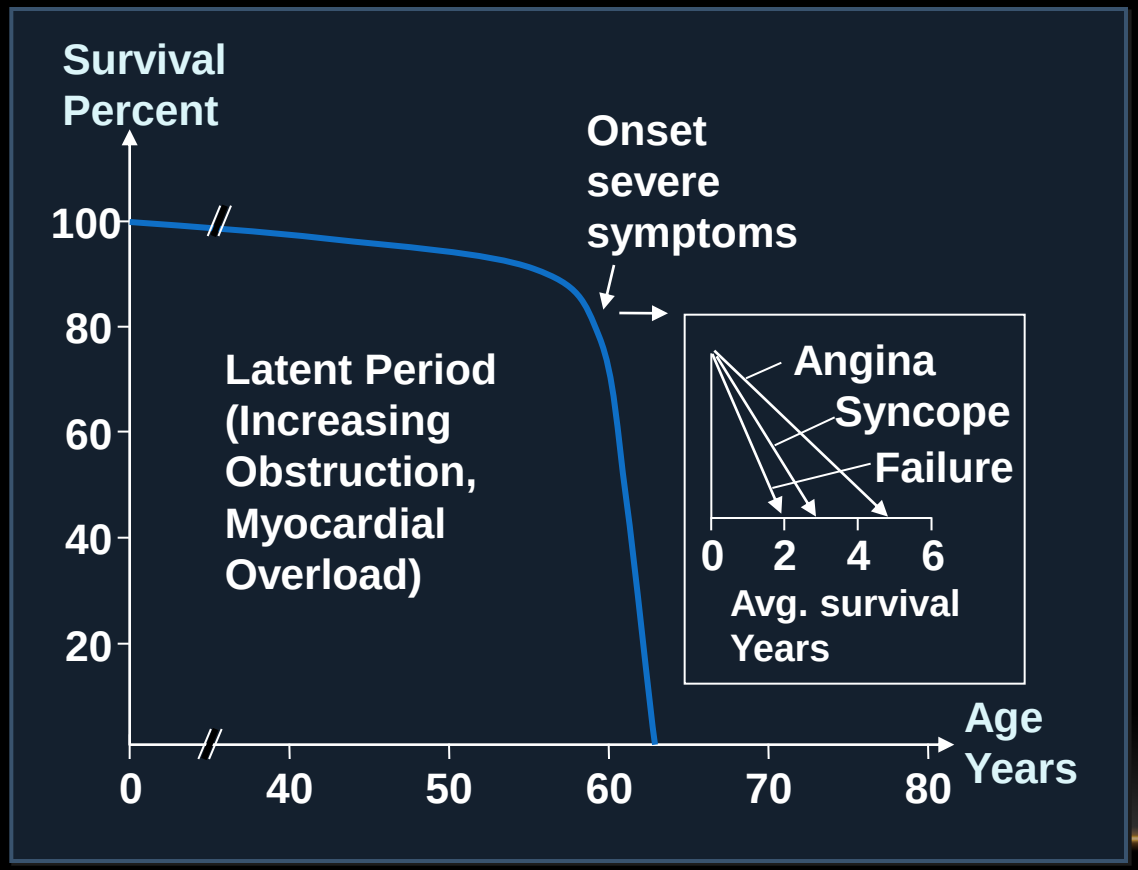
Severity	Area (cm2)	Mean gradient (mmHg)
MILD	>1.5	< 25
M(		
SEVERE	< 1.0	> 40

HAKKE FORMULA:

$$AVA = \frac{\text{C.O.}}{\text{Sq root Peak-to-peak gradient}}$$

AORTIC STENOSIS IS LIFE-THREATENING AND MAY PROGRESS RAPIDLY !

TREATMENT OPTIONS AND TIMING MATTERS

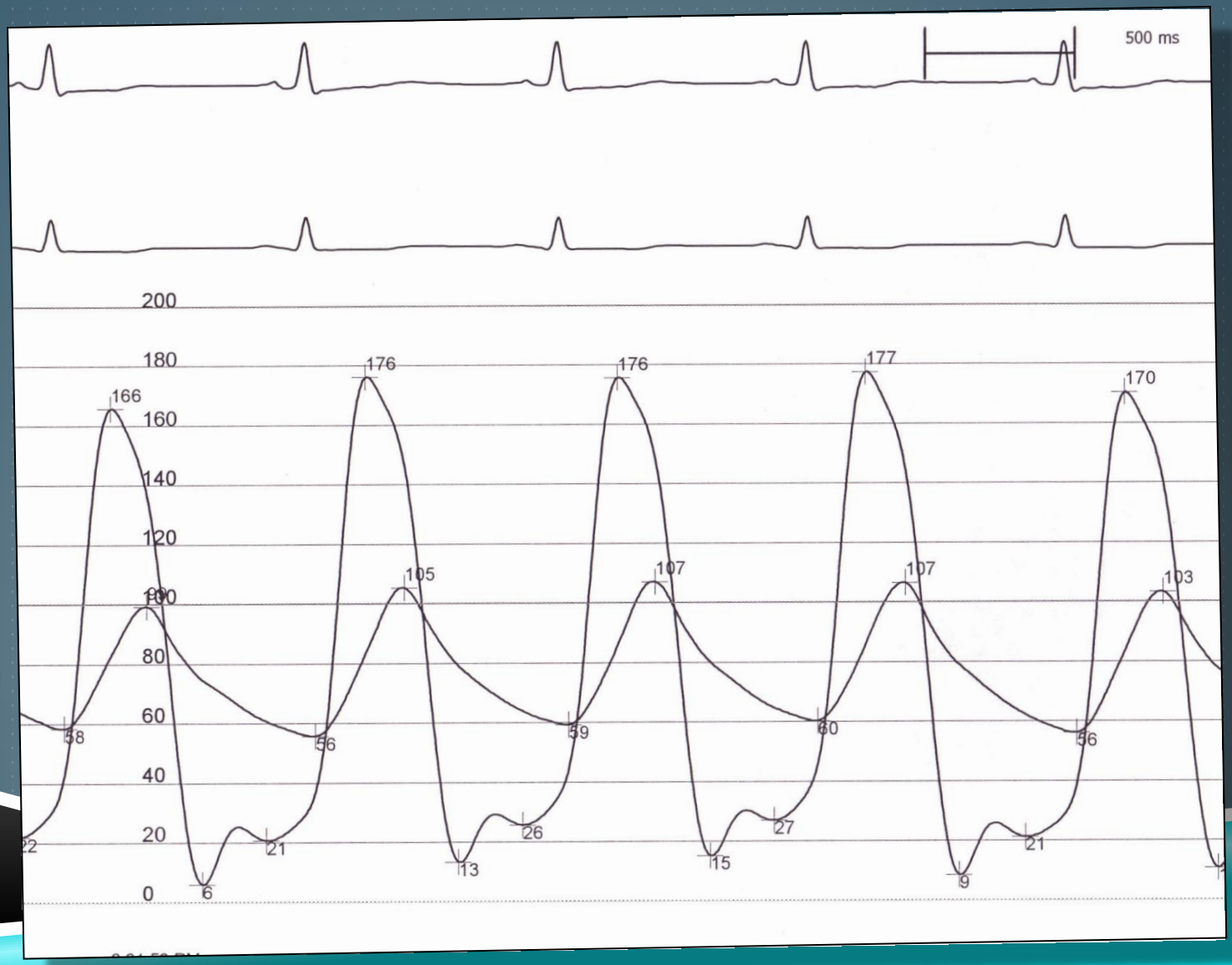


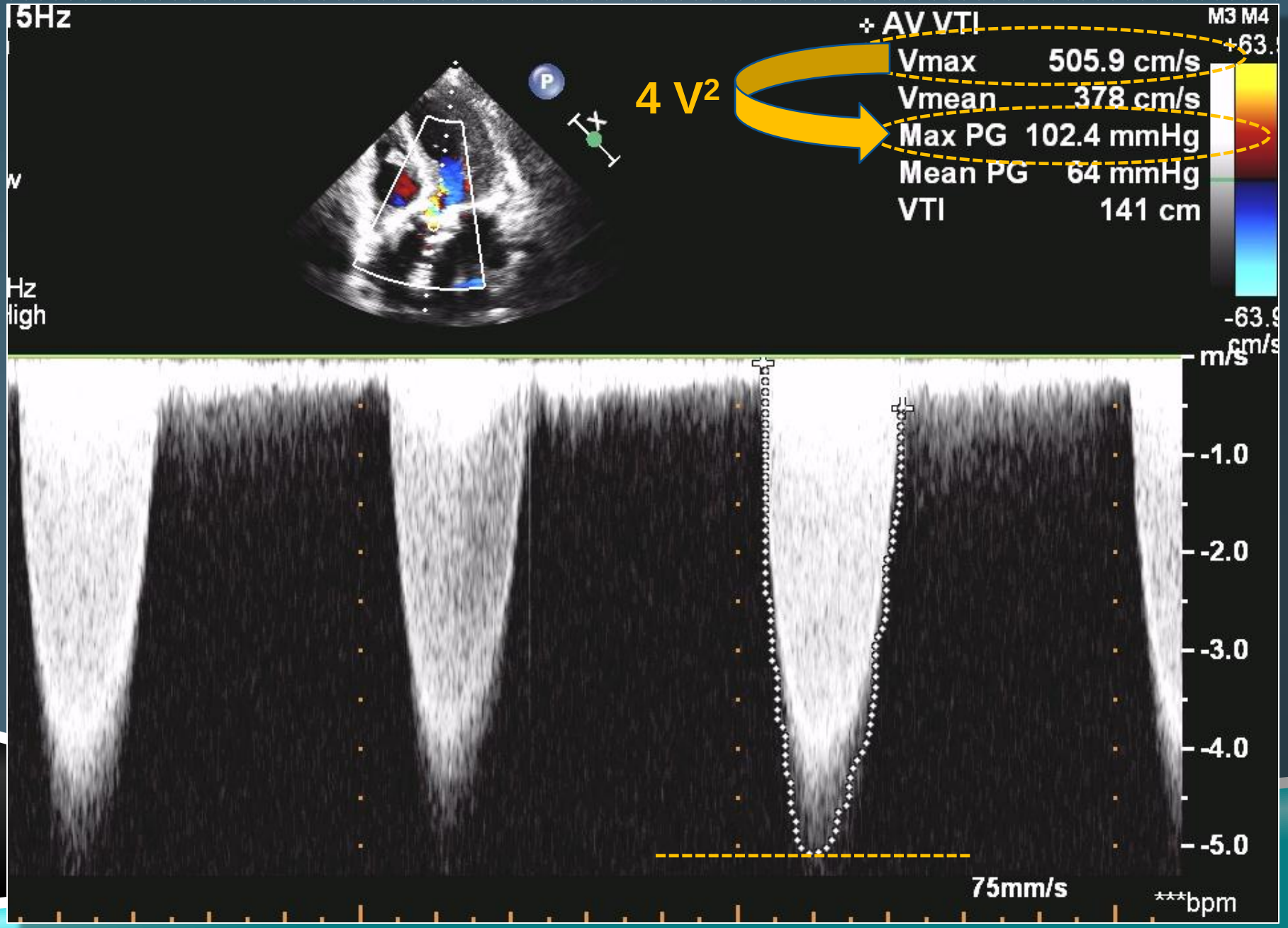
"Survival after onset of symptoms is 50% at two years and 20% at five years."[1]

"Surgical intervention [for severe AS] should be performed promptly once even … minor symptoms occur."[2]

Sources: [1] S.J. Lester et al., "The Natural History and Rate of Progression of Aortic Stenosis," Chest 1998
[2] C.M. Otto, "Valve Disease: Timing of Aortic Valve Surgery," Heart 2000
Chart: Ross J Jr, Braunwald E. Aortic stenosis. Circulation. 1968;38 (Suppl 1):61-7.

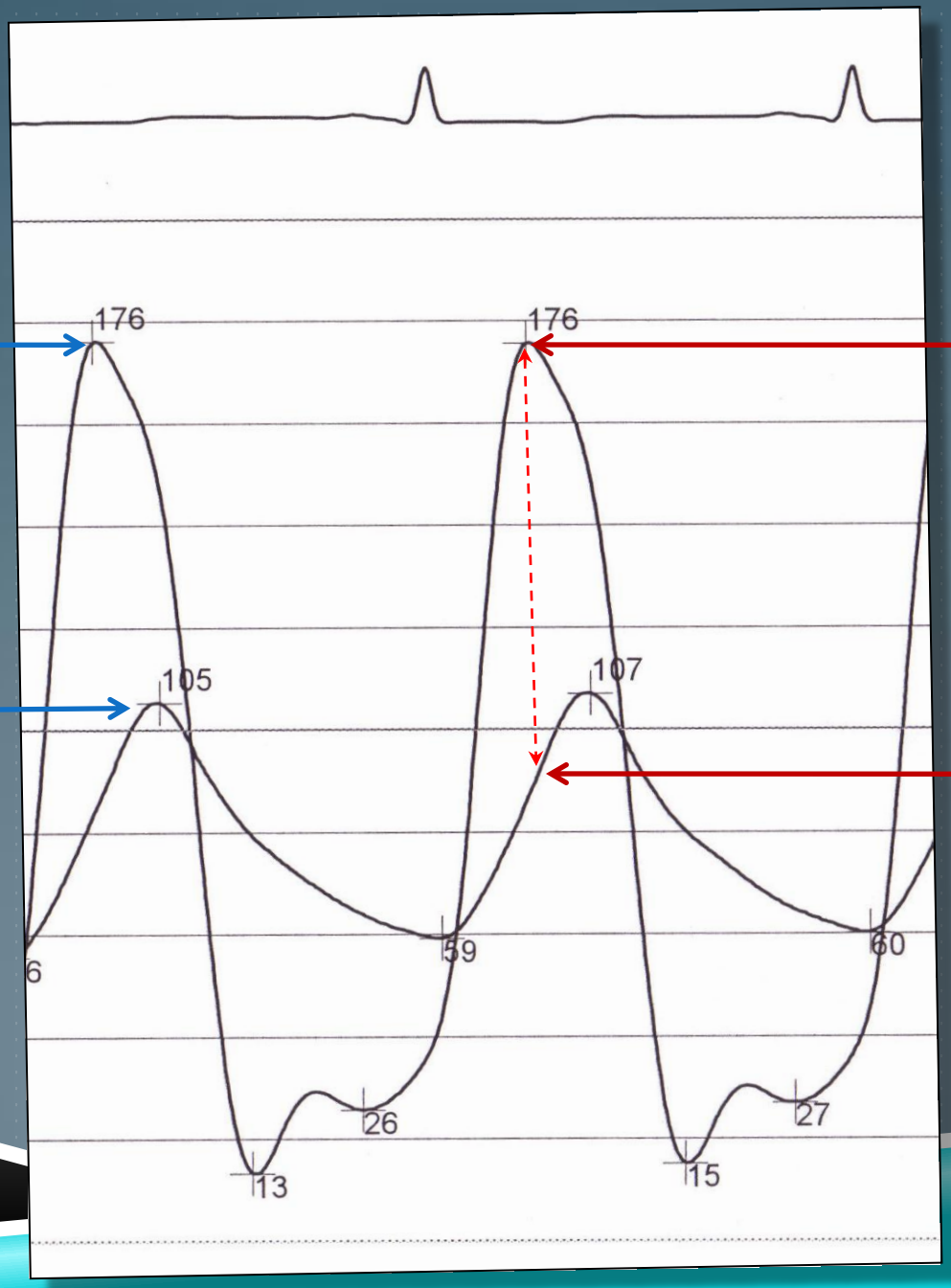
82 yr old Aortic Stenosis. Baseline aortic valve gradient: 70 mmHg.




5Hz
AV VTI
Vmax 505.9 cm/s
Vmean 378 cm/s
Max PG 102.4 mmHg
Mean PG 64 mmHg
VTI 141 cm
4 V2
M3 M4
m/s
-1.0
-2.0
-3.0
-4.0
-5.0
75mm/s
***bpm

CATH LAB

ECHO LAB

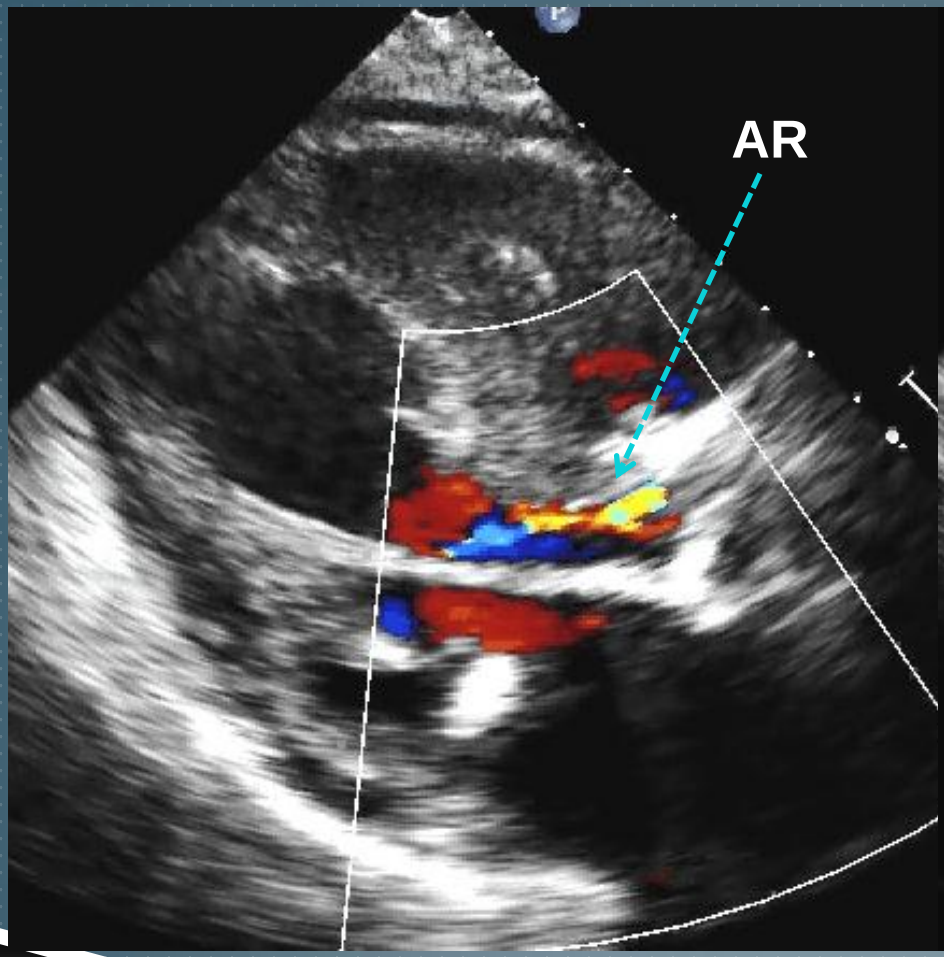


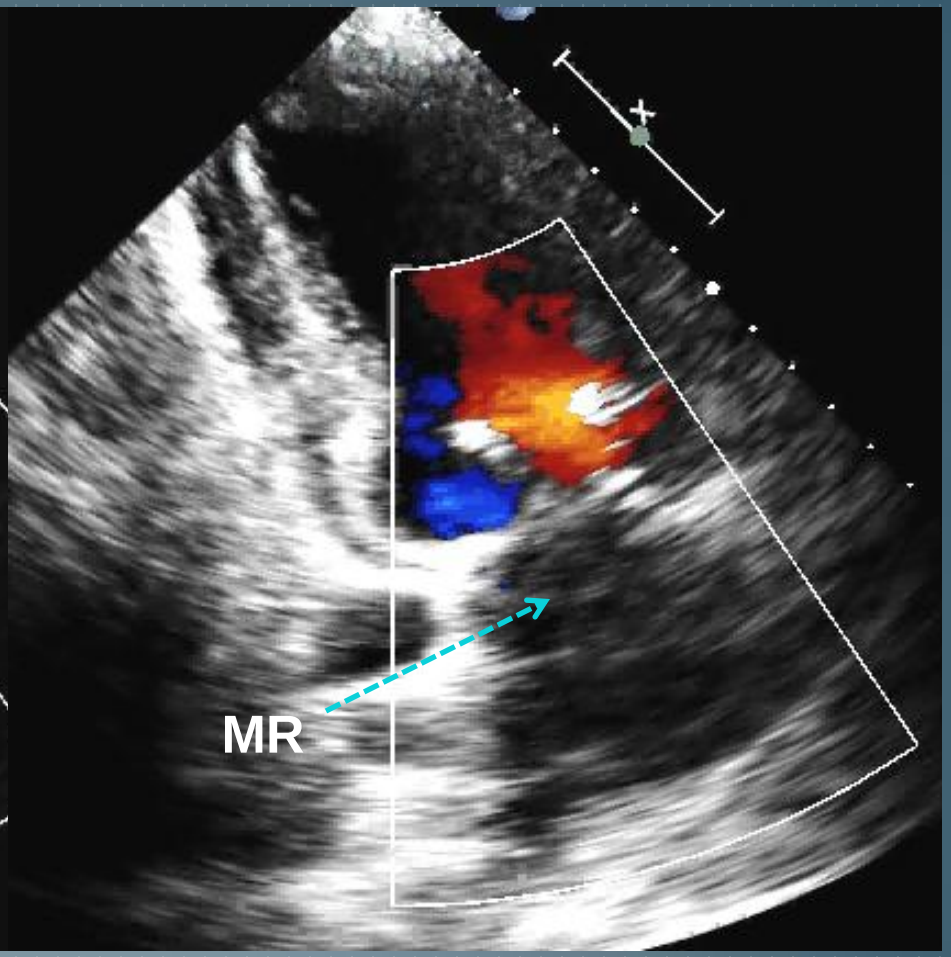
Peak-to-Peak Gradient 71 mmHg

Max Gradient 84 mm Hg

Mean Gradient: 65 mmHg

Mean Gradient: 64 mmHg


AR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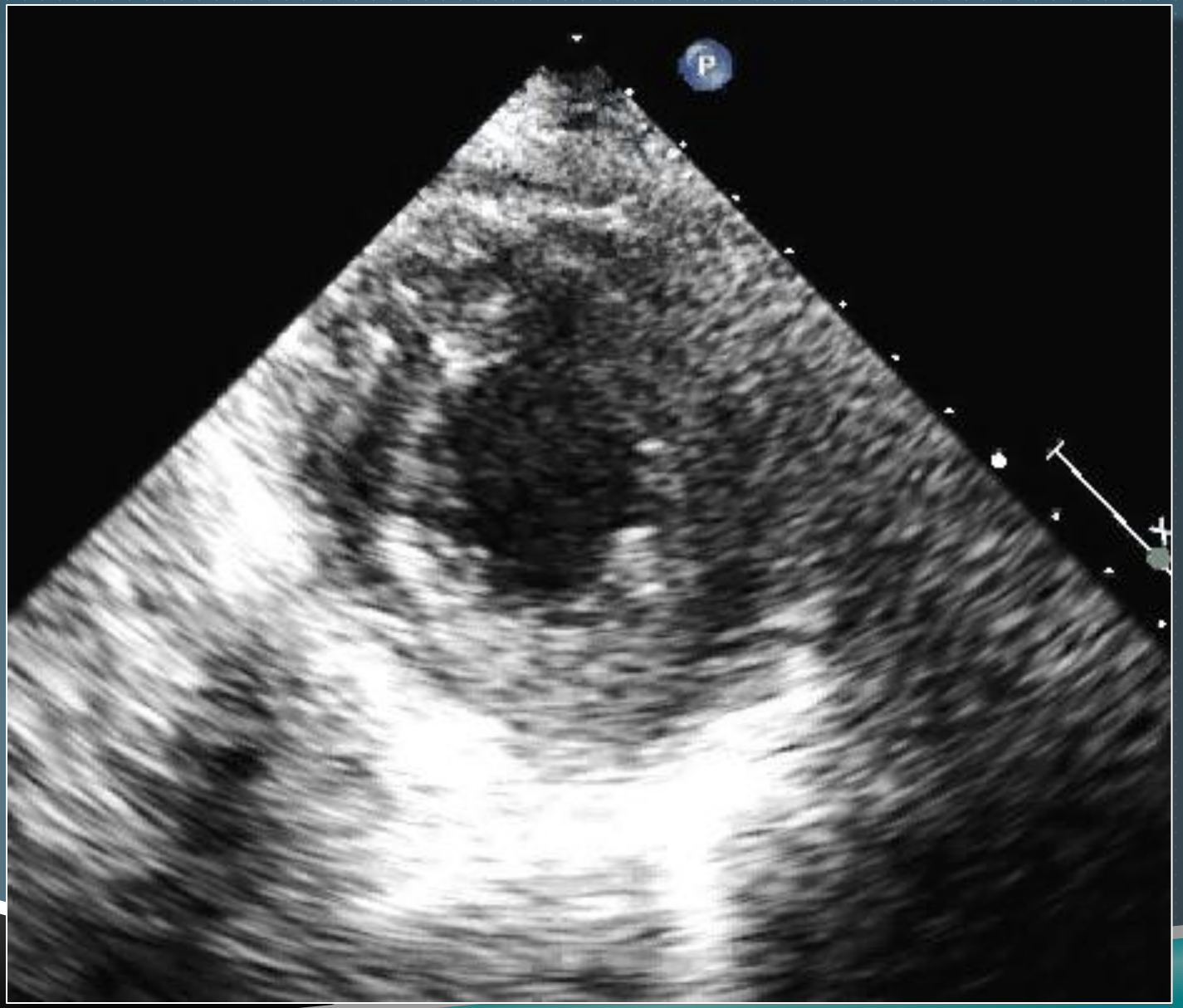
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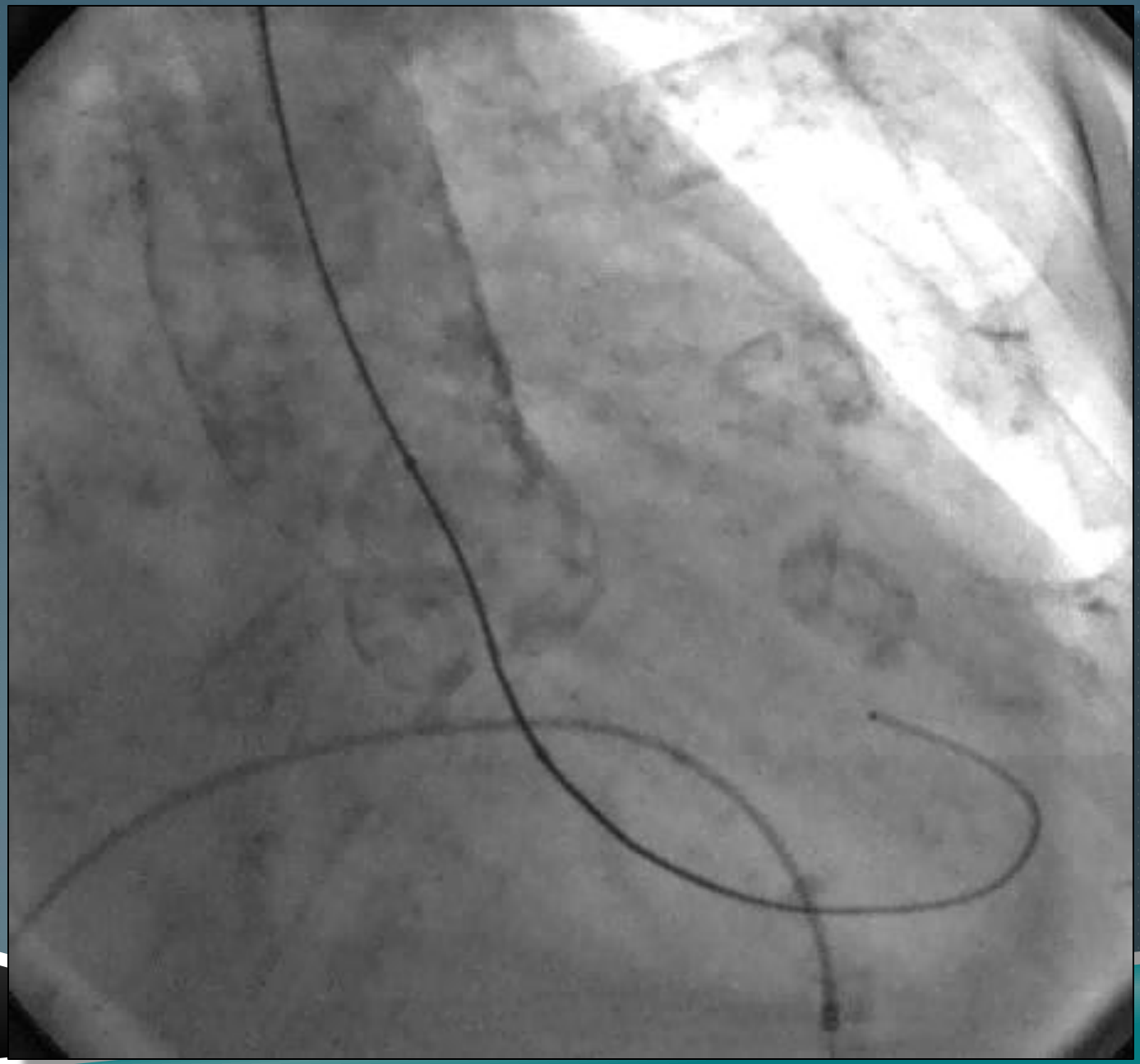
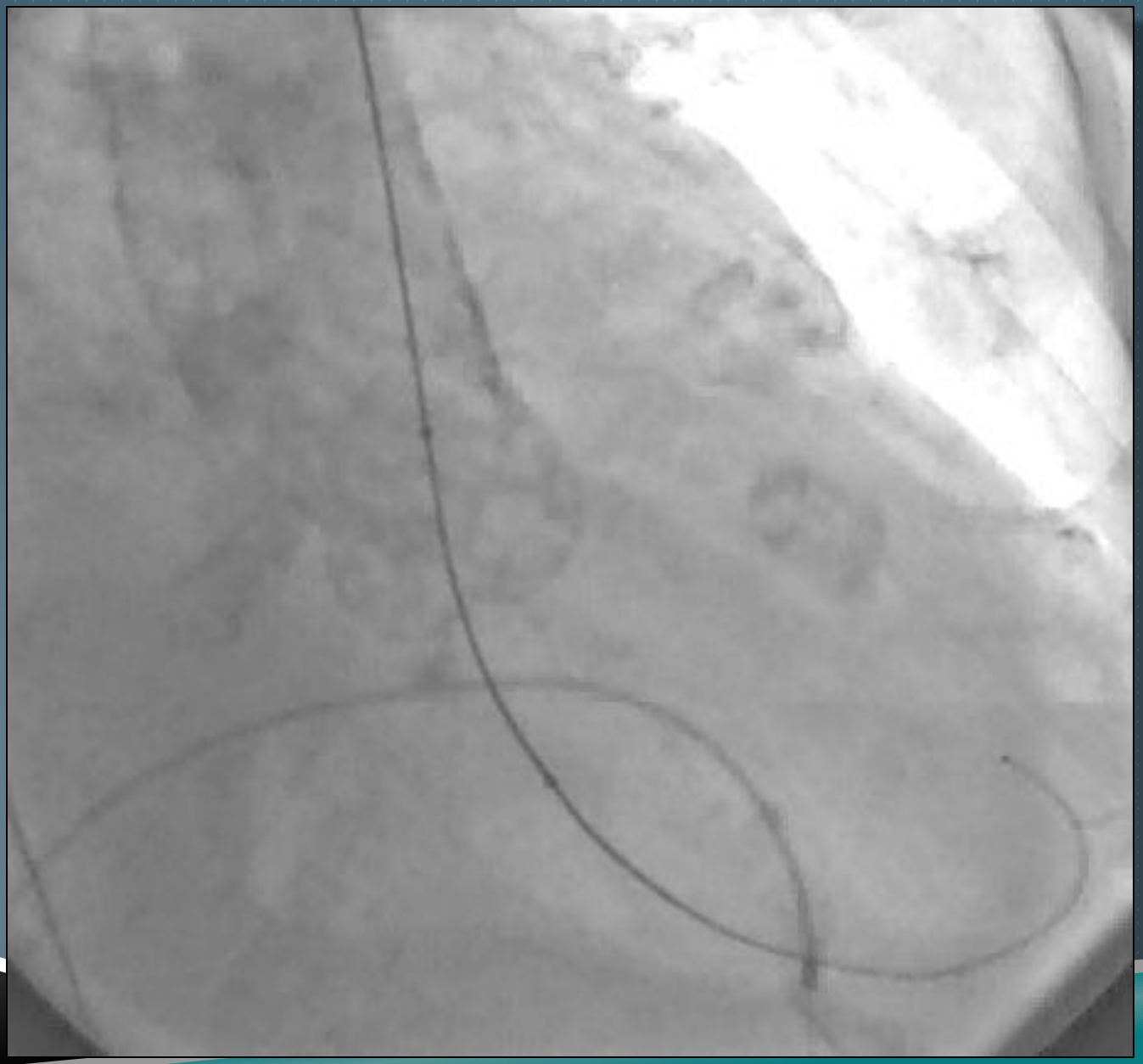
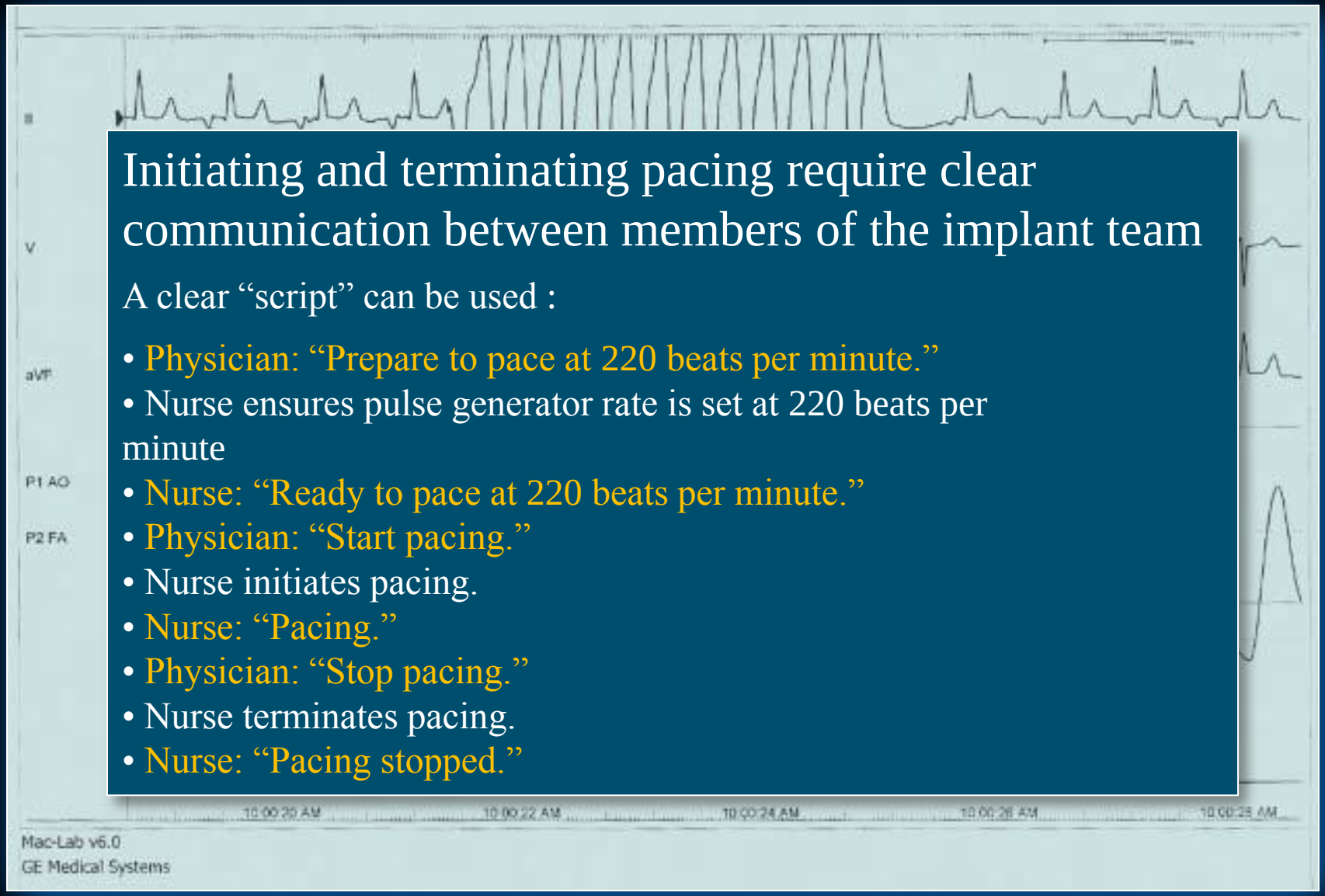
Porcelain Aorta





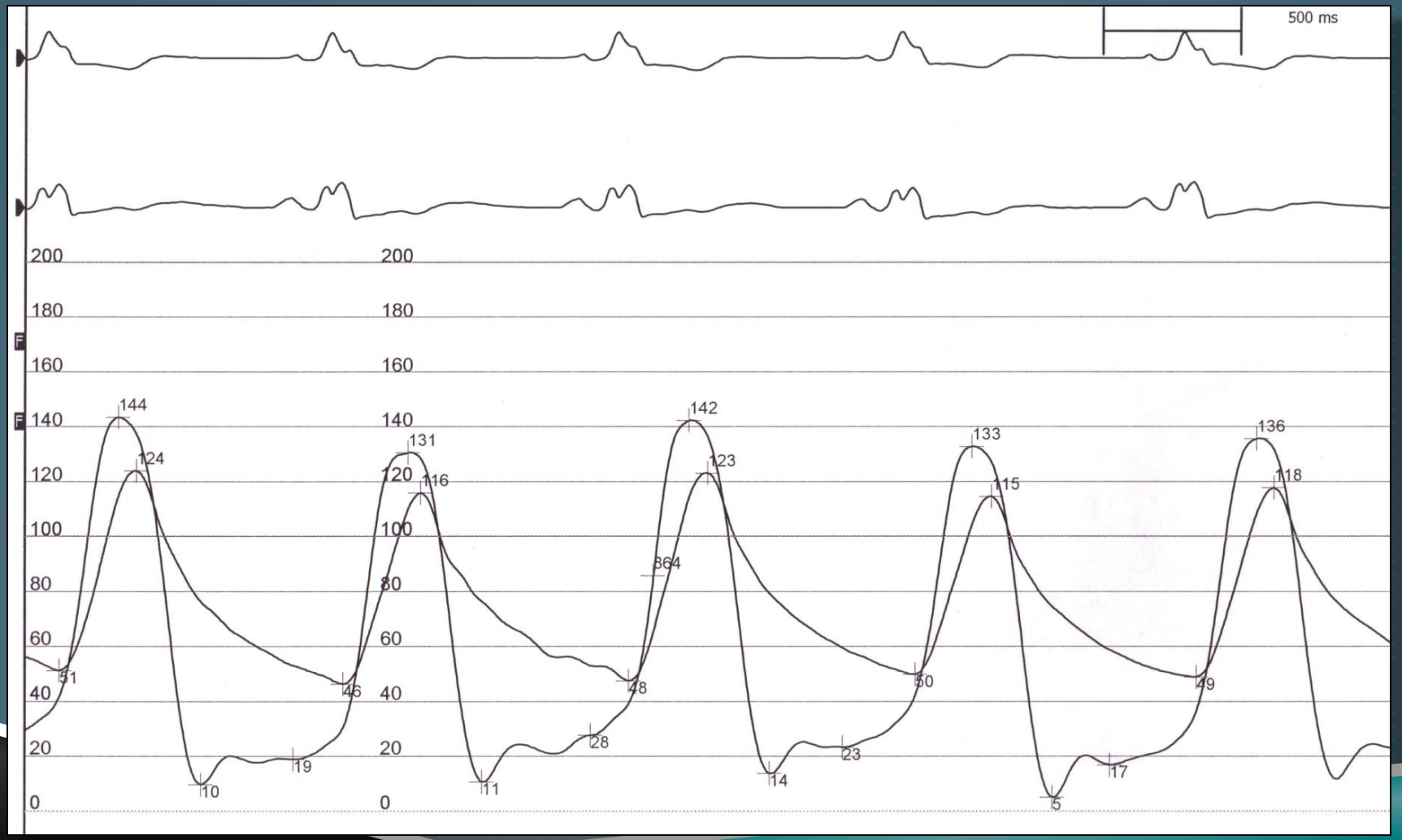


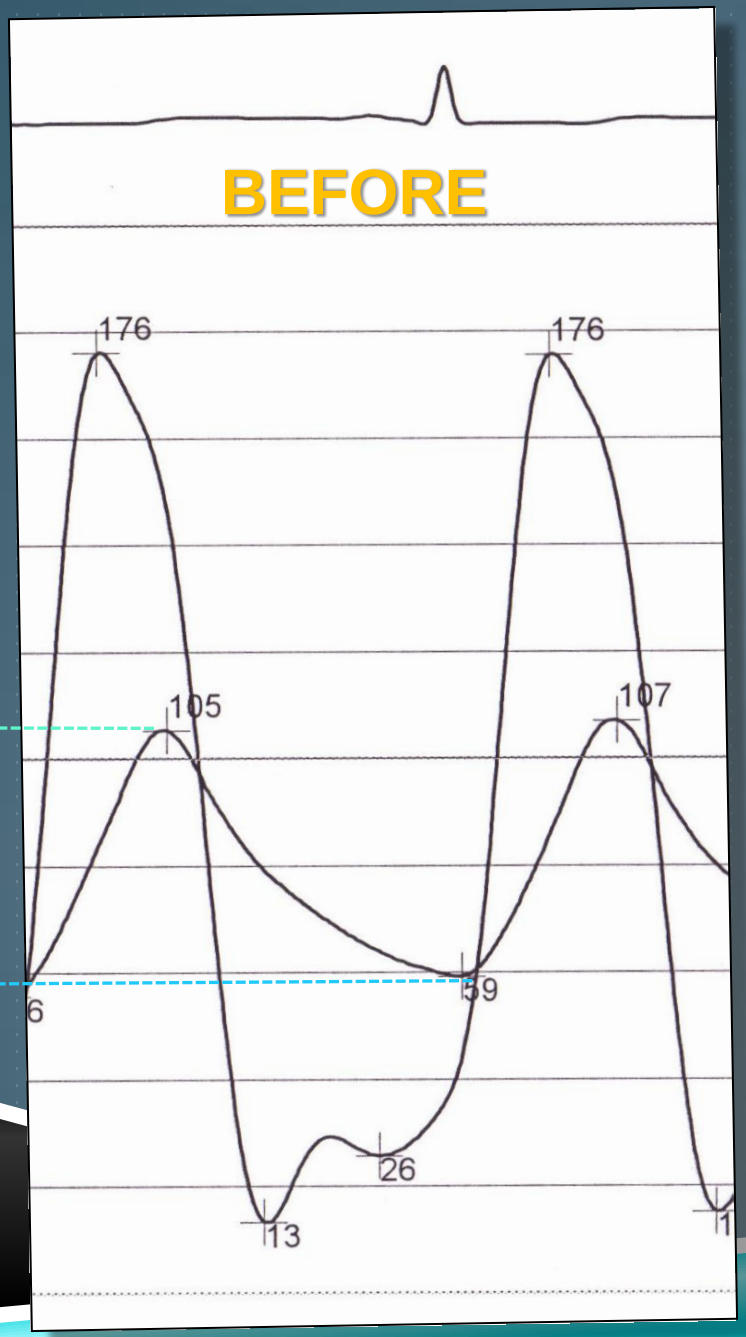
Initiating and terminating pacing require clear communication between members of the implant team

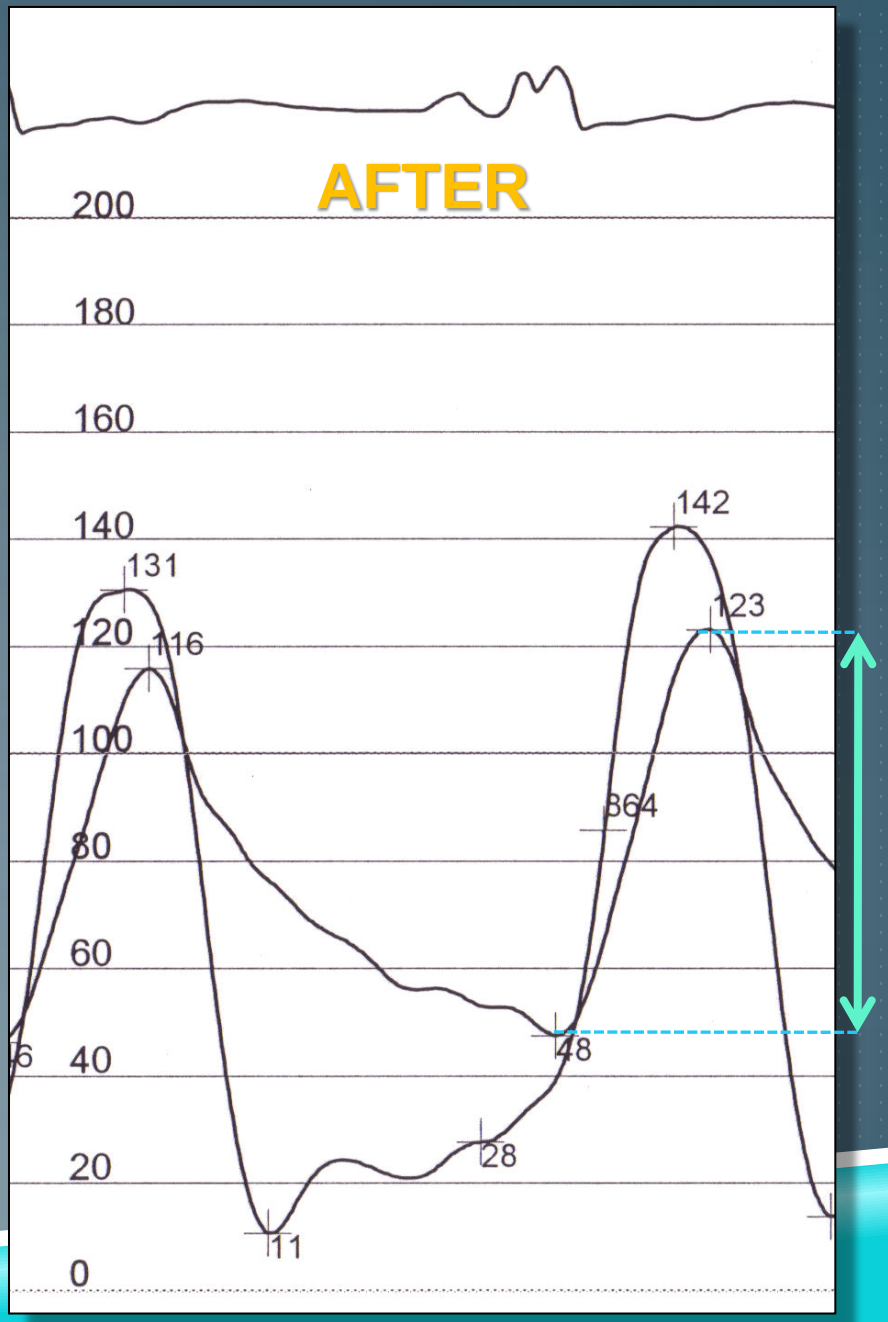
A clear "script" can be used :

- Physician: "Prepare to pace at 220 beats per minute."
- Nurse ensures pulse generator rate is set at 220 beats per minute
- Nurse: "Ready to pace at 220 beats per minute."
- Physician: "Start pacing."
- Nurse initiates pacing.
- Nurse: "Pacing."
- Physician: "Stop pacing."
- Nurse terminates pacing.
- Nurse: "Pacing stopped."

Post PABV: Peak gradient 18-20 mmHg




BEFORE
176
176
105
107
6
59
26
13
1


AFTER
200
180
160
140
120
100
80
60
40
20
0
142
131
123
116
864
6
48
28
11

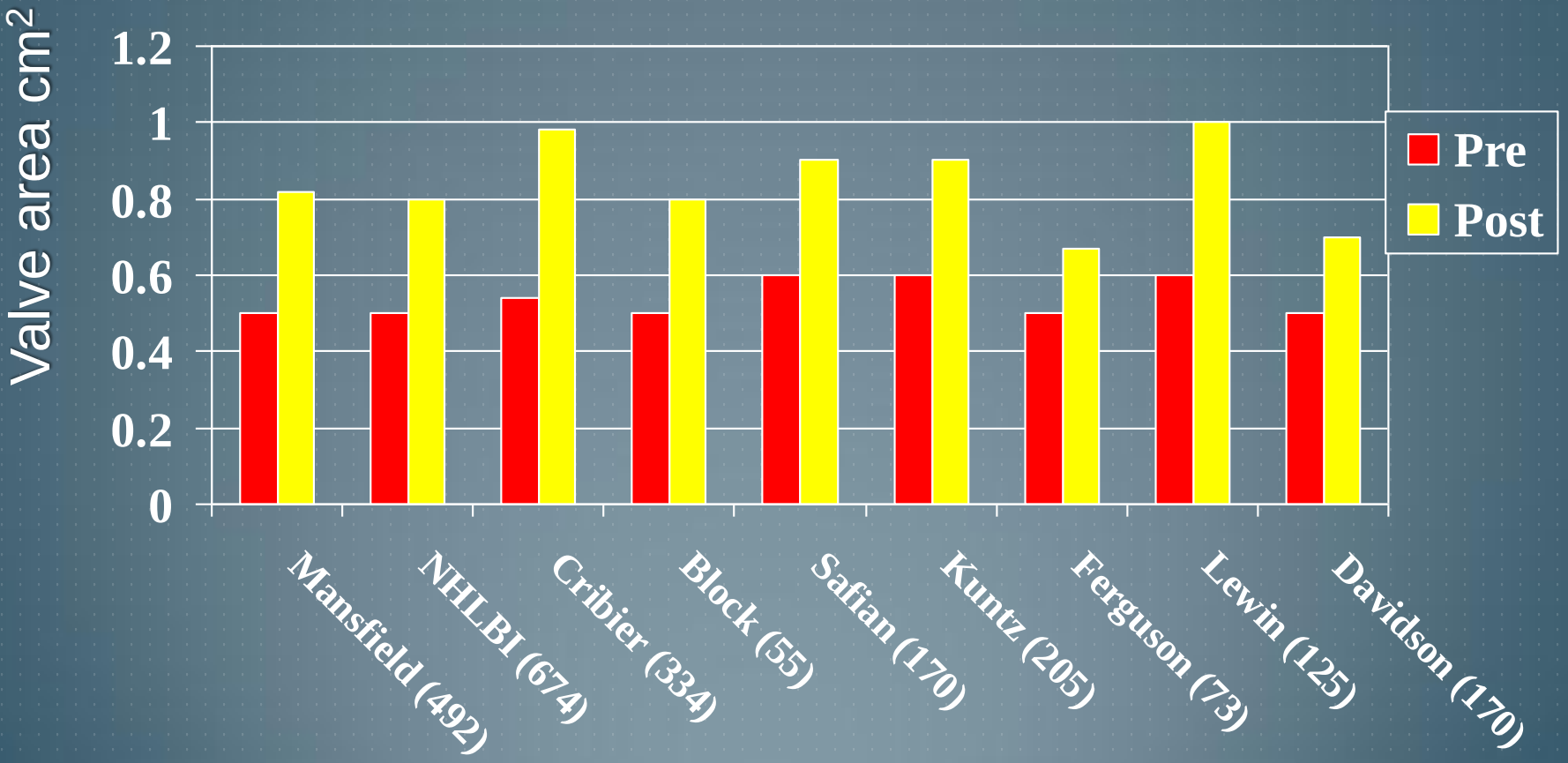
MECHANISM OF PABV DILATATION

1. Annular and leaflet stretch
2. Microfracture of valvular calcium
3. Commissural separation: not important

HEMODYNAMIC RESULTS

AVA: From mean 0.5 cm^2 increased to 0.8 cm^2

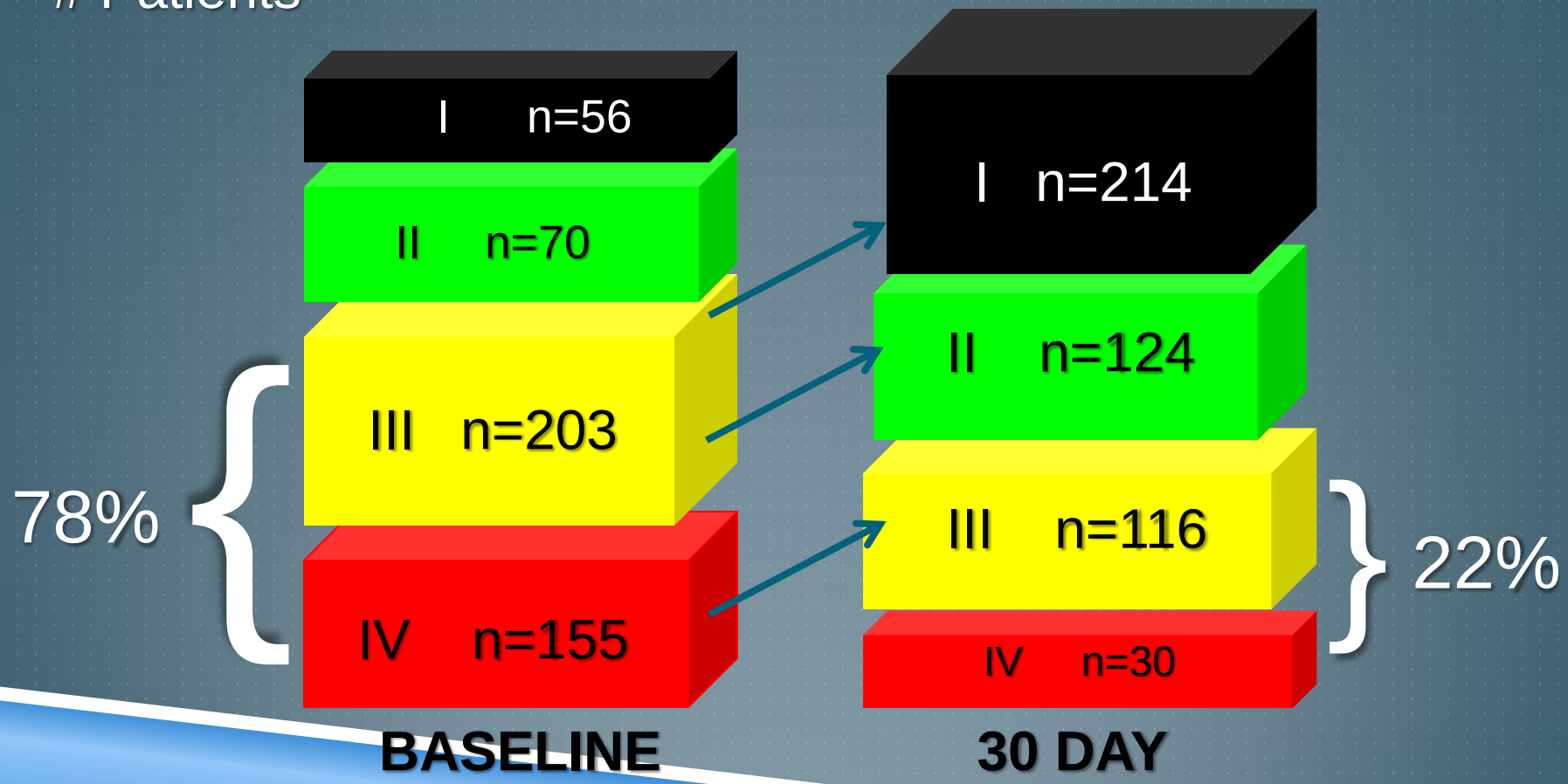
(71% had a final AVA < 1cm^2)



NYHA FUNCTIONAL CLASS

NHLBI PABV REGISTRY (N=672)

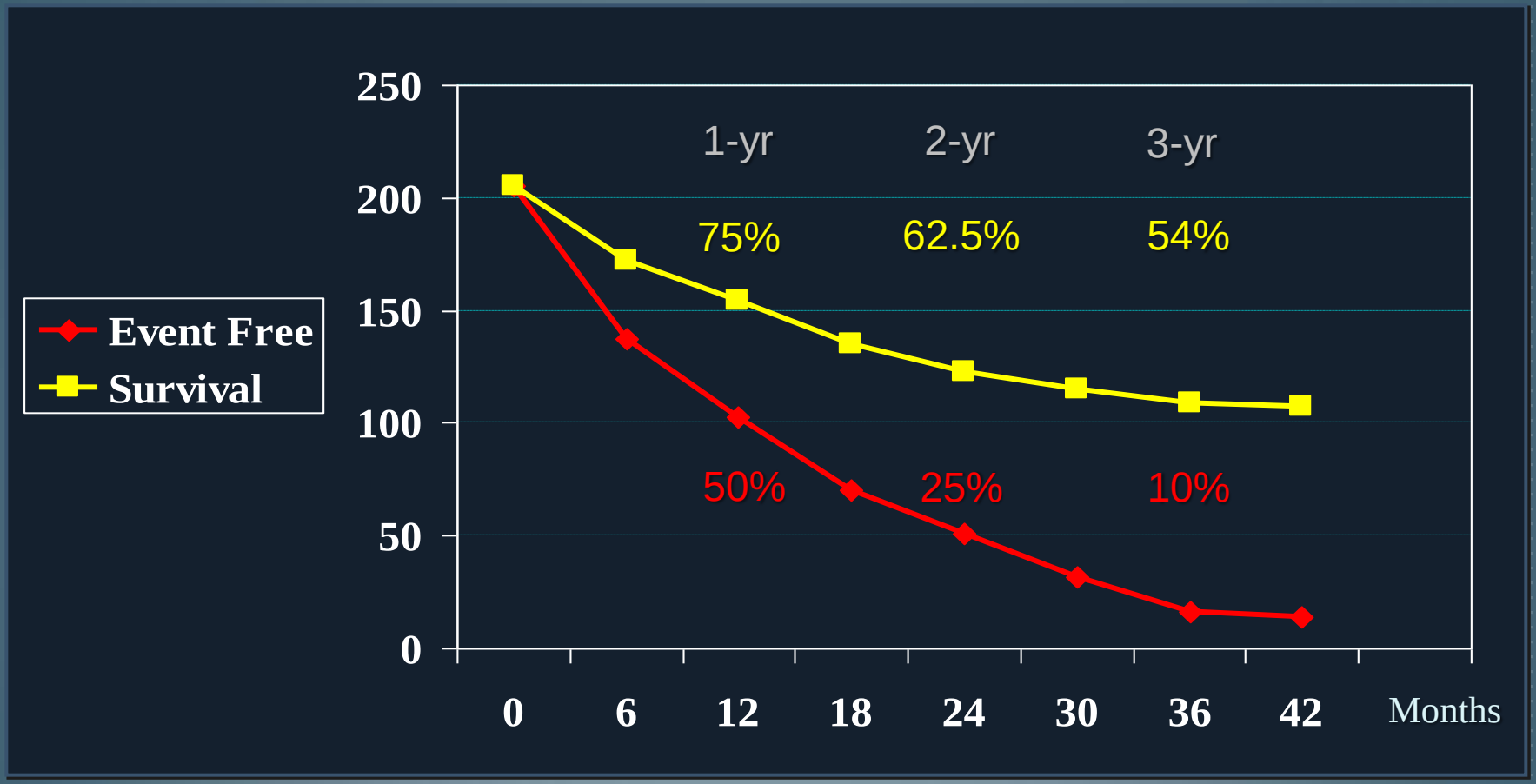
80% OF PATIENTS FEEL BETTER



Bashore, Davidson, Berman et al Circulation 1991: vol 84 no. 6

BALLOON AORTIC VALVULOPLASTY

LONG TERM OUTCOMES



Kuntz R NEJM 1991;325:17

BALLOON VALVULOPLASTY: 2008 ACC/AHA GUIDELINES: INDICATIONS

Class IIb

- PABV might be reasonable as a *bridge to surgery* in hemodynamically unstable adult patients with AS who are at high risk for AVR.
- BAV might be reasonable for *palliation* in adult patients with AS in whom AVR cannot be performed because of serious comorbid conditions.

Evolving Indications

- BAV as a bridge to transcatheter AVR
- Diagnostic intervention on low output/ low gradient AS to predict response to transcatheter AVR, (afterload mismatch vs. intrinsic contractility depression)

TRANSCATHETER AORTIC VALVE IMPLANTATION (TAVI)

Dr. Alain Cribier
First-in-Man TAVI

April 16, 2002

Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION
American Heart Association
Learn and Live

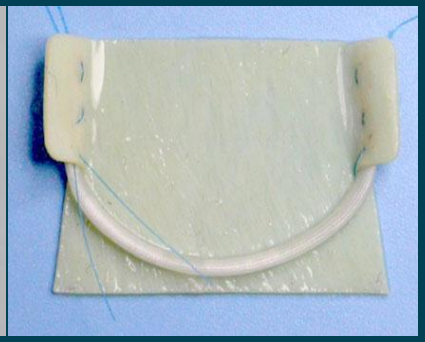
Percutaneous Transcatheter Implantation of an Aortic Valve Prosthesis for Calcific Aortic Stenosis

First Human Case Description

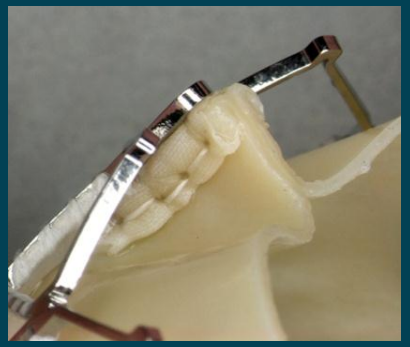
Alain Cribier, MD; Helene Eltchaninoff, MD; Assaf Bash, PhD; Nicolas Borenstein, MD; Christophe Tron, MD; Fabrice Bauer, MD; Genevieve Derumeaux, MD; Frederic Anselme, MD; François Laborde, MD; Martin B. Leon, MD

AHA; Nov, 2002

EDWARDS SAPIEN XT THV



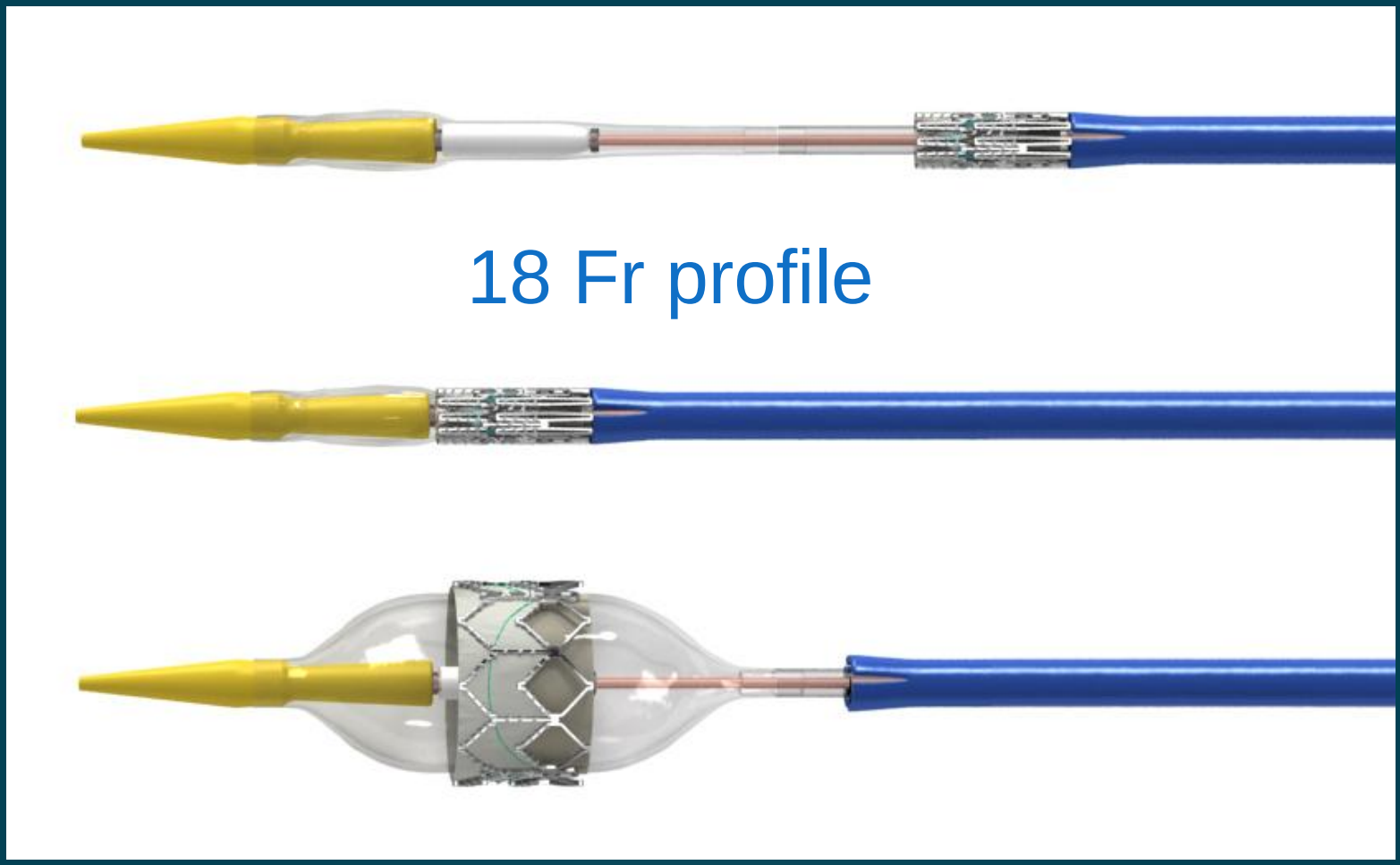
Cobalt Frame & New Leaflet Geometry



Tissue Attachment

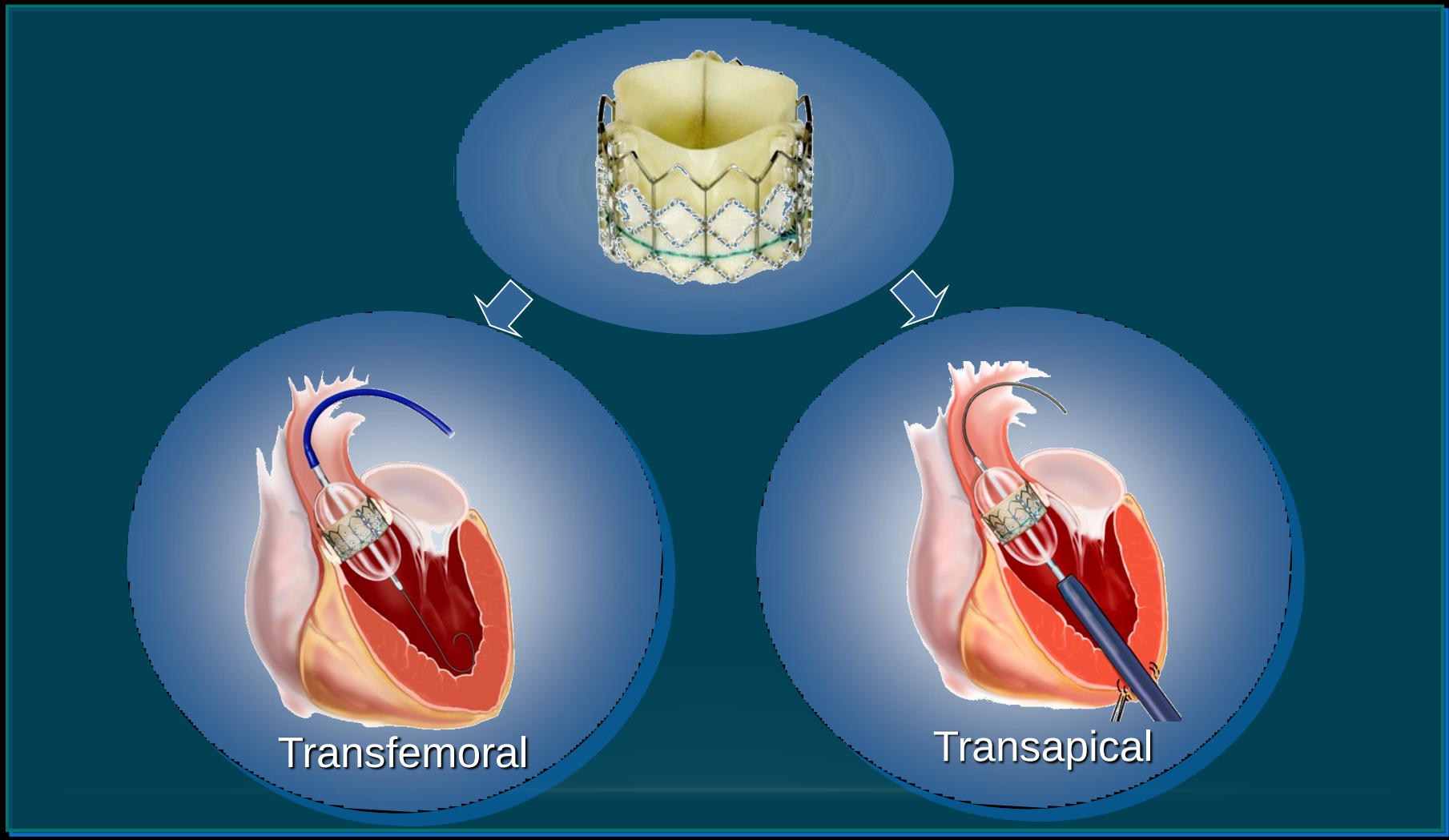
Sapien XT

Sapien XT + NovaFlex Delivery System

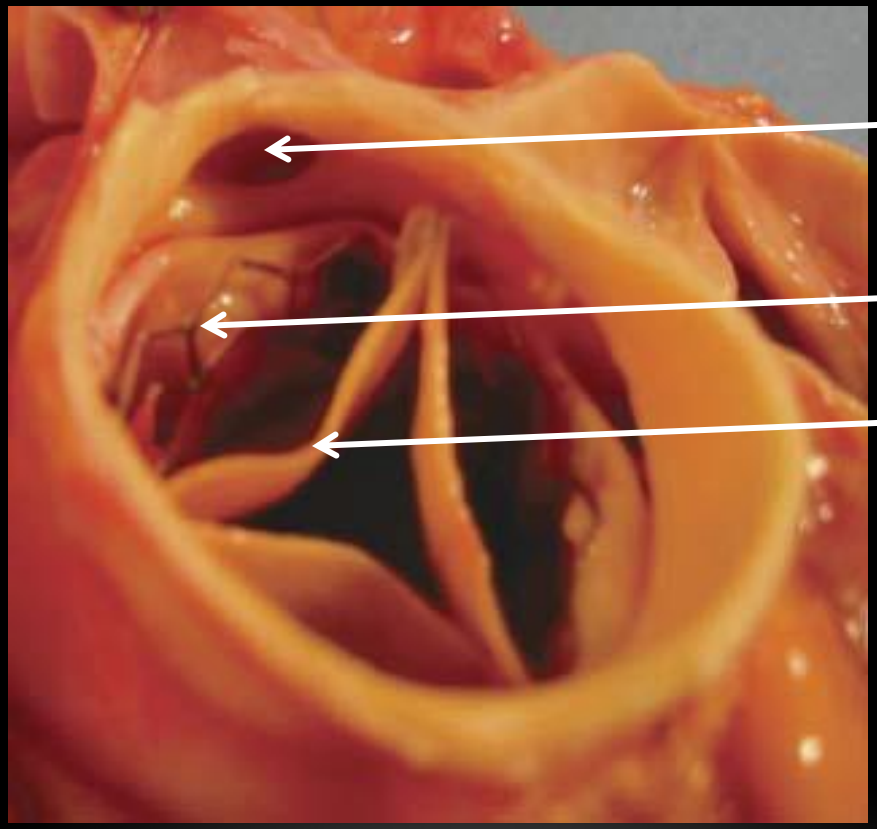


Transcatheter AVR

Femoral and Trans-apical Access

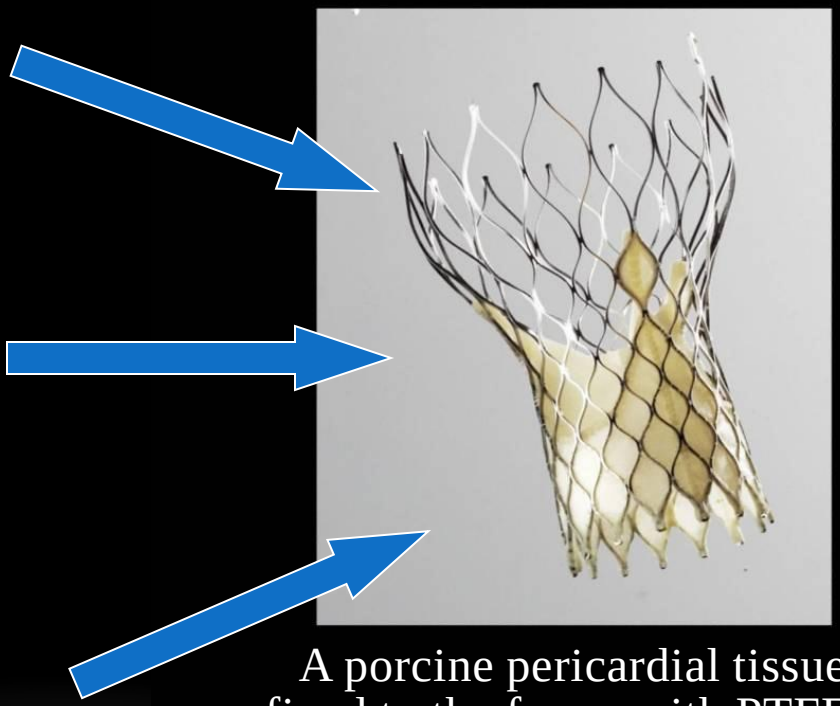


AORTIC STENT VALVE IMPLANTED



CoreValve Self-Expanding Aortic Bioprosthesis

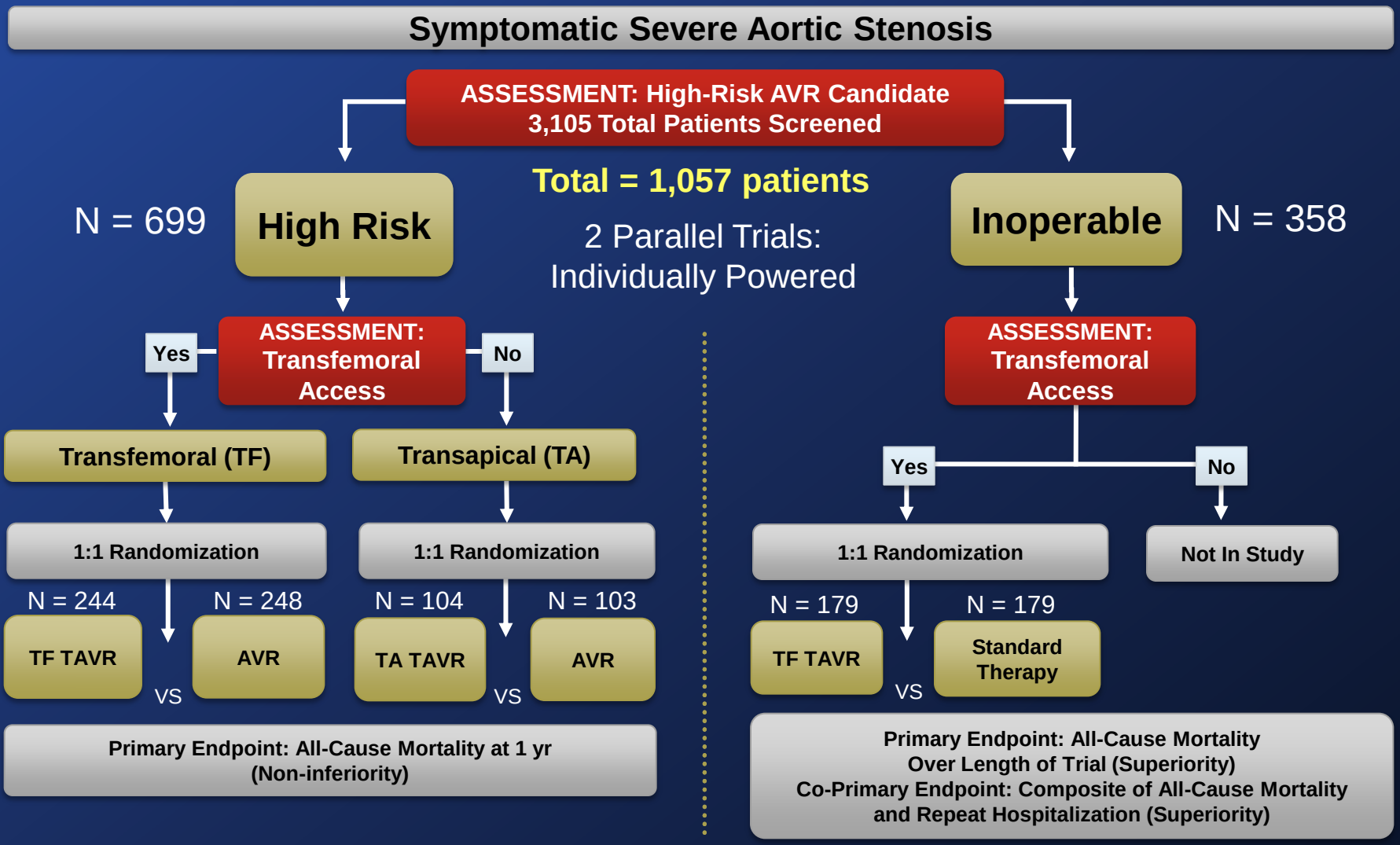
- HIGHER PART: low radial force area axes the system and increases quality of anchoring
- MIDDLE PART: functional valve area with three leaflets and constrained to avoid coronaries (convexo-concave) – avoids need for rotational positioning
- LOWER PART: high radial force of the frame pushes aside the native calcified leaflets for secure anchoring and avoids recoil and para-valvular leaks



A porcine pericardial tissue valve fixed to the frame with PTFE sutures

Medtronic
Alleviating Pain · Restoring Health · Extending Life

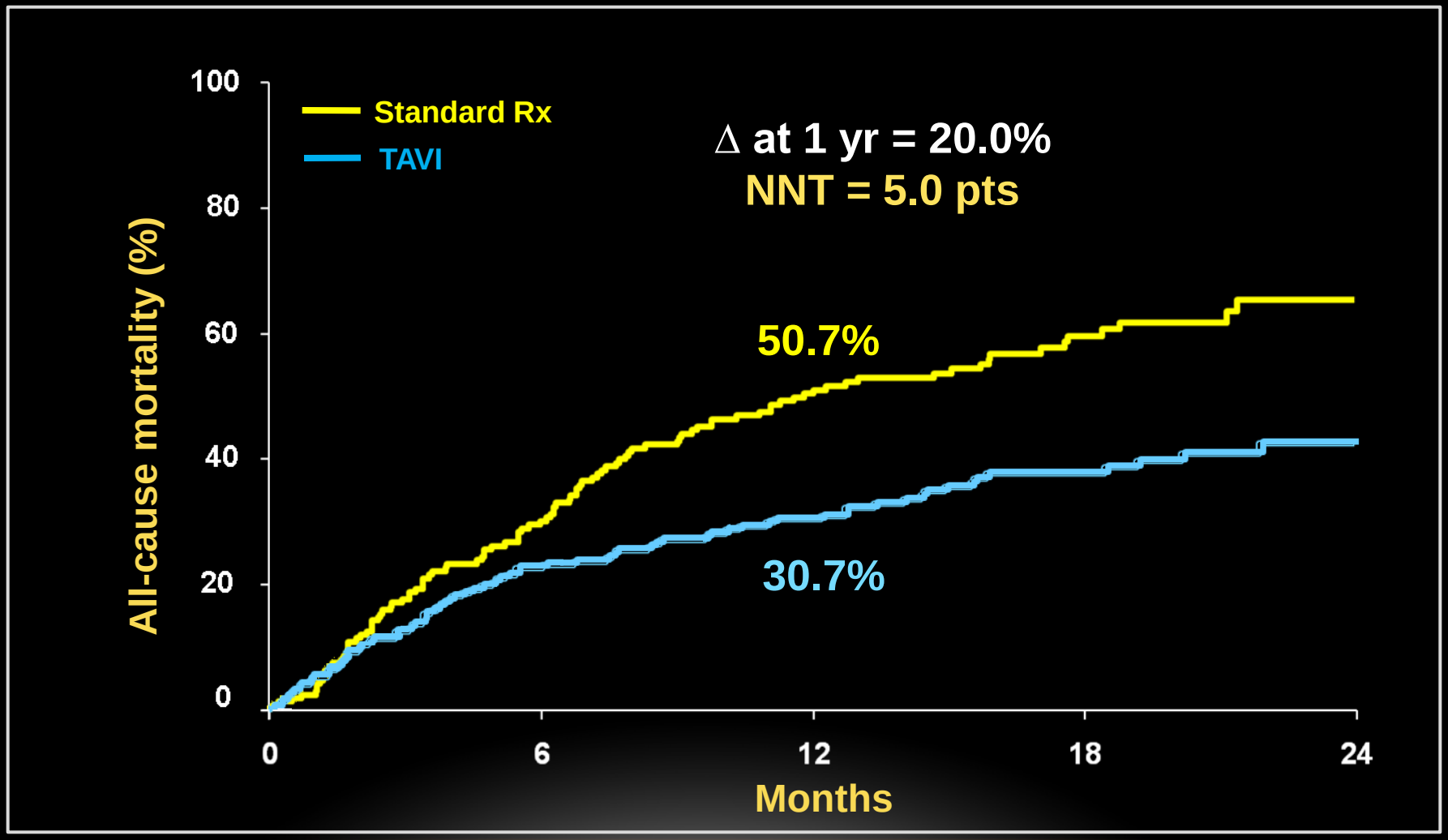
PARTNER Study Design



TAVI

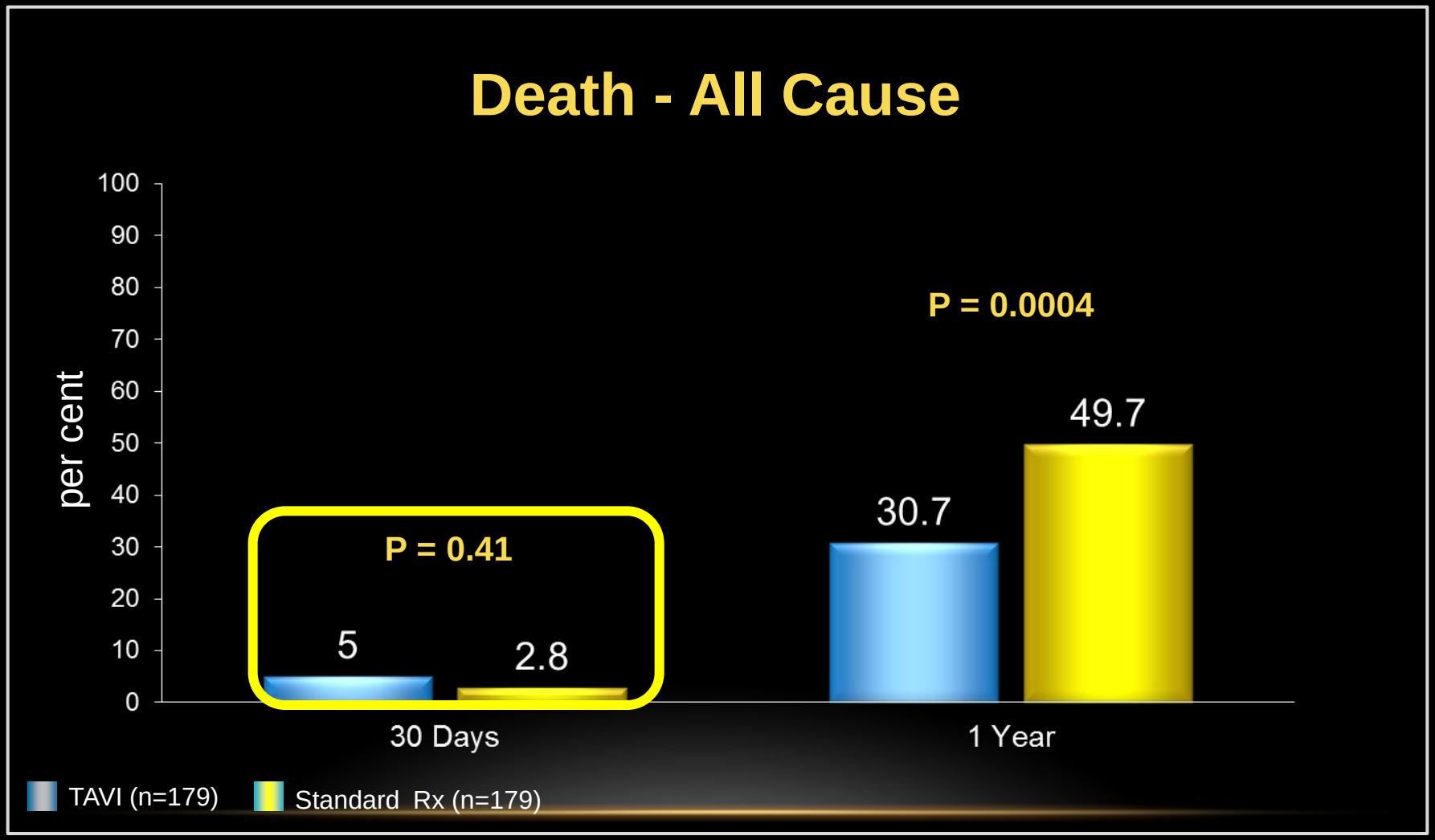
Inoperable group: Outcomes

All Cause Mortality



Numbers at Risk					
TAVI	179	138	122	67	26
Standard Rx	179	121	83	41	12

CLINICAL OUTCOMES AT 30 DAYS AND 1 YEAR



PARTNER QOL ANALYSES

TAVI not only
added years to life,
but also,
life to years!

PARTNER PERSPECTIVES - "INOPERABLE"

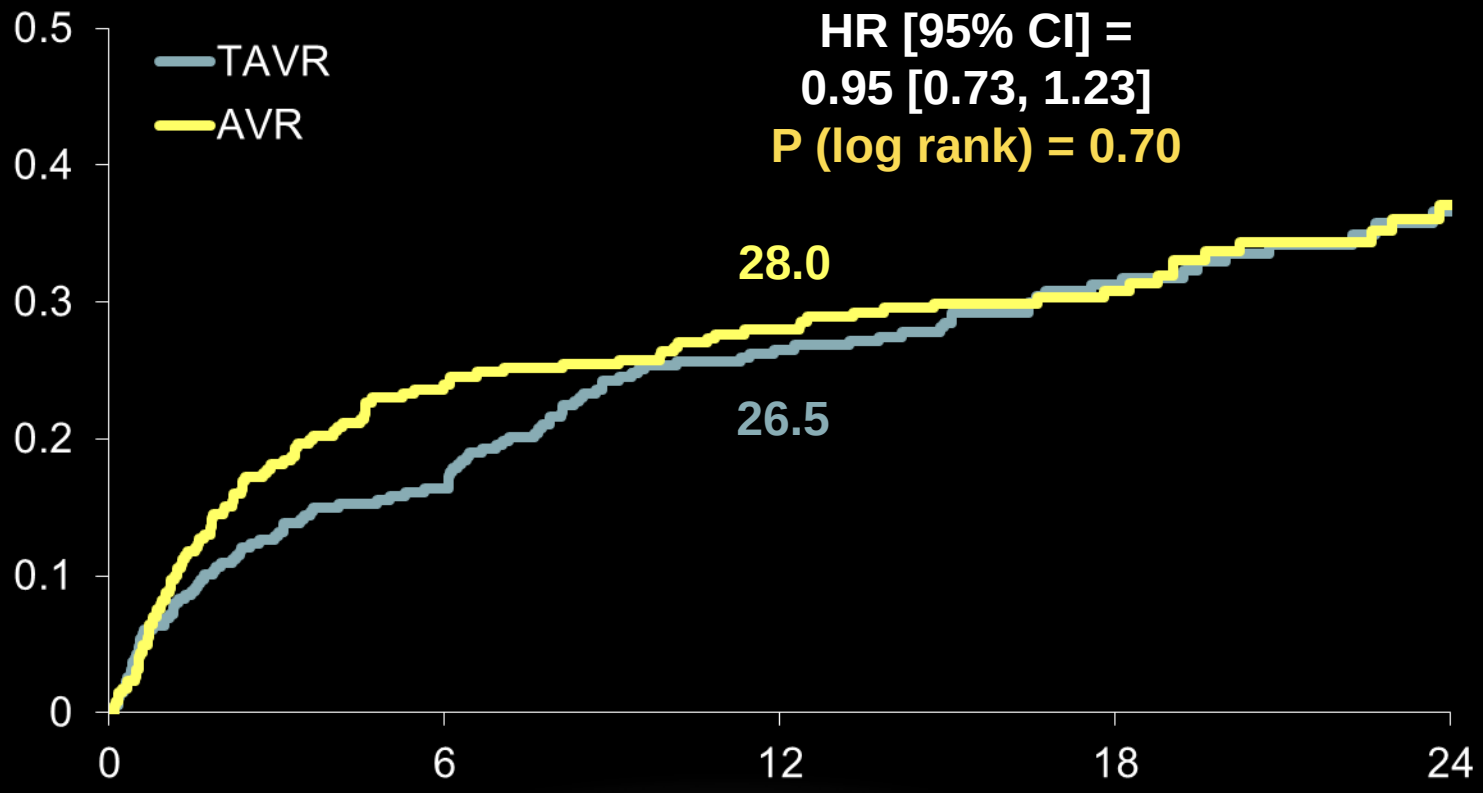
- The HEART VALVE TEAM approach is preferred
- Standard therapy is associated with a prohibitive 1-year mortality.
- TAVI resulted in…
  - Low (~5%) 30-day mortality
  - Historic reduction in 1-year mortality
  - Improved symptoms in survivors
  - New complications (e.g. strokes, vascular)
- *Balloon-expandable TAVR is the new standard-of-care for inoperable patients with severe AS!*

TAVI

High Risk Group: OUTCOMES

ALL-CAUSE MORTALITY OR STROKE

ALL PATIENTS (N=699)



No. at Risk	Months				
TAVR	348	289	252	143	65
AVR	351	247	232	138	63

PARTNER PERSPECTIVES - “HIGH RISK”

- TAVI and AVR procedural mortality were similar and better than anticipated (30 days: TAVR 3.4%, AVR 6.5%, P=0.07) .
- Mortality at 1-year was also similar
- TAVI resulted in…
  - Earlier improvement in symptoms (same at 1-year)
  - Improved echo AV gradients-areas (small difference)
  - Different peri-procedural hazards – TAVI increased strokes, vascular complics and AVR increased bleeding and new onset AF

PARTNER - “HIGH RISK”

Balloon-expandable TAVR is a new alternative therapy to surgical AVR in selected high-risk patients with severe AS!

NEW TAVI TECHNOLOGIES

- Direct Flow
- Sadra
- AorTx
- Jena Valve
- HLT
- ABPS PercValve
- EndoTech
- Ventor Embracer
- Symetis