



Corso di Ecocardiografia a numero chiuso

**IL PERCORSO CLINICO DEL PAZIENTE CON PROTESI VALVOLARE,
VALVOLE ARTIFICIALI PERCUTANEE ED ENDOCARDITE SU PROTESI
Milano, Atahotel Executive 28 - 29 Ottobre 2010**

**Modelli protesici e loro emodinamica Doppler.
Il limite della normalità.
(Le protesi normali nella rappresentazione illusoria
degli ultrasuoni. Quali le trappole per il cardiologo
esperto in imaging non invasivo)**

Daniele Bertoli



Protesi valvolari ed ecocardiografia

- L'ecocardiografia è la metodica di scelta per lo studio non invasivo delle protesi valvolari
- La valutazione morfologica e funzionale delle valvole protesiche differisce da quella delle valvole native
- E' richiesta una competenza specifica



GUIDELINES AND STANDARDS

Recommendations for Evaluation of Prosthetic Valves With Echocardiography and Doppler Ultrasound

A Report From the American Society of Echocardiography's Guidelines and Standards Committee and the Task Force on Prosthetic Valves, Developed in Conjunction With the American College of Cardiology Cardiovascular Imaging Committee, Cardiac Imaging Committee of the American Heart Association, the European Association of Echocardiography, a registered branch of the European Society of Cardiology, the Japanese Society of Echocardiography and the Canadian Society of Echocardiography, Endorsed by the American College of Cardiology Foundation, American Heart Association, European Association of Echocardiography, a registered branch of the European Society of Cardiology, the Japanese Society of Echocardiography, and Canadian Society of Echocardiography

Journal of the American Society of Echocardiography
September 2009



Essential parameters in the comprehensive evaluation of prosthetic valve function

1. Clinical information
2. Imaging of the valve
3. Doppler echocardiography of the valve
4. Other echocardiographic data
5. Previous postoperative studies, when available



Clinical information

- Date of valve replacement
- Type and size of the prosthetic valve
- Height, weight, body surface area
- Symptoms and related clinical findings
- Blood pressure and heart rate



Protesi valvolari ed ecocardiografia

- Valutazione morfologica
- Valutazione funzionale



Valutazione morfologica

- Protesi biologiche
- Protesi meccaniche



Protesi biologiche

– Stented

- Porcine
- Pericardio bovino

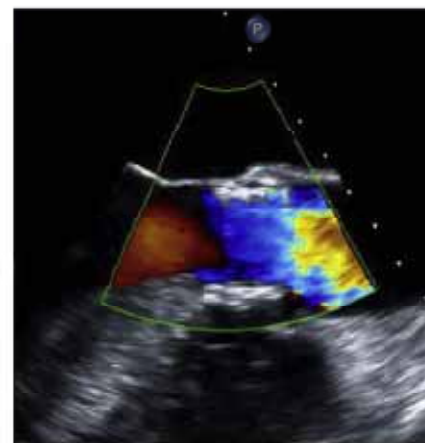
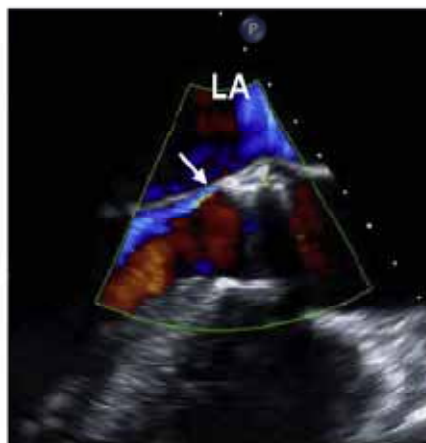
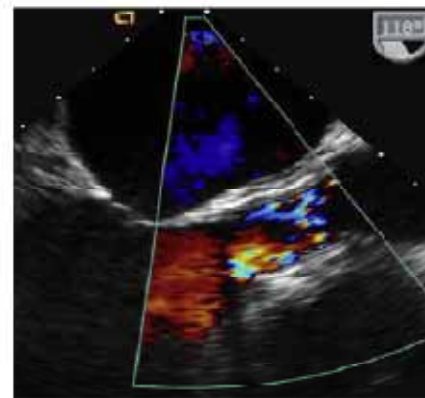
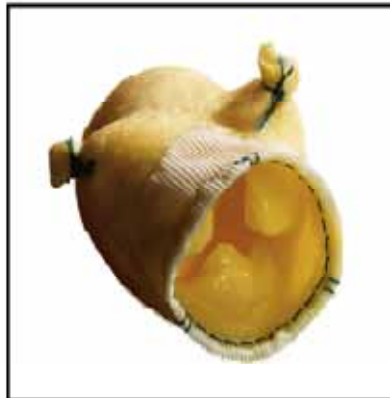
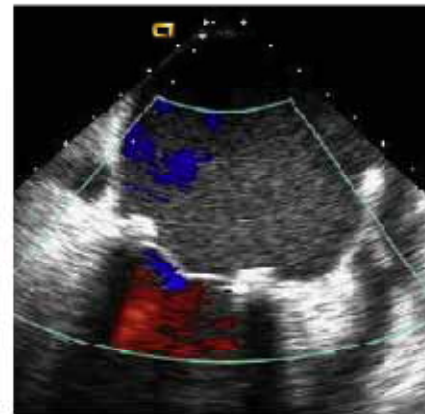
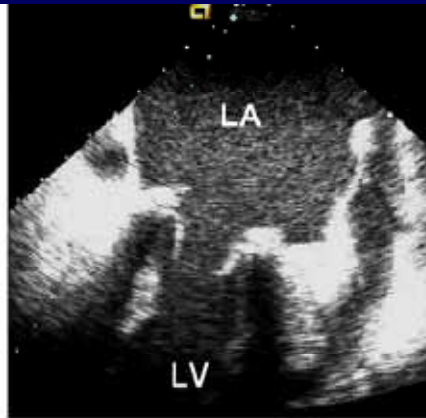
– Stentless

- preparazioni di aorta porcina (Medtronic Freestyle, Toronto SJM)
- Tricomposite (Cryolife, BioCor SJM)
- Pericardio bovino (Sorin Freedom)

– Homograft

– Percutanee



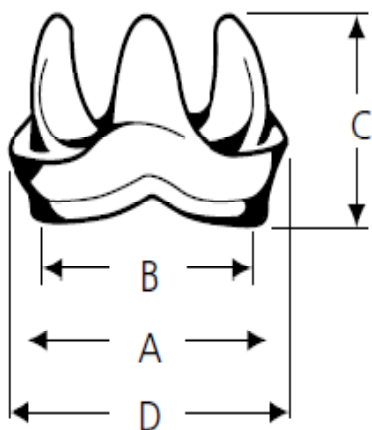


Carpentier-Edwards Aortic Porcine Bioprosthesis



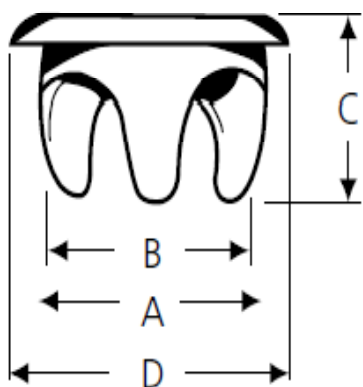
Specifications

Significant dimensions in millimeters (nominal values)



Model 2625 Aortic

A. Mounting Diameter (Annulus)	19	21	23	25	27	29	31
B. Graft Mounting Diameter (Stent I.D.)	17	19	21	23	25	27	29
C. Profile Height	19	19	20	21	22	22	24
D. External Sewing Ring Diameter	24	27	29	31	34	36	37



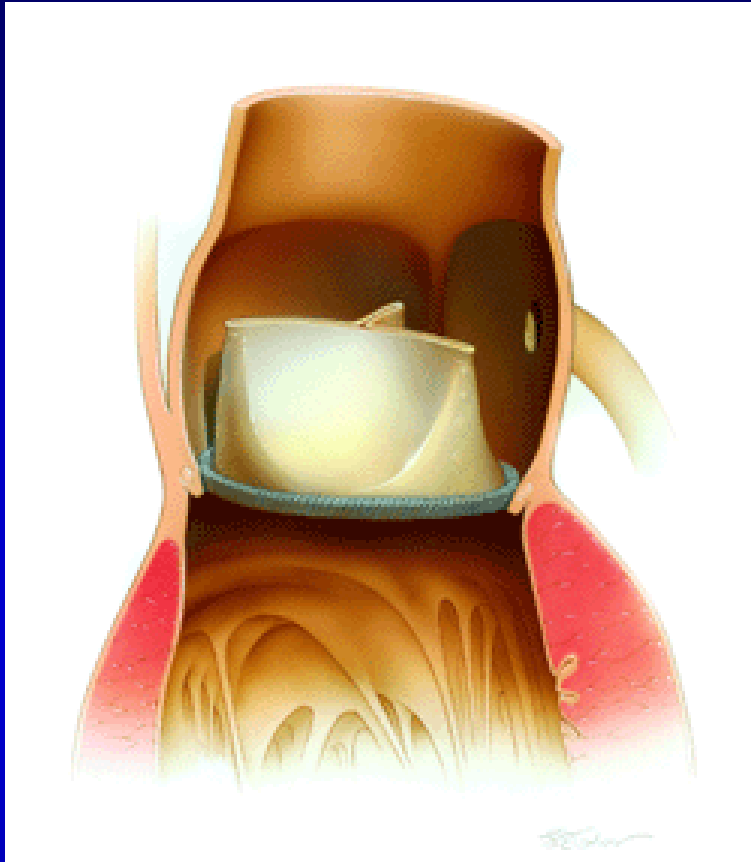
Model 6625 Mitral

A. Mounting Diameter (Annulus)	25	27	29	31	33	35
B. Graft Mounting Diameter (Stent I.D.)	23	25	27	29	31	33
C. Profile Height	19	21	23	24	25	26
D. External Sewing Ring Diameter	34	36	38	40	42	44

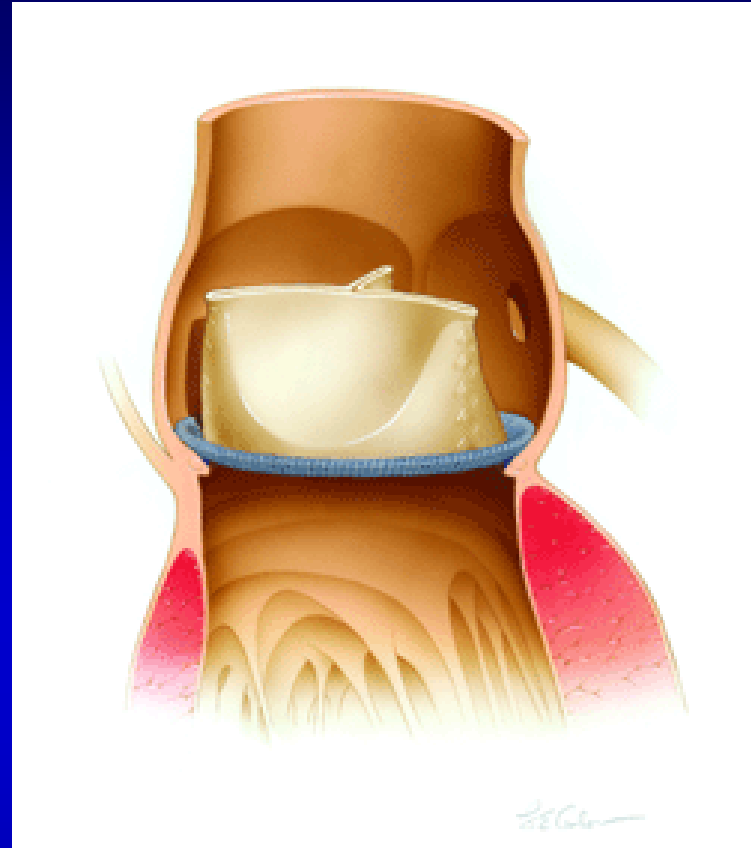


Carpentier-Edwards S.A.V. Aortic Porcine Bioprosthesis





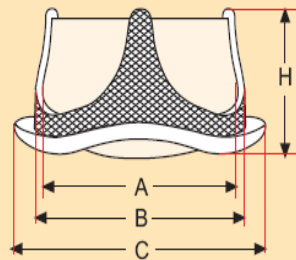
Intra-annular Position



Supra-annular Position



SOPRANO™ - AORTIC VALVE



A = Valve orifice diameter (T.A.D.)

B = External diameter

C = Sewing ring diameter

H = Total height

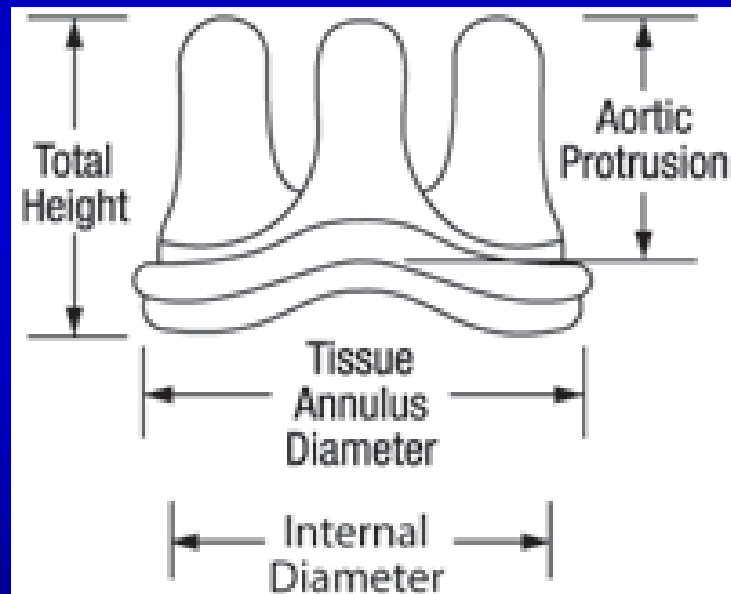
Size	18	20	22	24	26	28
REF	Art 18 SOP	Art 20 SOP	Art 22 SOP	Art 24 SOP	Art 26 SOP	Art 28 SOP
Ord. Code	ICV0876	ICV0877	ICV0878	ICV0879	ICV0880	ICV0881
A (mm)	17,8	19,8	21,7	23,7	25,6	27,6
B (mm)	21	23	25	27	29	31
C (mm)	26	28	30	32	35	38
H (mm)	12	14	15	16	18	19

Nominal values

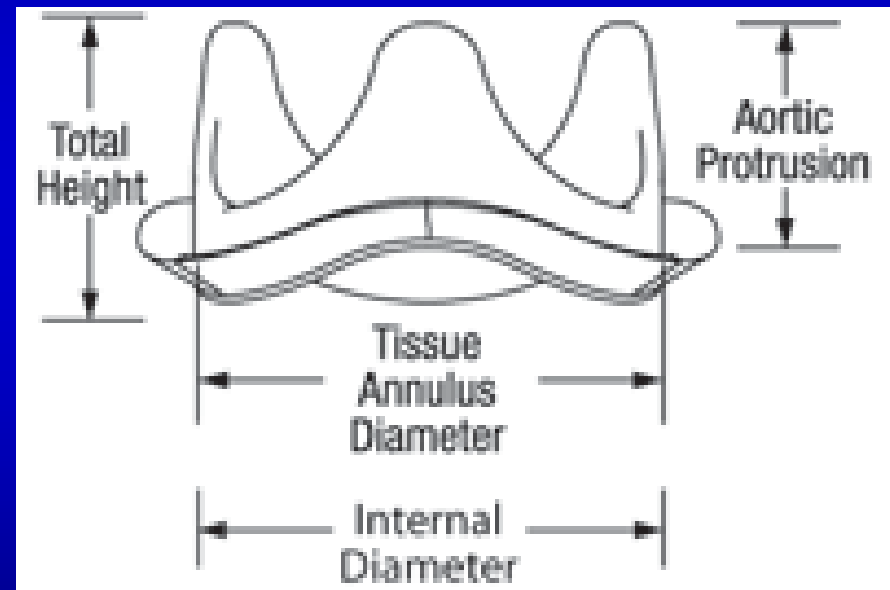


SJM Epic Stented Valve

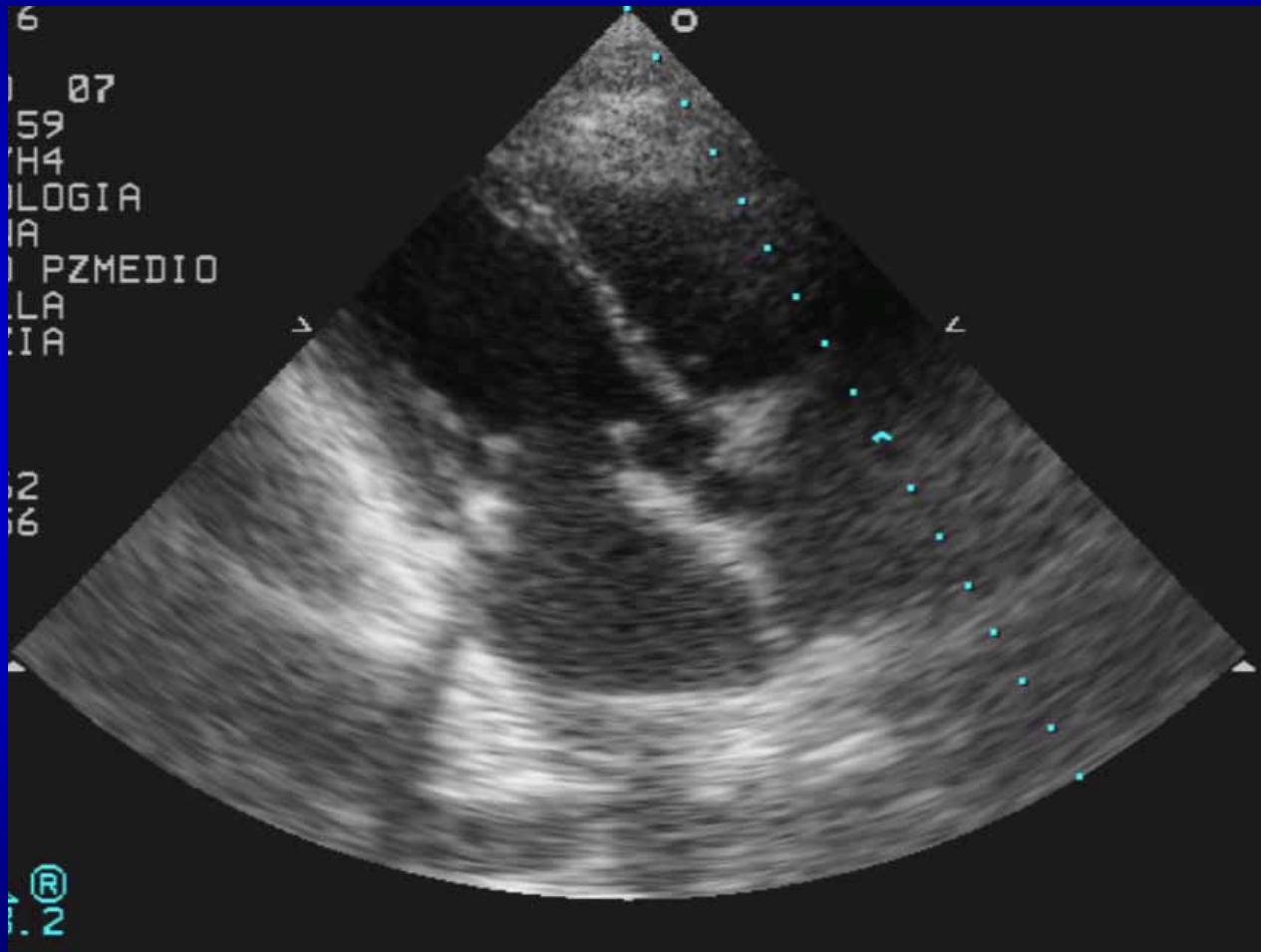
Aortic



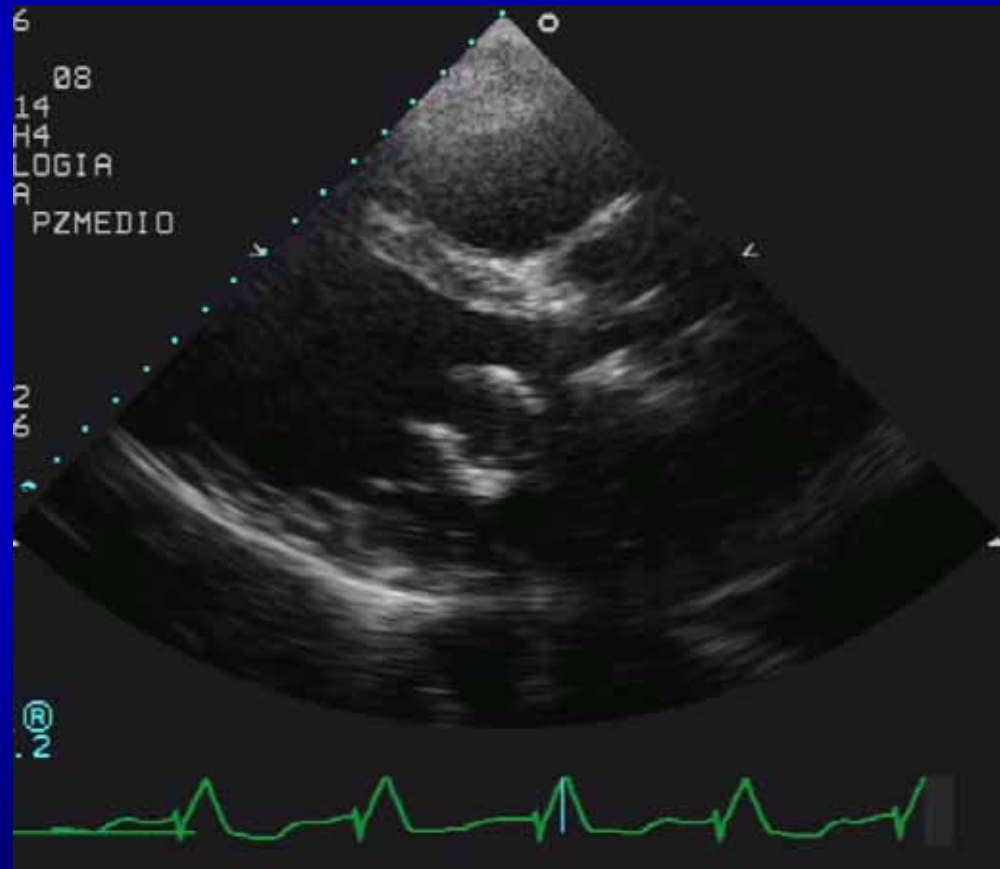
Supra (Aortic)



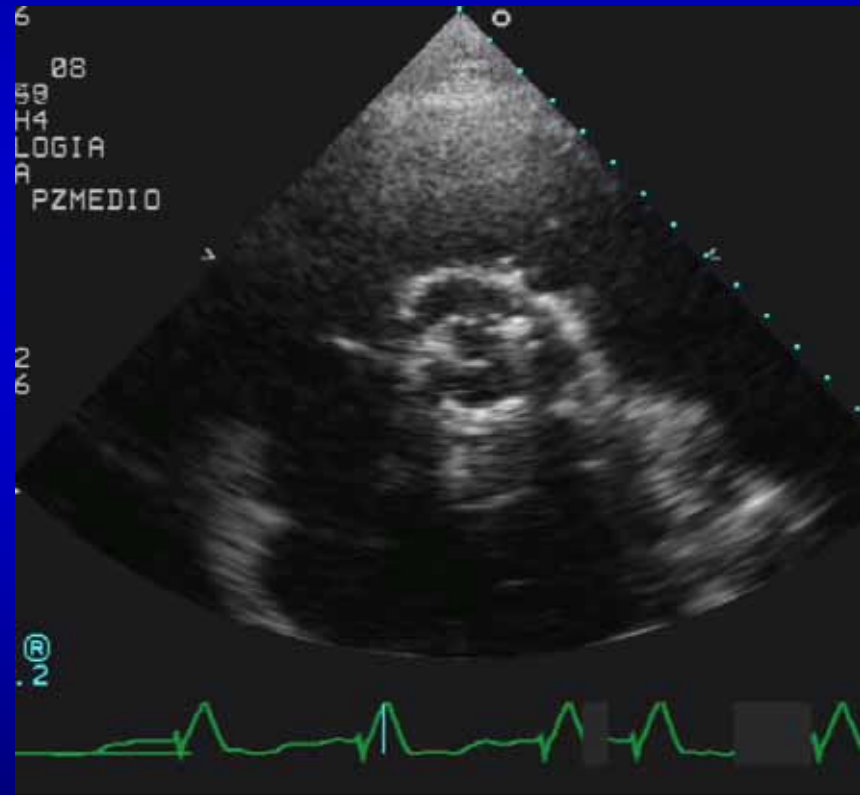
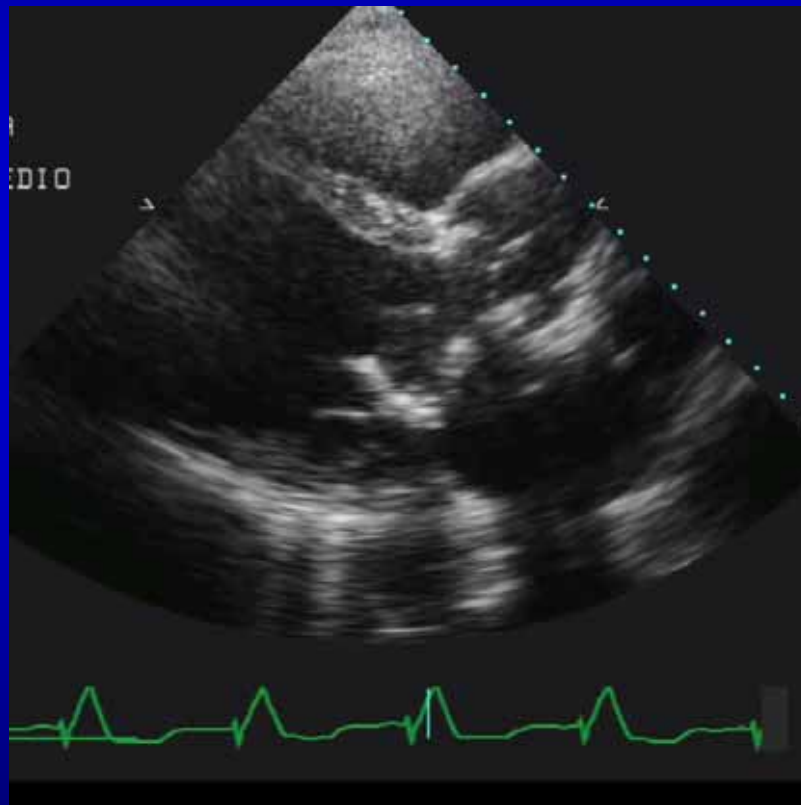
Protesi biologica stented



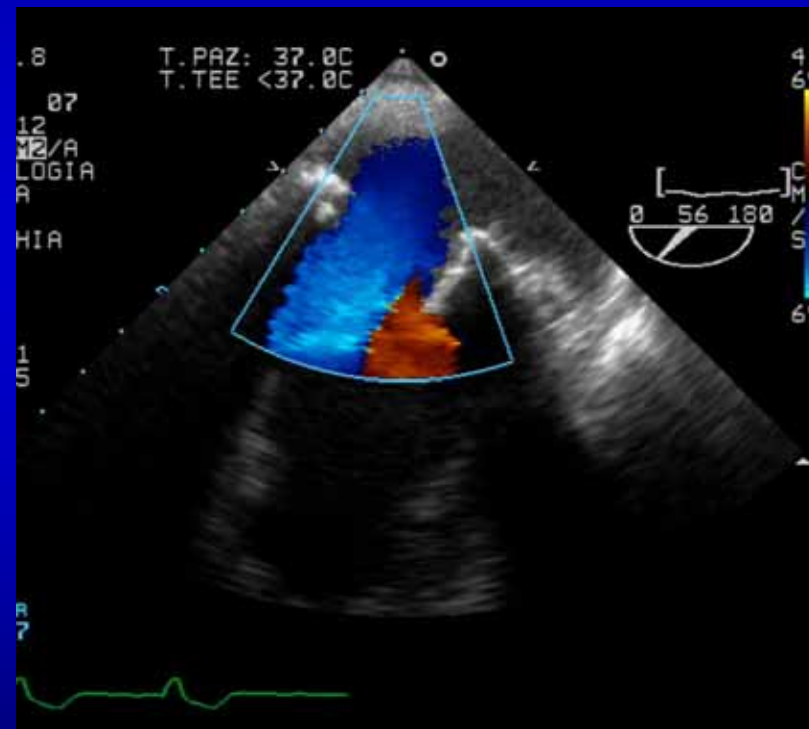
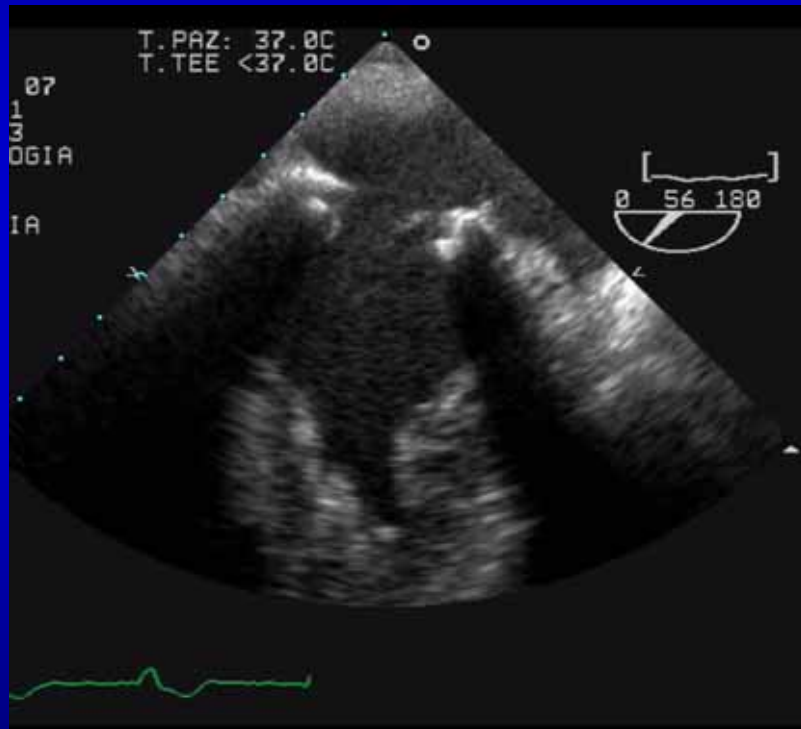
Protesi biologica stented



Protesi aortica stented



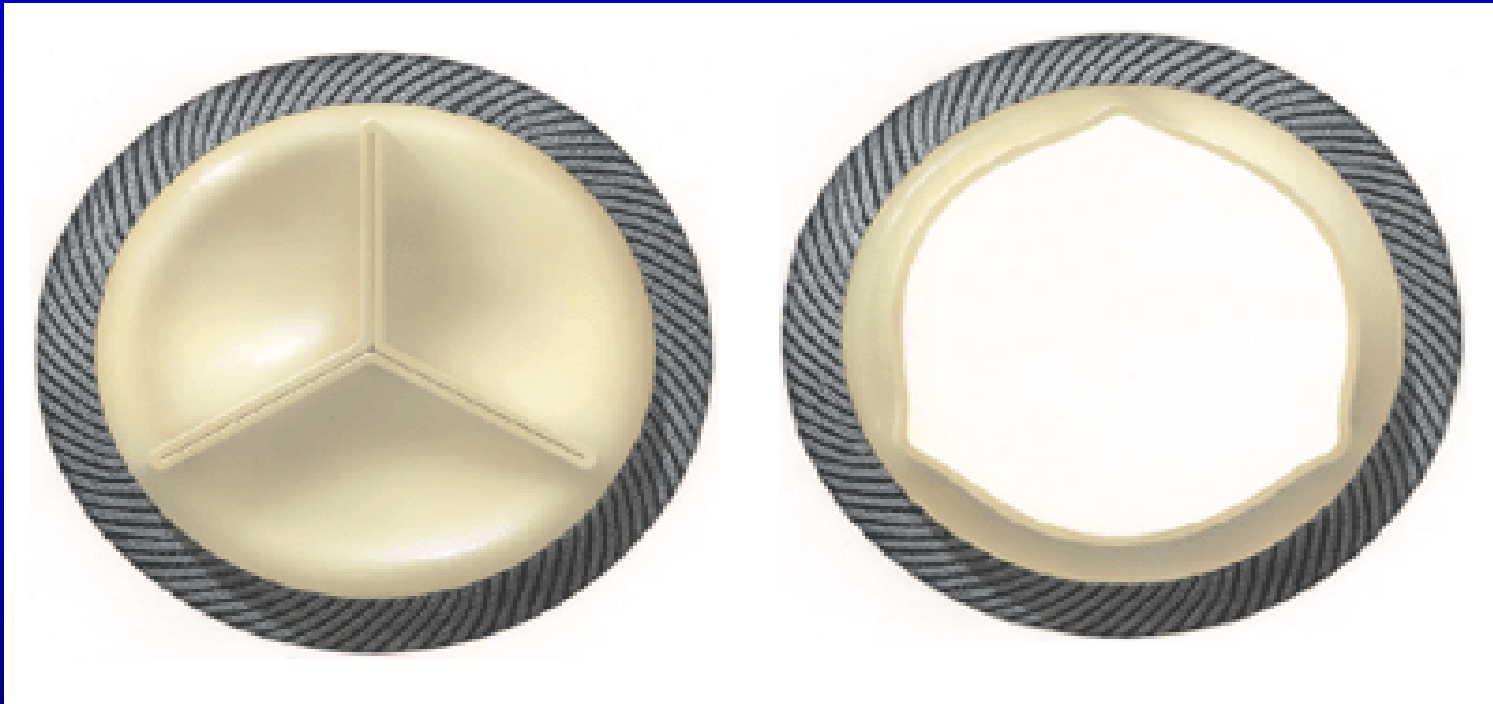
Hancock mitralica



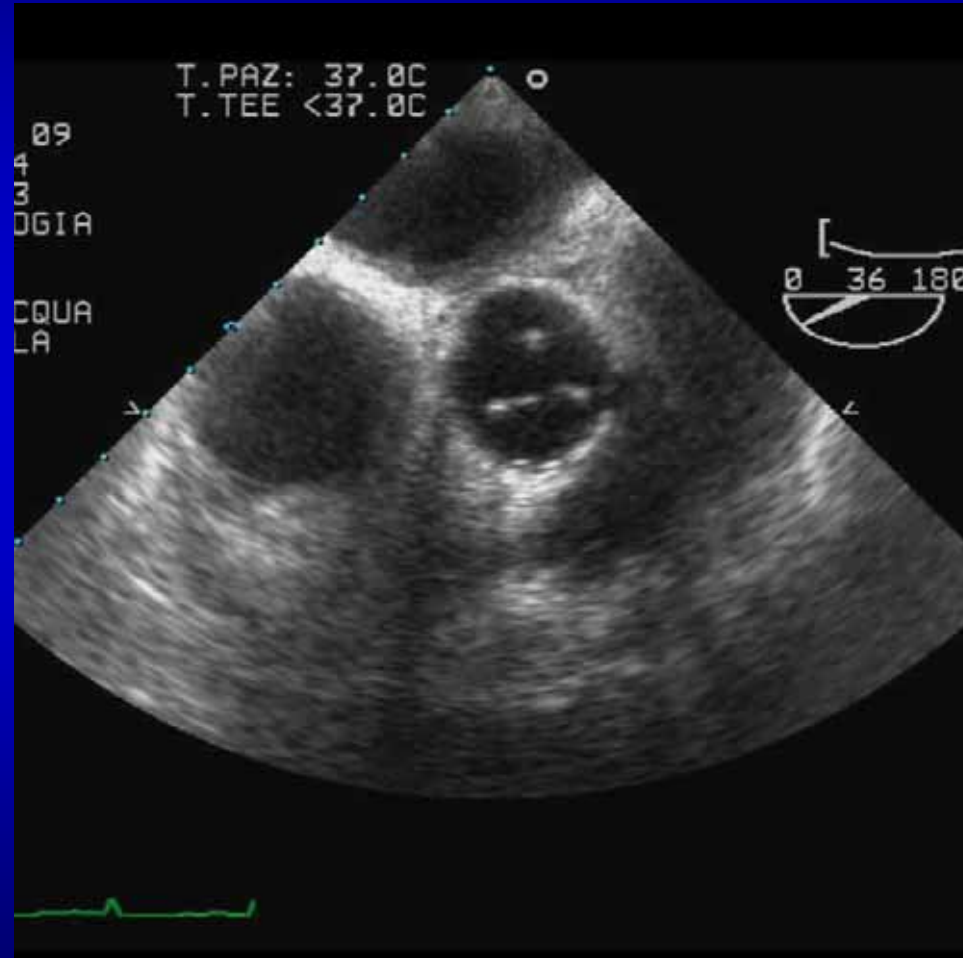
MITROFLOW (Sorin Group) PERICARDIAL AORTIC VALVE



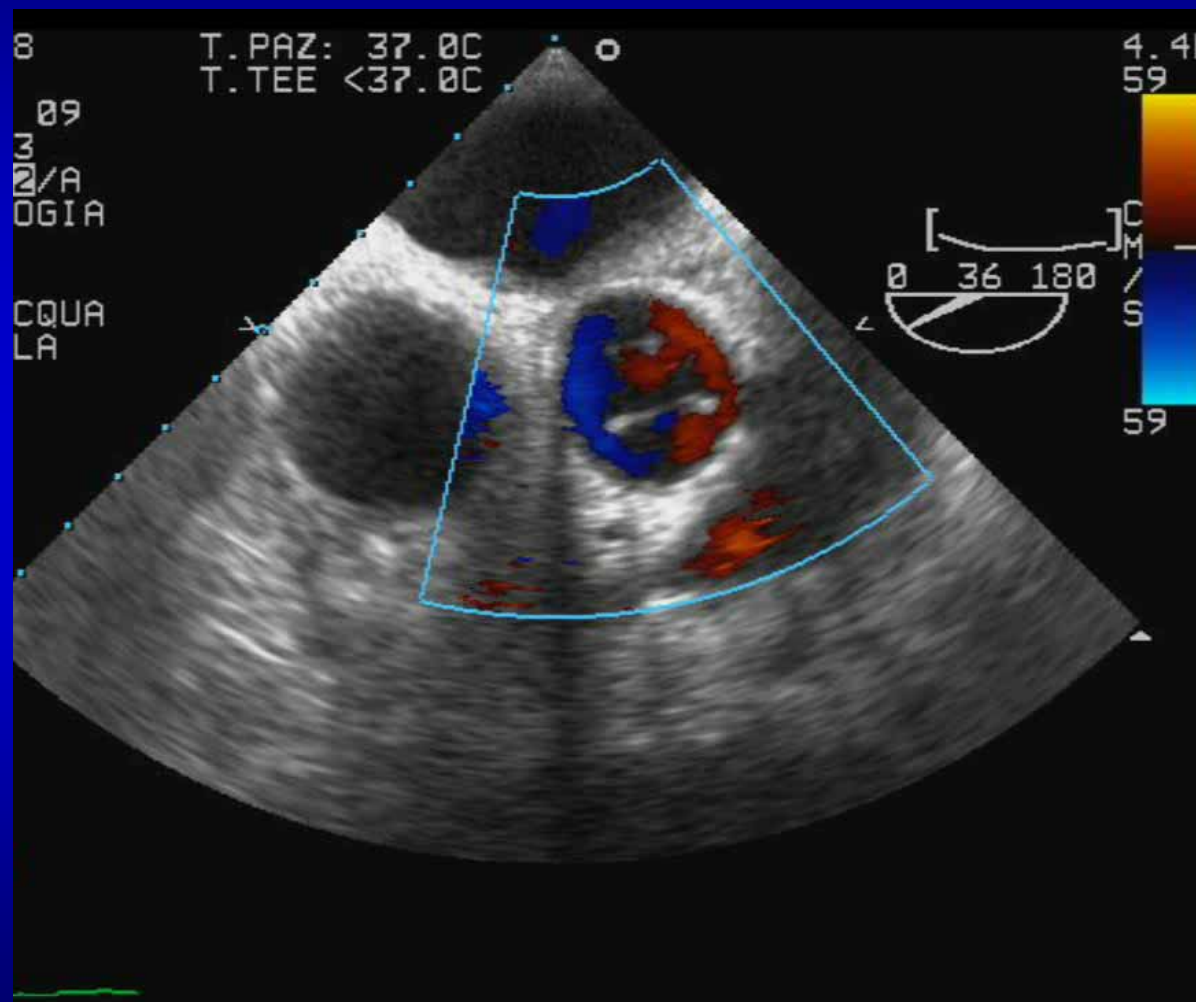
Mitroflow Aortic Pericardial Heart Valve



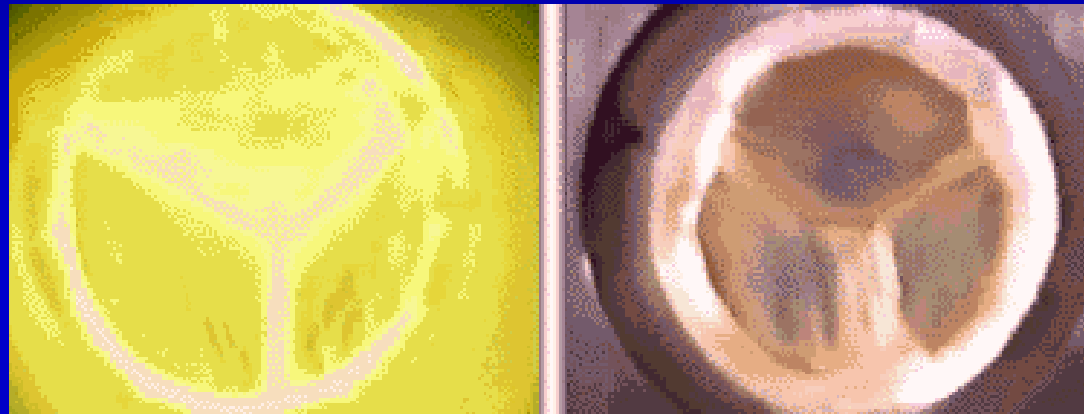
Mitroflow aortica



Mitroflow aortica



Medtronic Stentless Freestyle Bioprosthesis



**23 mm Stentless
Freestyle
Bioprosthesis**

**23 mm Stented
Bioprosthesis**



Freestyle Aortic Root Bioprosthesis

Total Root/Stentless Design
(allows choice of surgical
implantation technique)

Polyester
Covering
(strengthens
and isolates
porcine
myocardial
tissue)

Surgeon's
Flags
(aid suture
placement)

AOA[®]
Treatment

Green
Demarcation
Line (indicates
suture area)

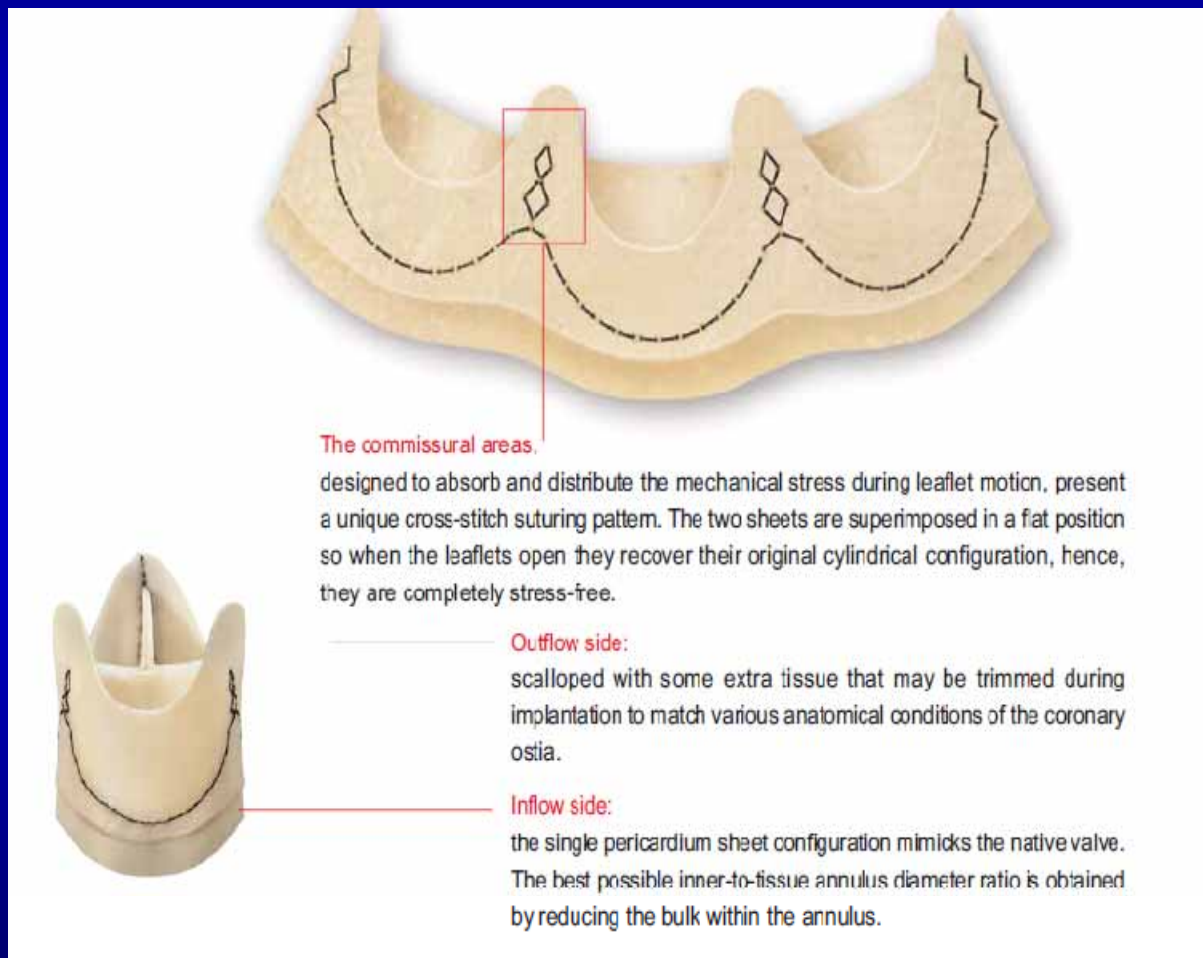
Physiologic Fixation™ ‡

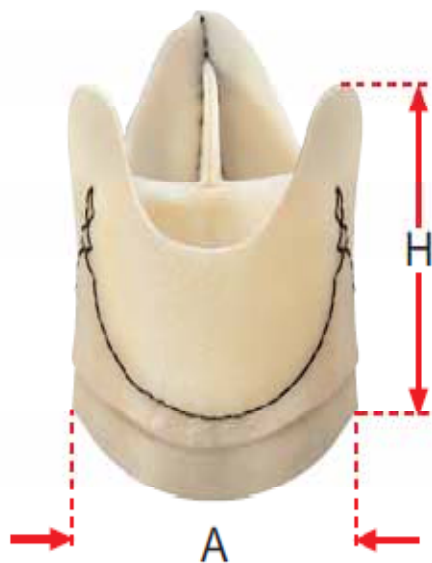


Edwards Prima Plus Stentless Porcine Bioprosthesis



SORIN PERICARBON™ FREEDOM STENTLESS

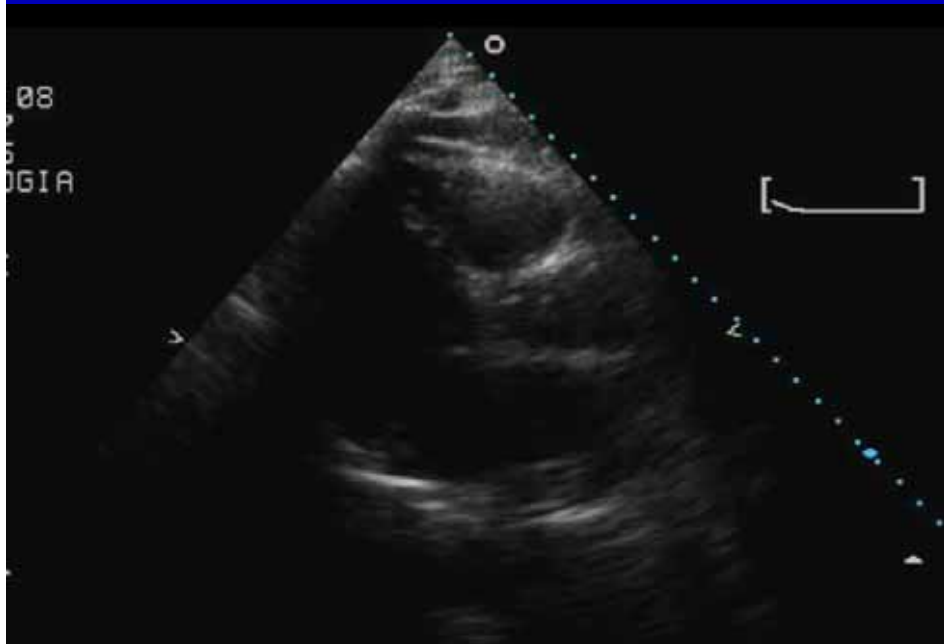




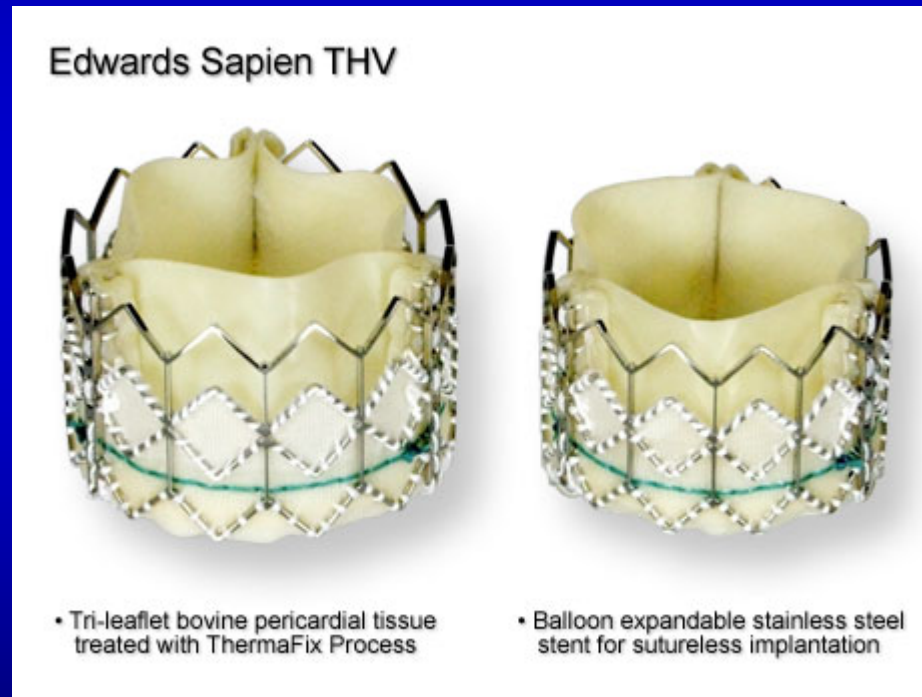
SIZE	REF	CODE	A Tissue Annulus Diameter	H
			External Diameter (mm)	Total Height (mm)
15	PF15	ICV0774	15	26.5
17	PF17	ICV0775	17	27.5
19	PF19	ICV0776	19	29
21	PF21	ICV0777	21	30
23	PF23	ICV0778	23	31.5
25	PF25	ICV0779	25	32.5
27	PF27	ICV0780	27	34
29	PF29	ICV0781	29	35



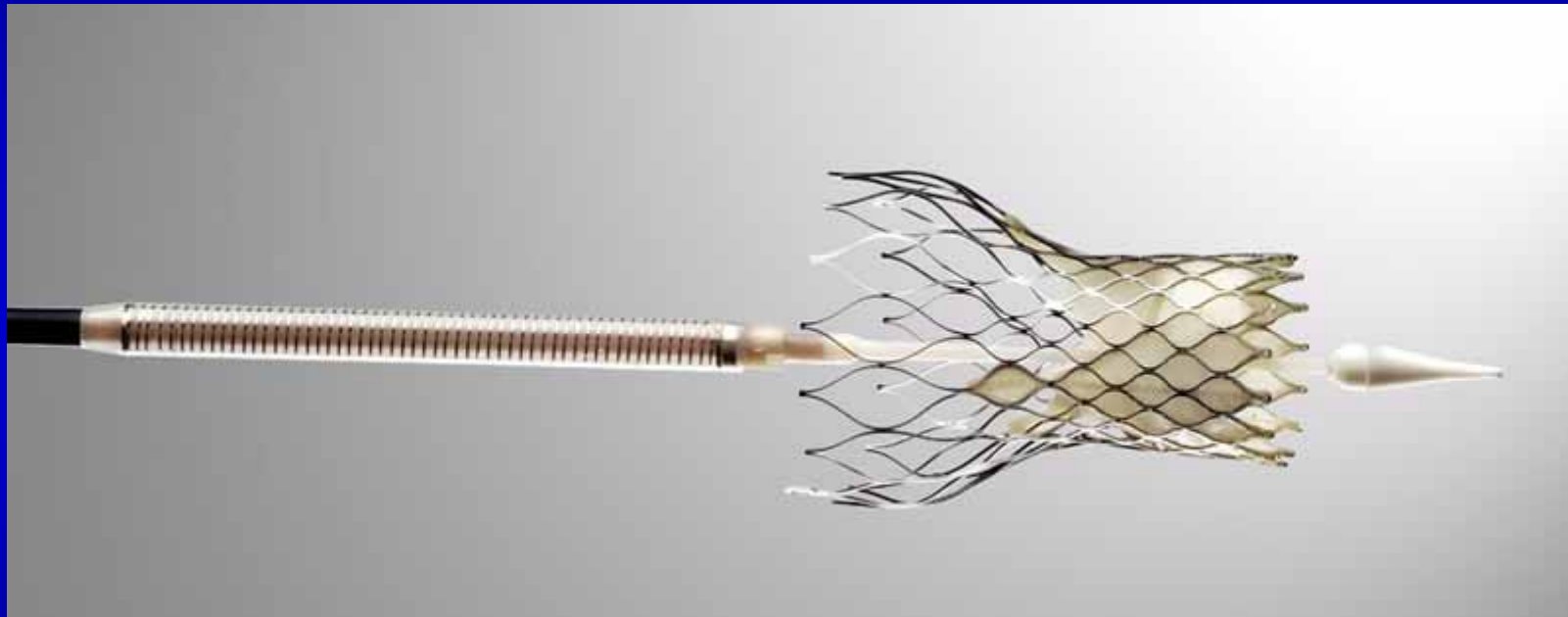
Sorin Freedom (stentless)

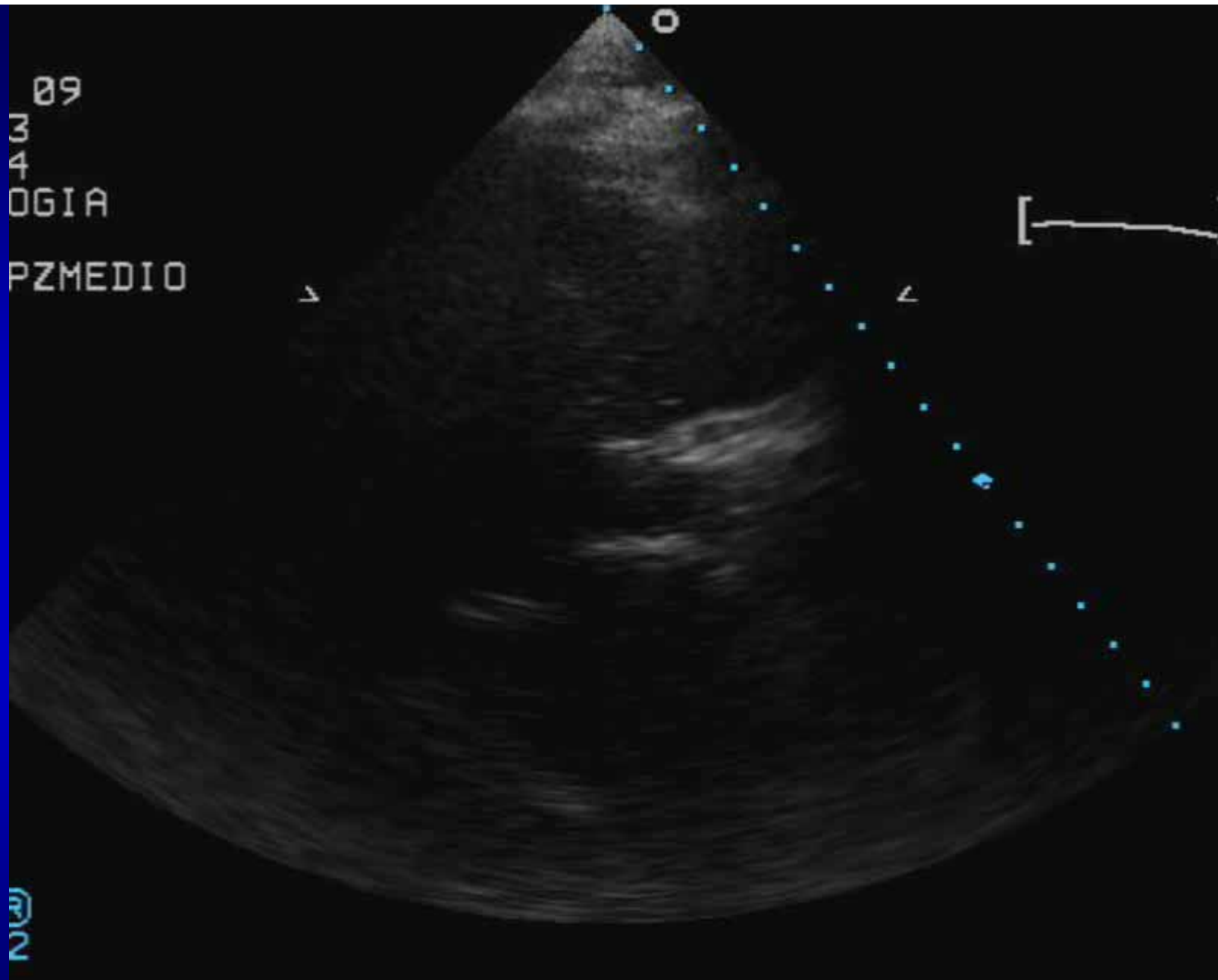


Edwards SAPIEN Transcatheter Heart Valve



Corevalve Medtronic





1.6

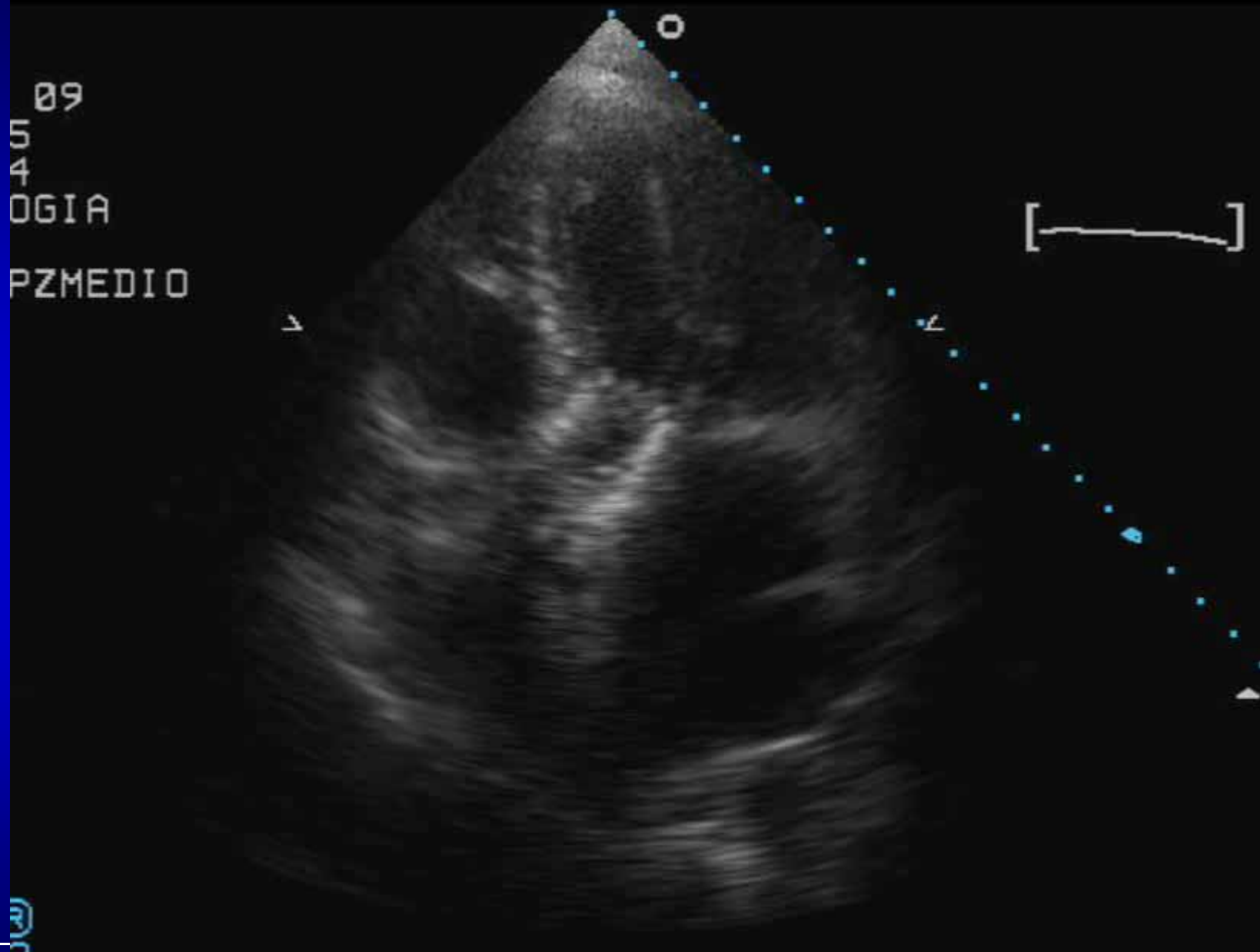
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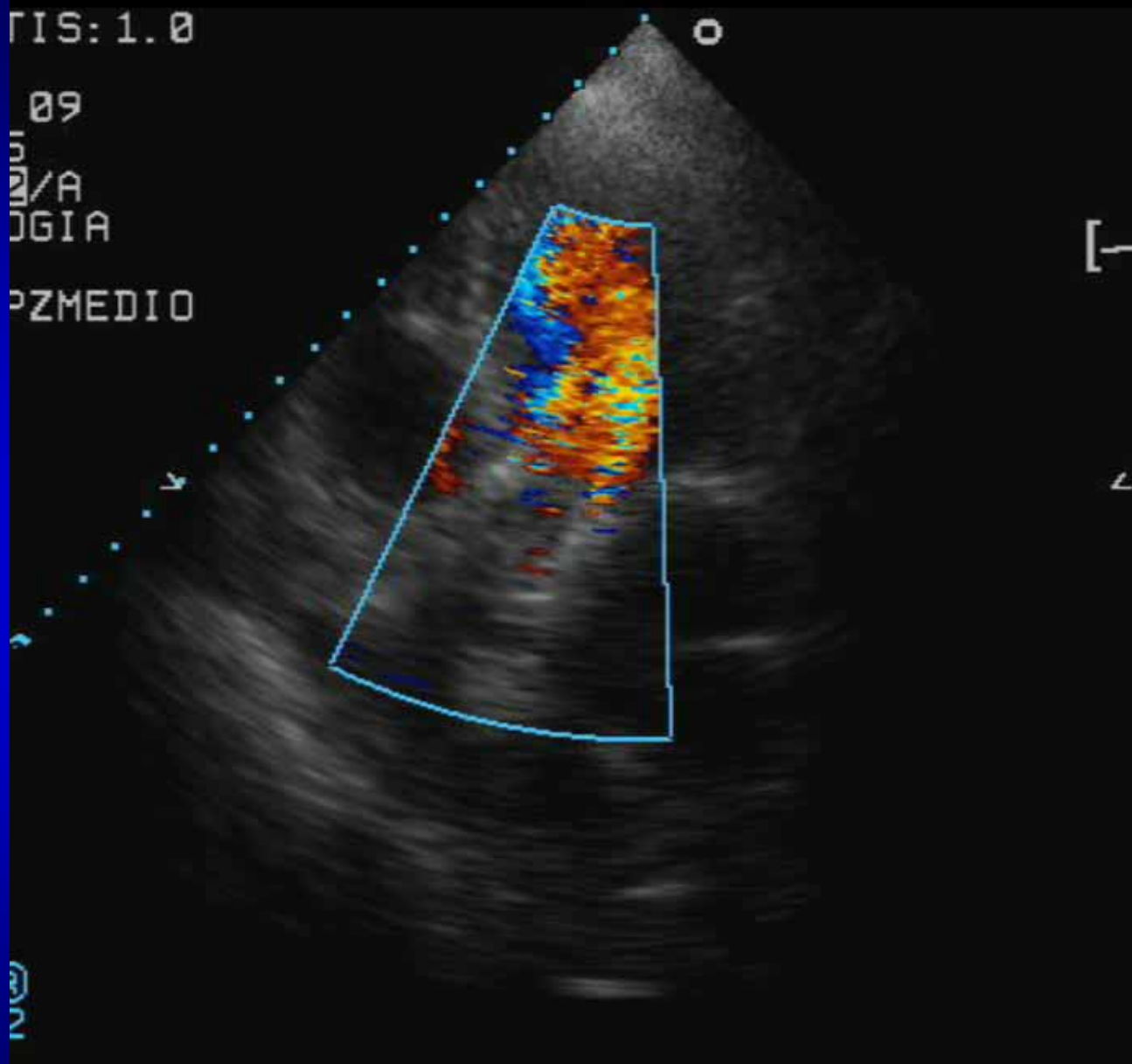
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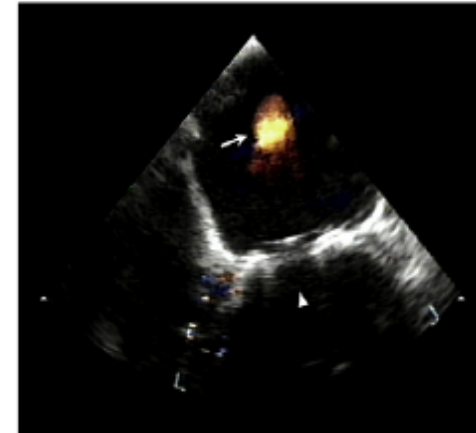
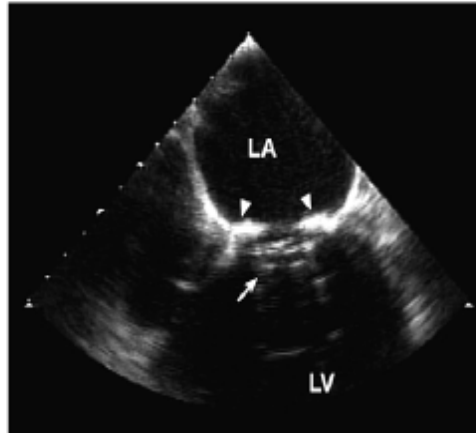
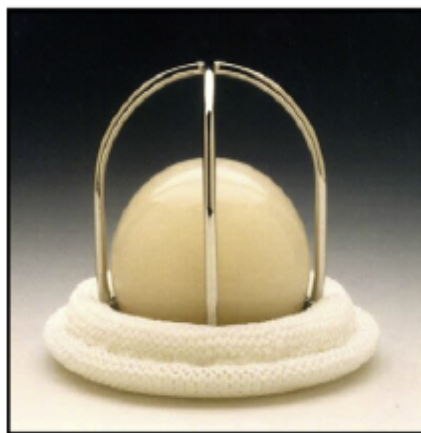
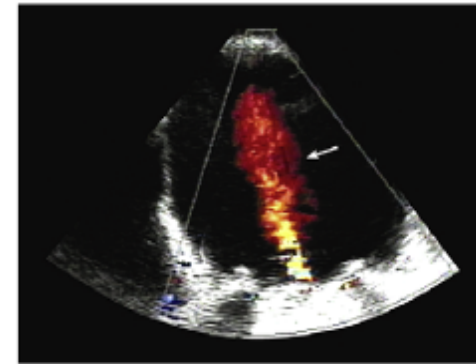
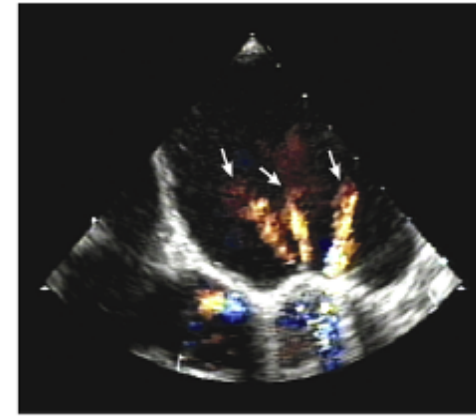
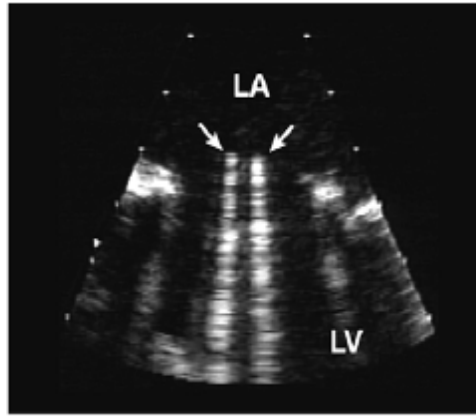
PROTESI MECCANICHE

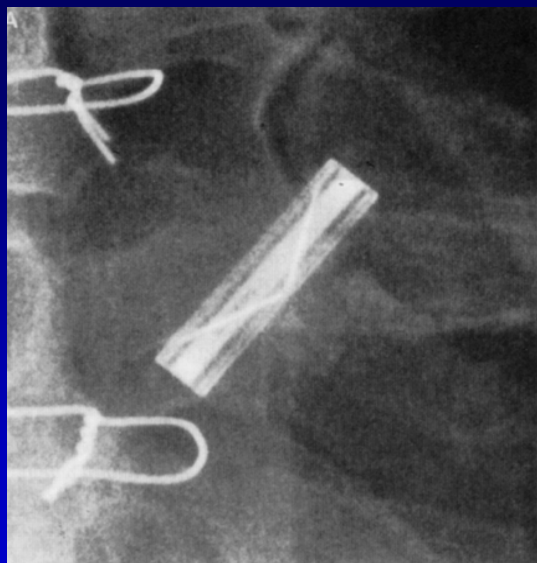
bileaflet

single tilting disc

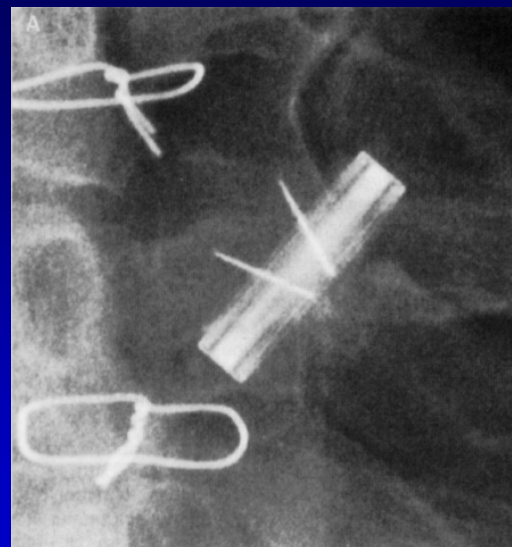
Caged-ball



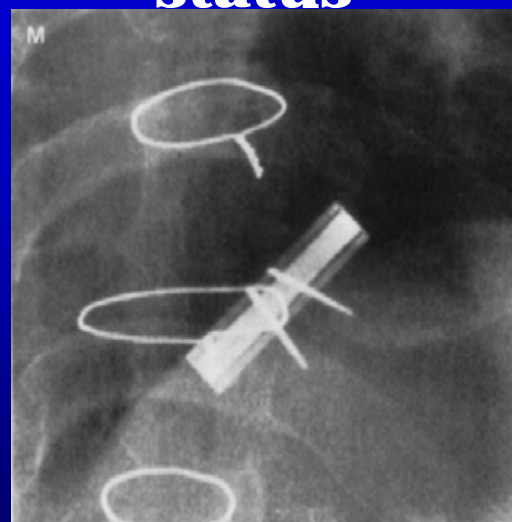
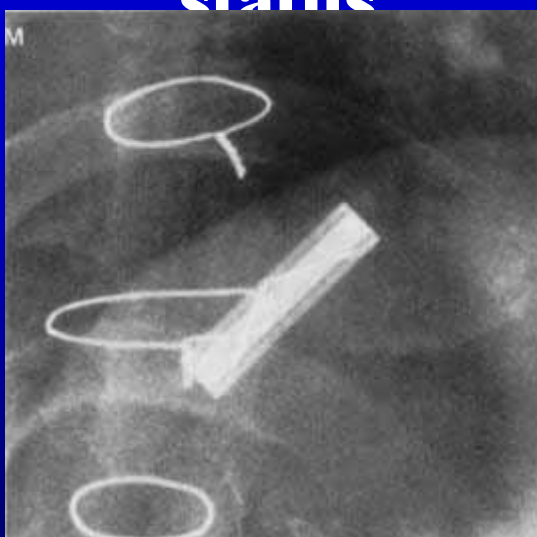




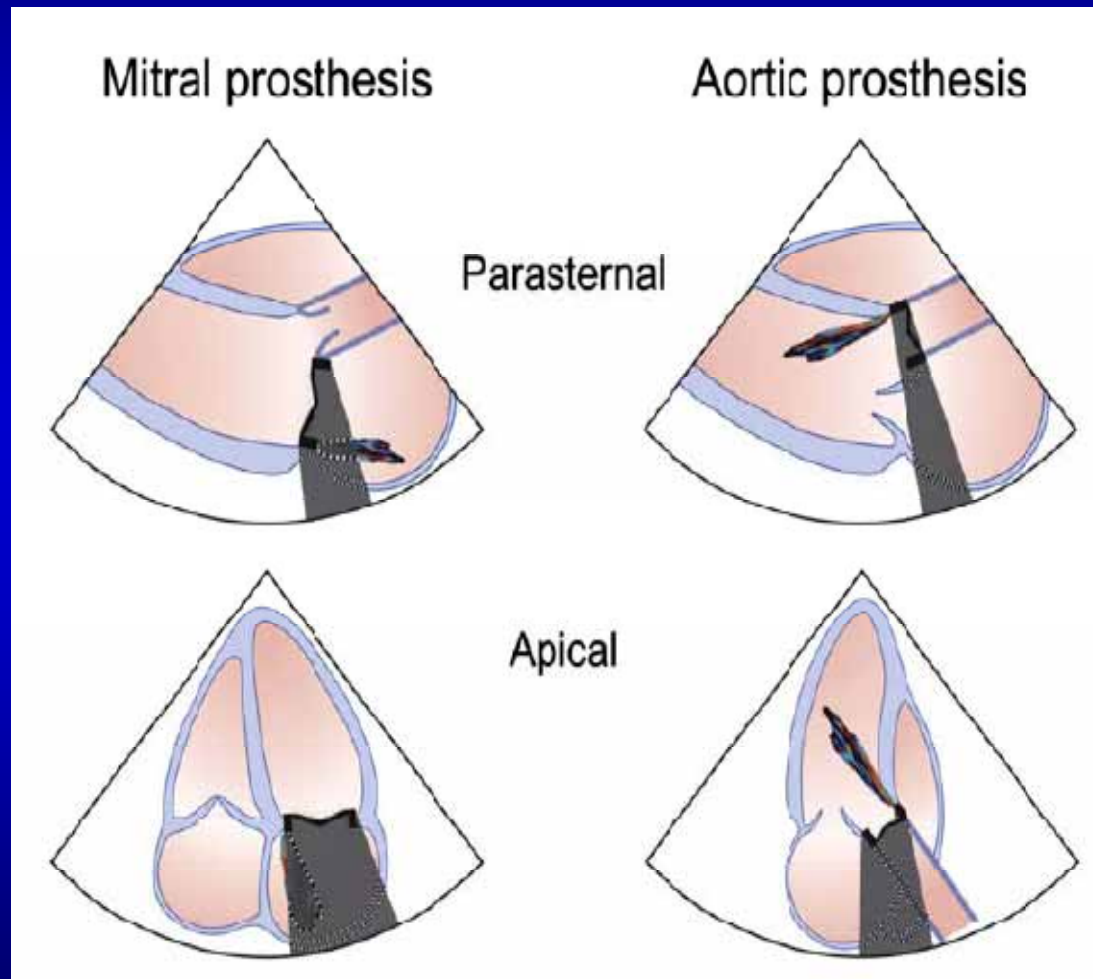
Leaflets in closed status



Leaflets in open status



Effect of mechanical prosthetic valve position and echocardiographic imaging view on shadowing and masking



St. Jude Medical Masters HP Series



St. Jude Medical Regent



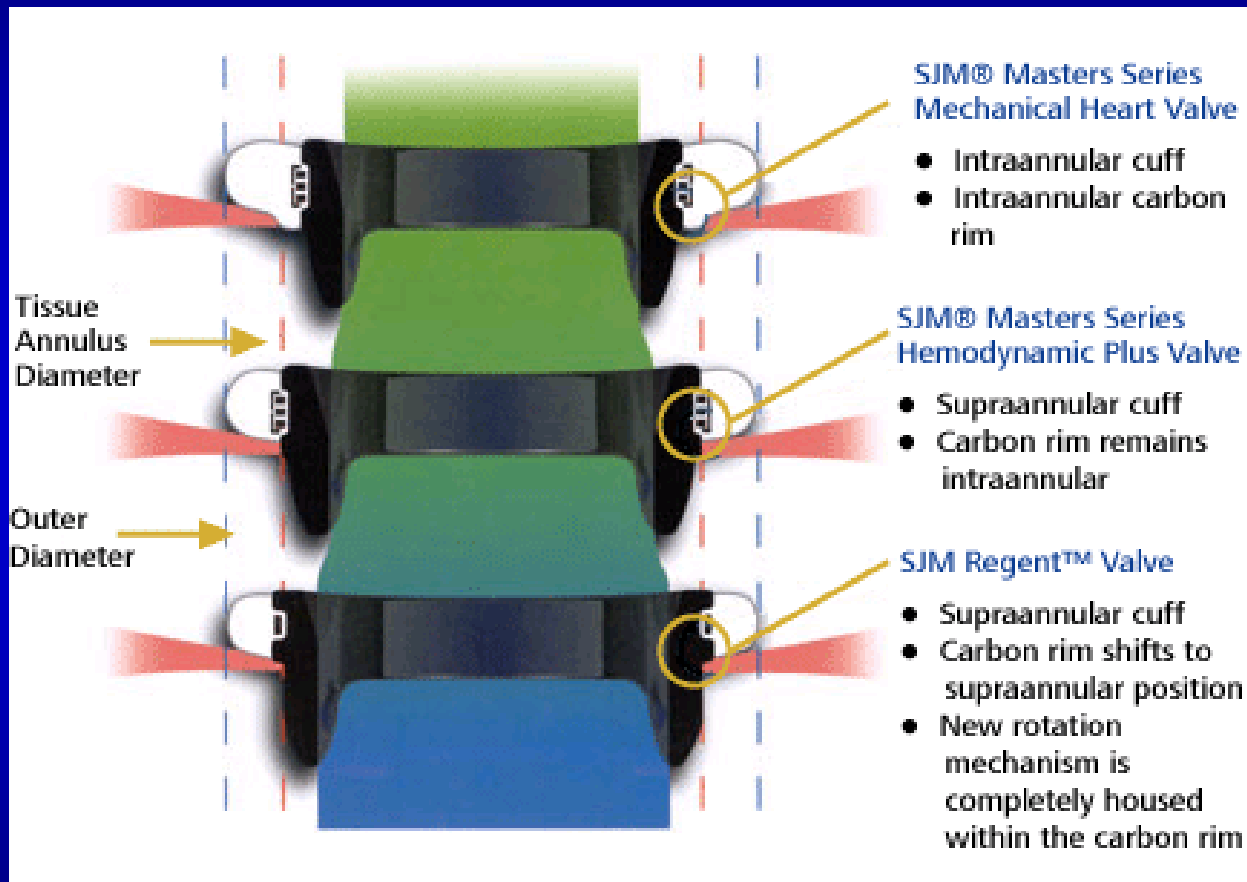
Effective Orifice Area Index (EOAI)^{2,3}

Valve Size (mm)	19	21	23	25	27	29
Avg. EOA (cm ²)	1.7	2.0	2.5	2.6	3.5	3.5
BSA (m ²)						
0.6	2.83	3.33	4.17	4.33	5.83	5.83
0.7	2.43	2.86	3.57	3.71	5.00	5.00
0.8	2.13	2.50	3.13	3.25	4.38	4.38
0.9	1.89	2.22	2.78	2.89	3.89	3.89
1.0	1.70	2.00	2.50	2.60	3.50	3.50
1.1	1.55	1.82	2.27	2.36	3.18	3.18
1.2	1.42	1.67	2.08	2.17	2.92	2.92
1.3	1.31	1.54	1.92	2.00	2.69	2.69
1.4	1.21	1.43	1.79	1.86	2.50	2.50
1.5	1.13	1.33	1.67	1.73	2.33	2.33
1.6	1.06	1.25	1.56	1.63	2.19	2.19
1.7	1.00	1.18	1.47	1.53	2.06	2.06
1.8	0.94	1.11	1.39	1.44	1.94	1.94
1.9	0.89	1.05	1.32	1.37	1.84	1.84
2.0	0.85	1.00	1.25	1.30	1.75	1.75
2.1	0.81	0.95	1.19	1.24	1.67	1.67
2.2	0.77	0.91	1.14	1.18	1.59	1.59
2.3	0.74	0.87	1.09	1.13	1.52	1.52
2.4	0.71	0.83	1.04	1.08	1.46	1.46
2.5	0.68	0.80	1.00	1.04	1.40	1.40

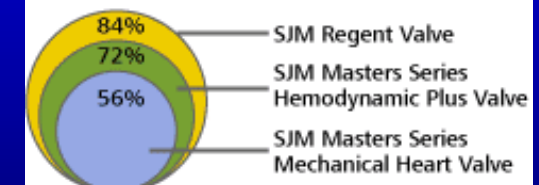
EOAI = EOA/BSA EOAI ≥ .85 cm²/m² .80 cm²/m² < EOAI ≤ .84 cm²/m² EOAI < .80 cm²/m²



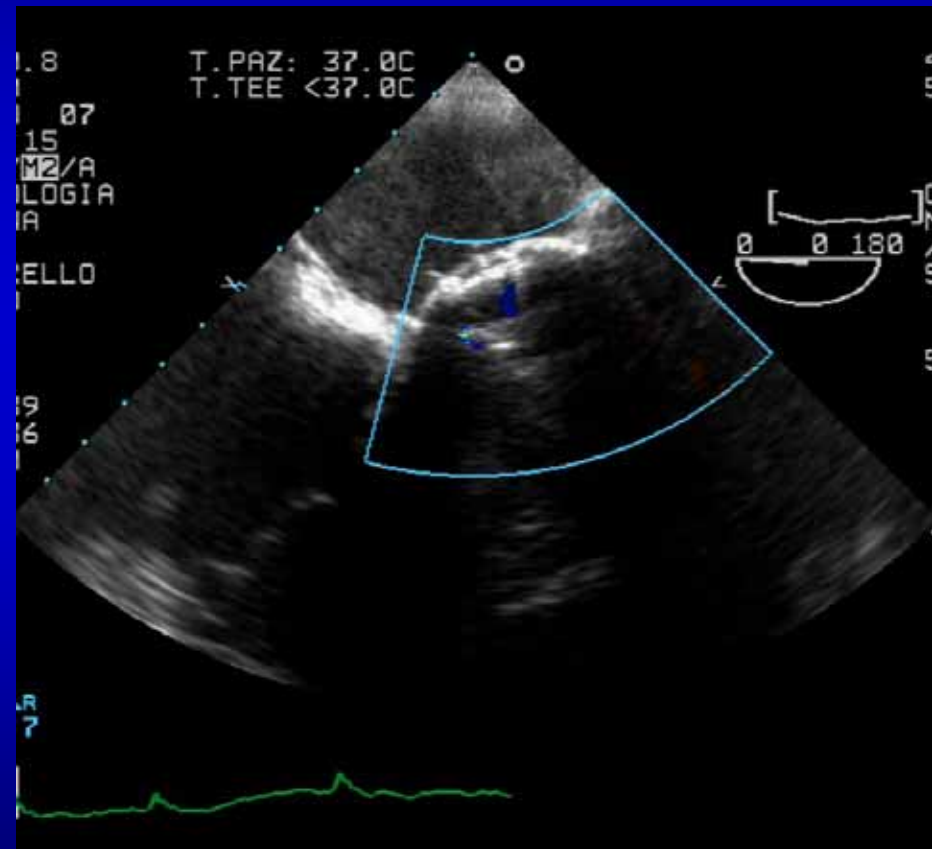
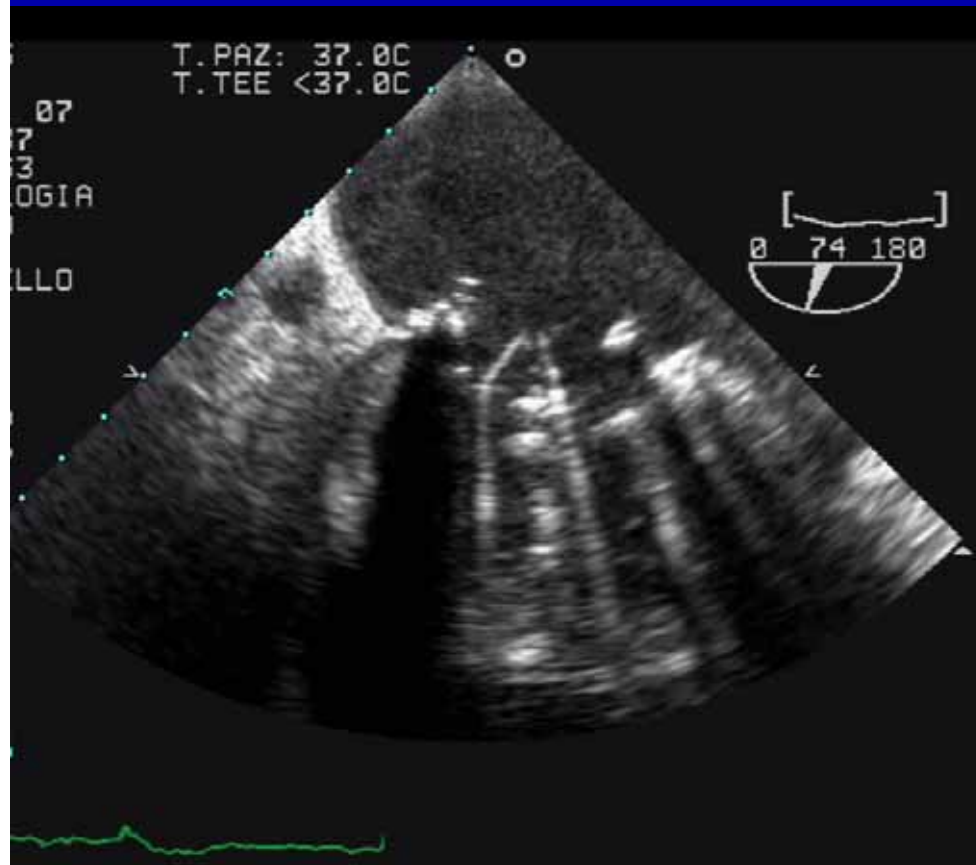
RAPPORTO ORIFIZIO/ANNULUS

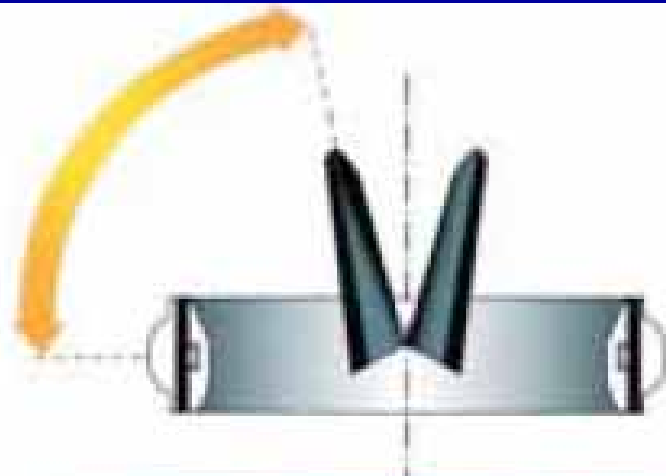


Orifice to annulus ratio-19 mm valve

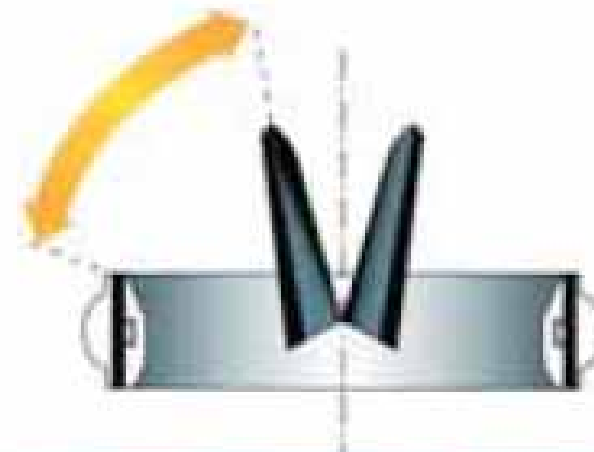


PROTESI MITRALICA BILEAFLET





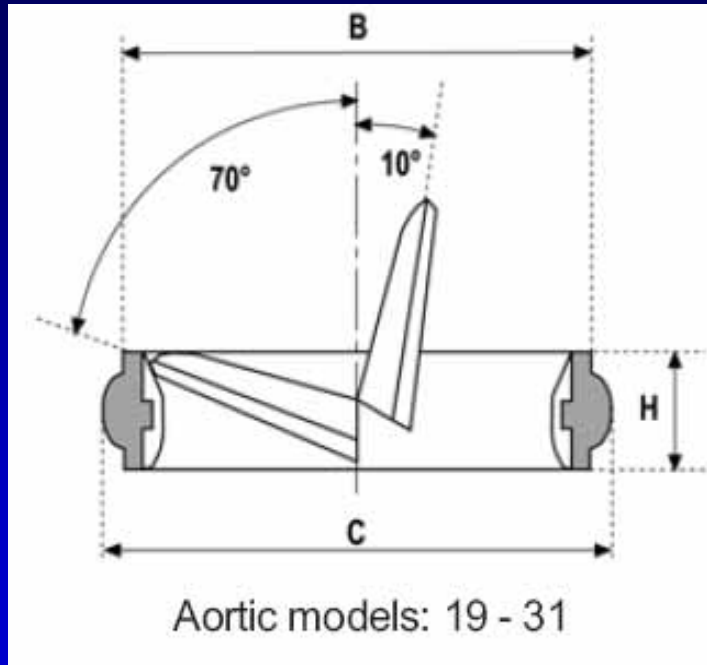
80° Opening Angle



60° Travel Arc



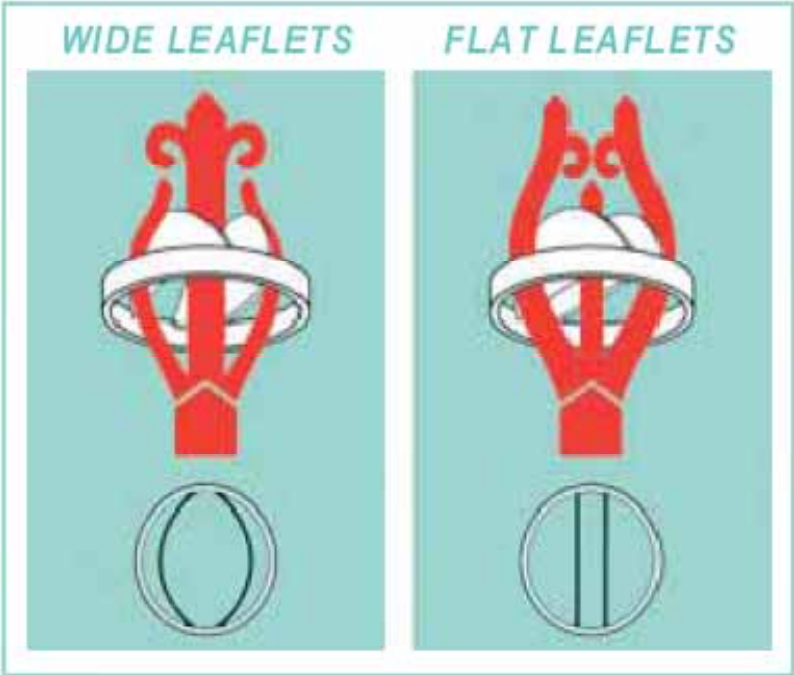
BICARBON™



SIZE	19	21	23	25	27	29	31	33
B (mm)	19.0	21.2	23.4	25.6	27.8	30.0	32.0	34.0
C (mm) aortic models	24.0	26.5	28.5	30.5	33.0	35.5	36.5	-
C (mm) mitral models	27.5	31.5	34.0	37.5	40.4	42.5	44.5	46.5
H (mm)	6.0	6.4	6.8	7.2	7.6	8.0	8.0	8.0

B = Tissue Annulus Diameter (TAD)
C = External Suture Ring Diameter
H = Housing Height





BICARBON™ SOLUTION

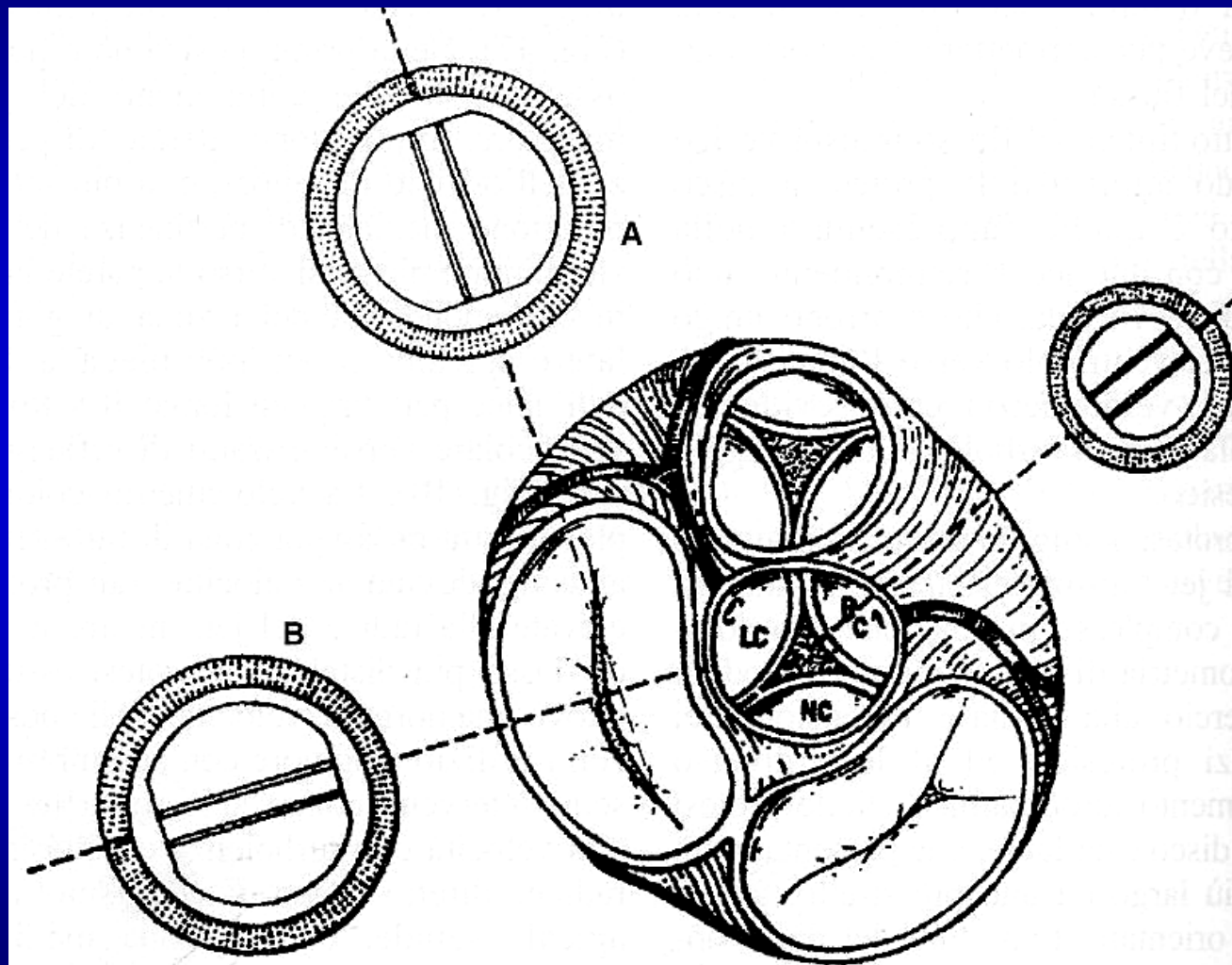


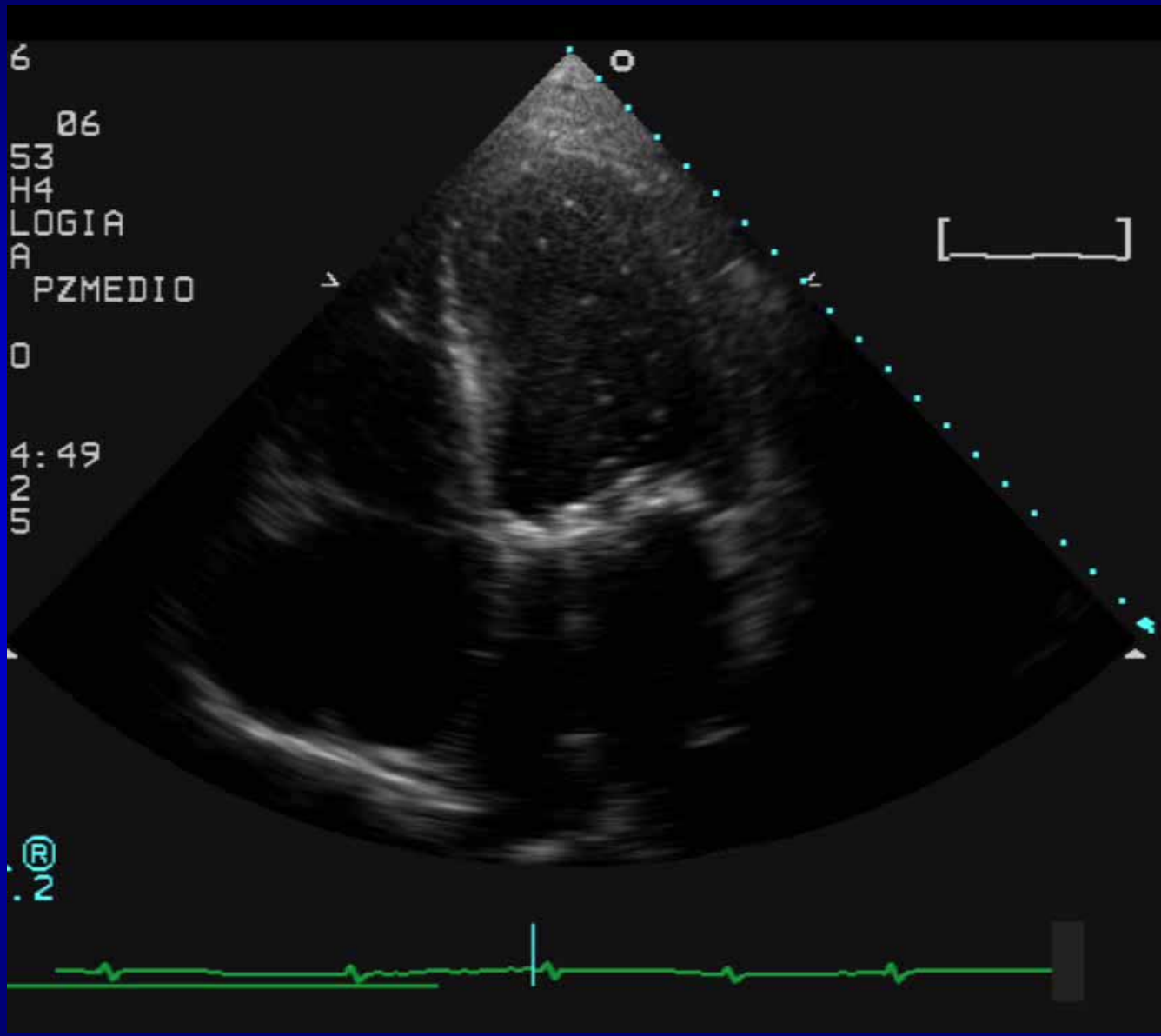
Asse di impianto per le bidisco

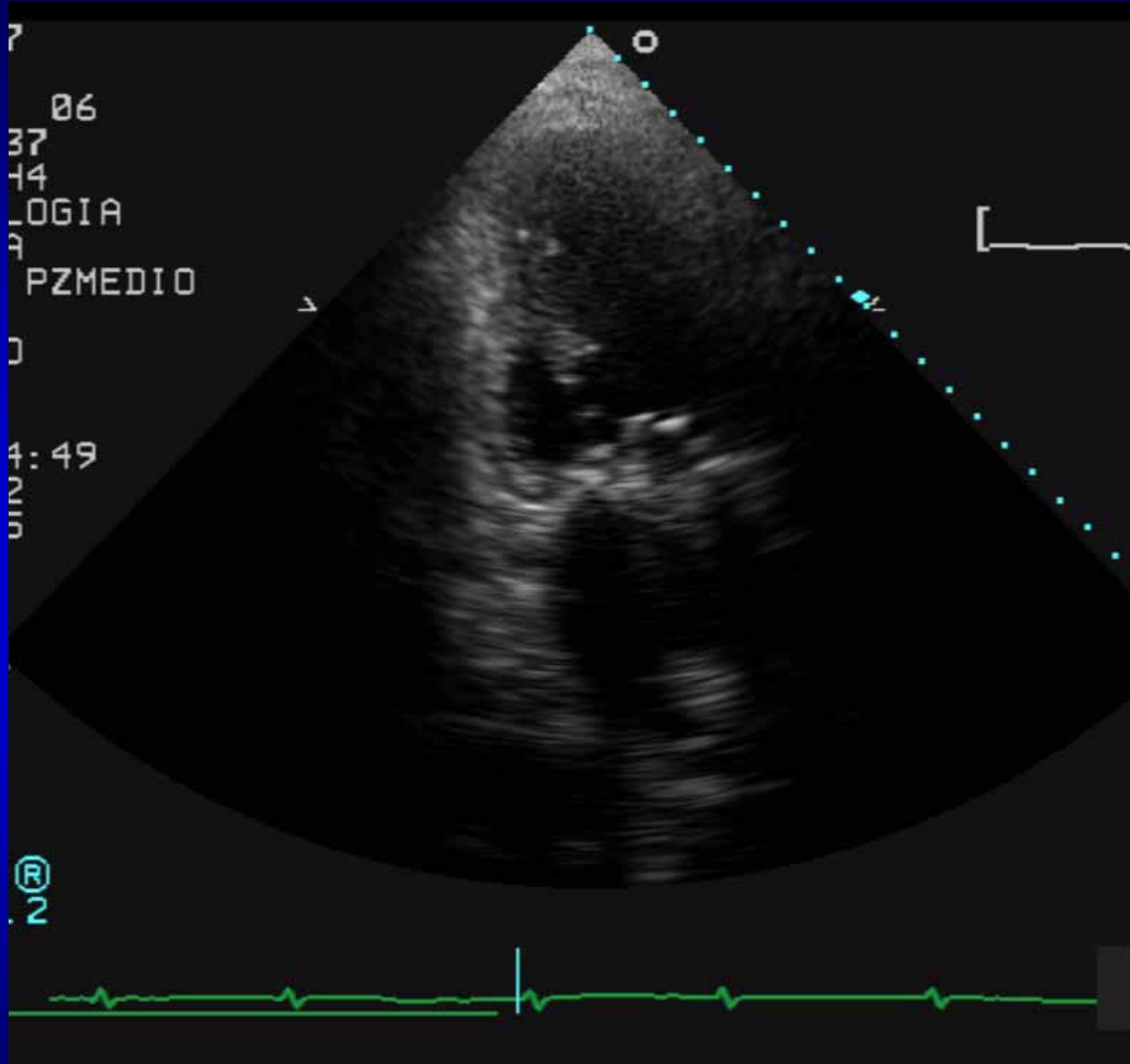
- Antianatomico per le mitraliche (ortogonale rispetto alla chiusura dei lembi)
- Ortogonale al setto per le aortiche



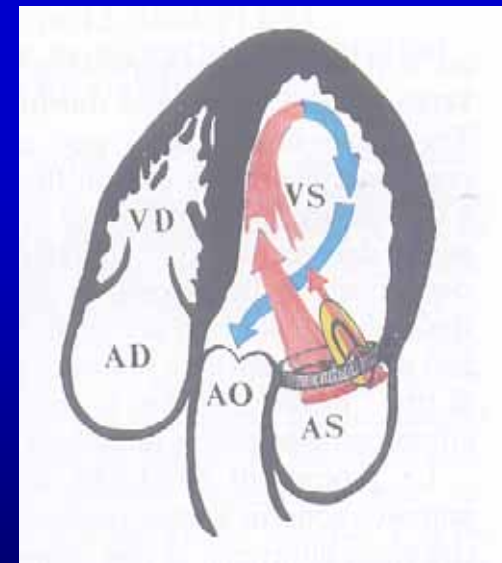
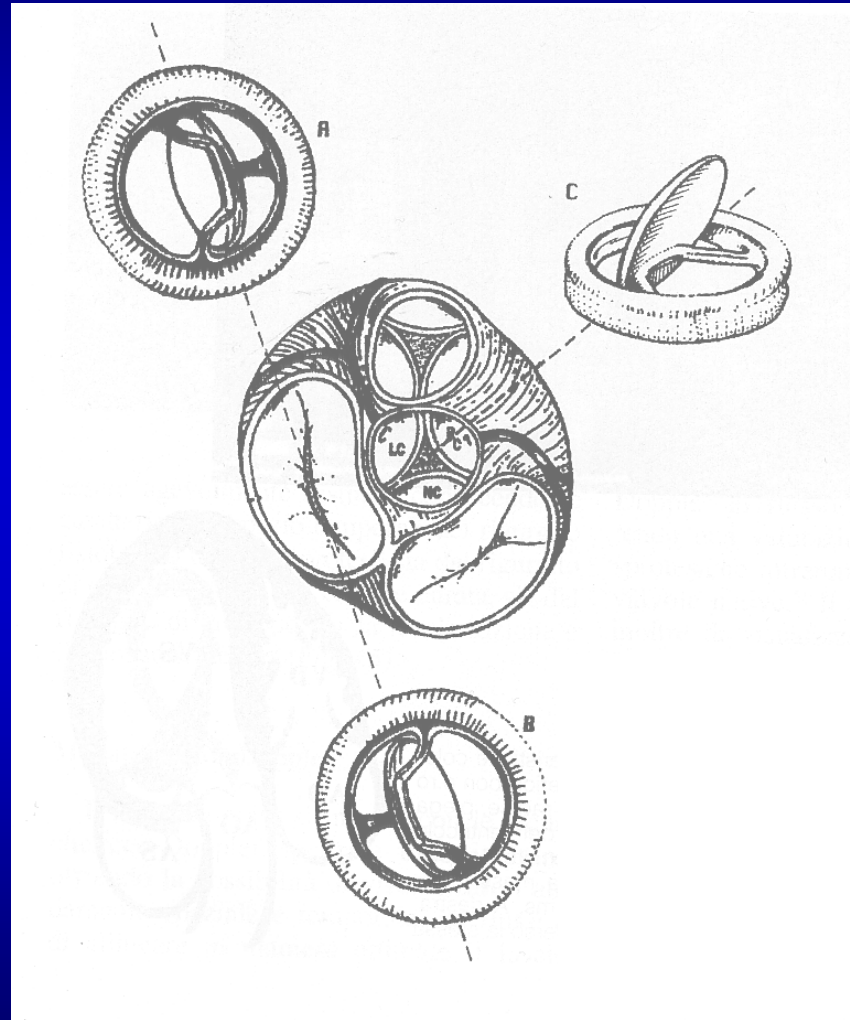
Protesi ad emidischi



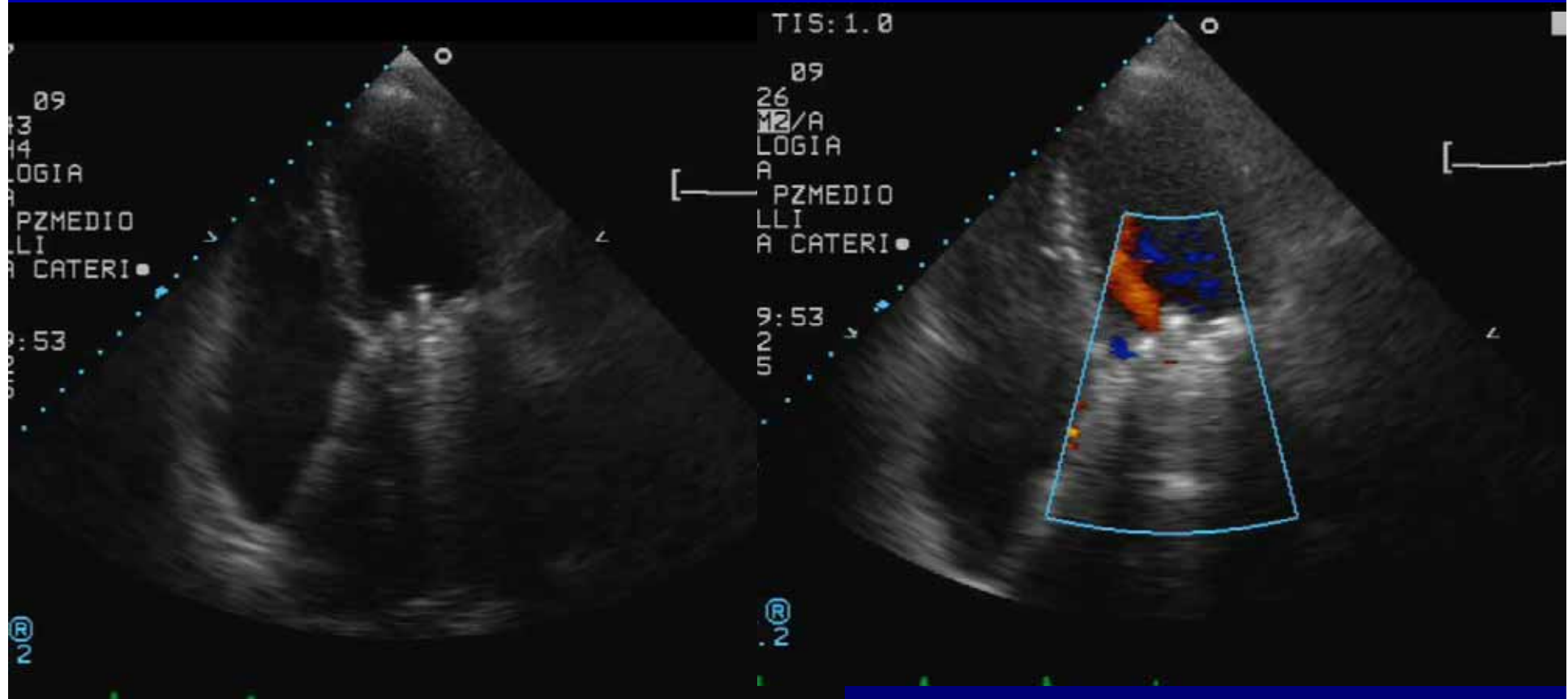




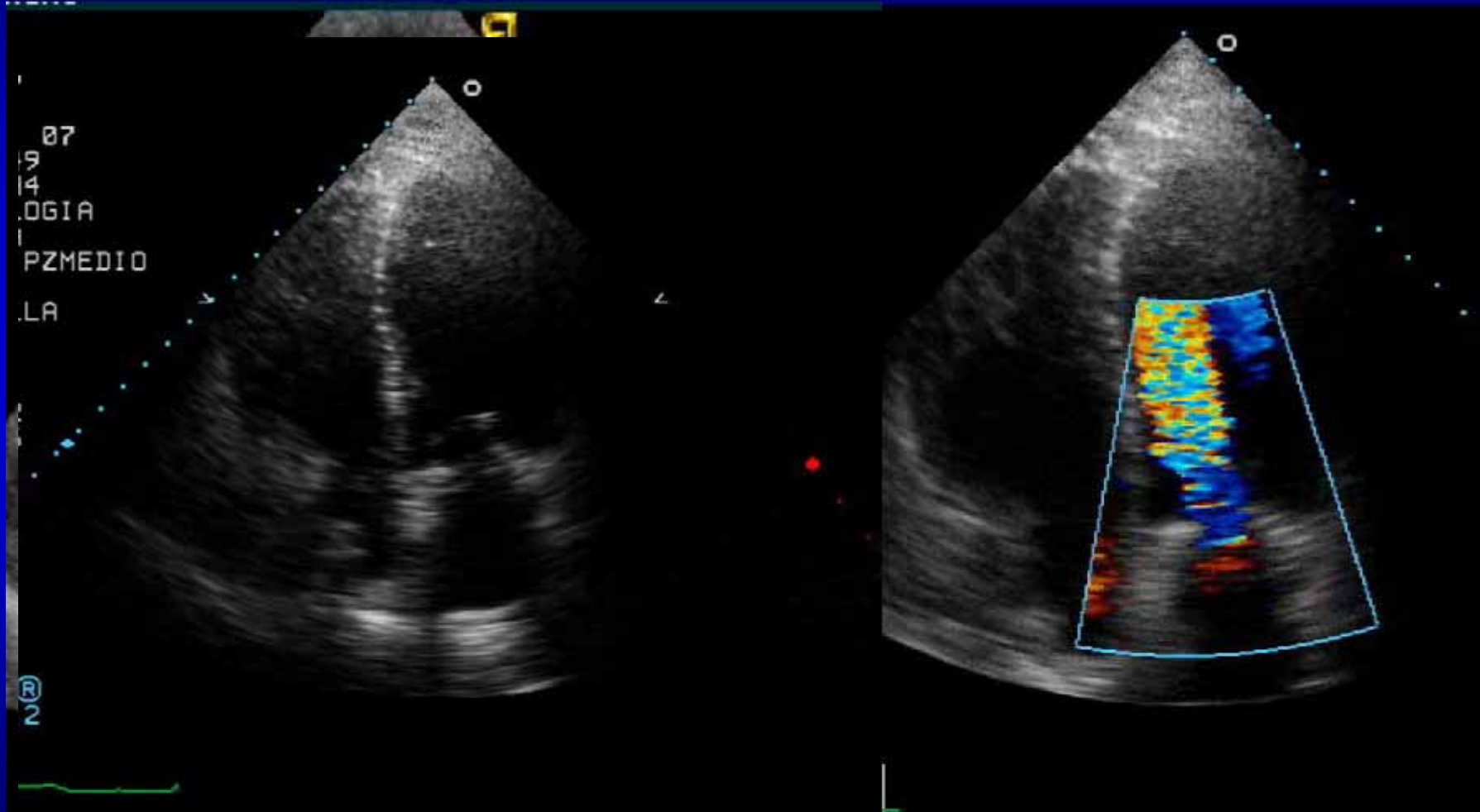
Protesi a disco oscillante



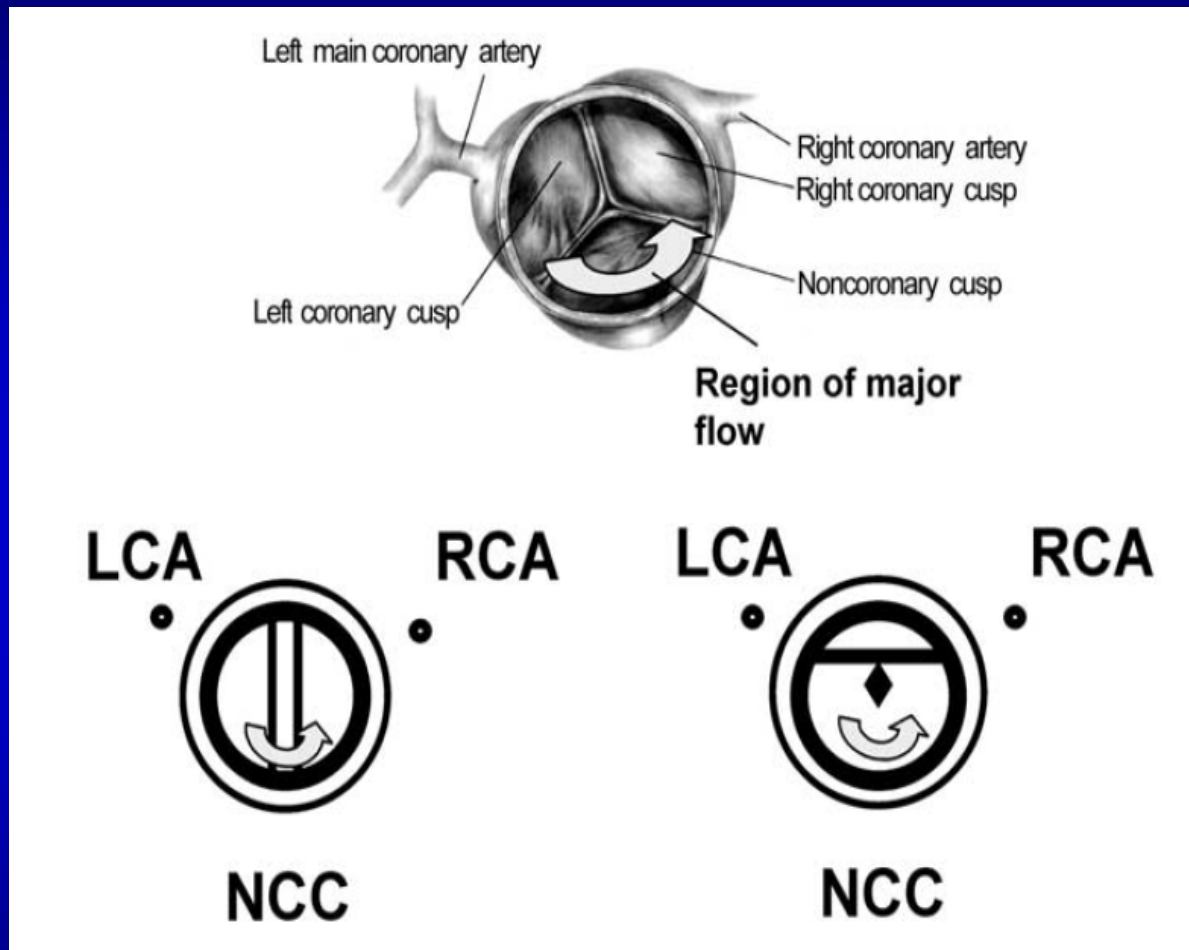
Tilting disc mitralica



Protesi Hancock orientata verso il SIV



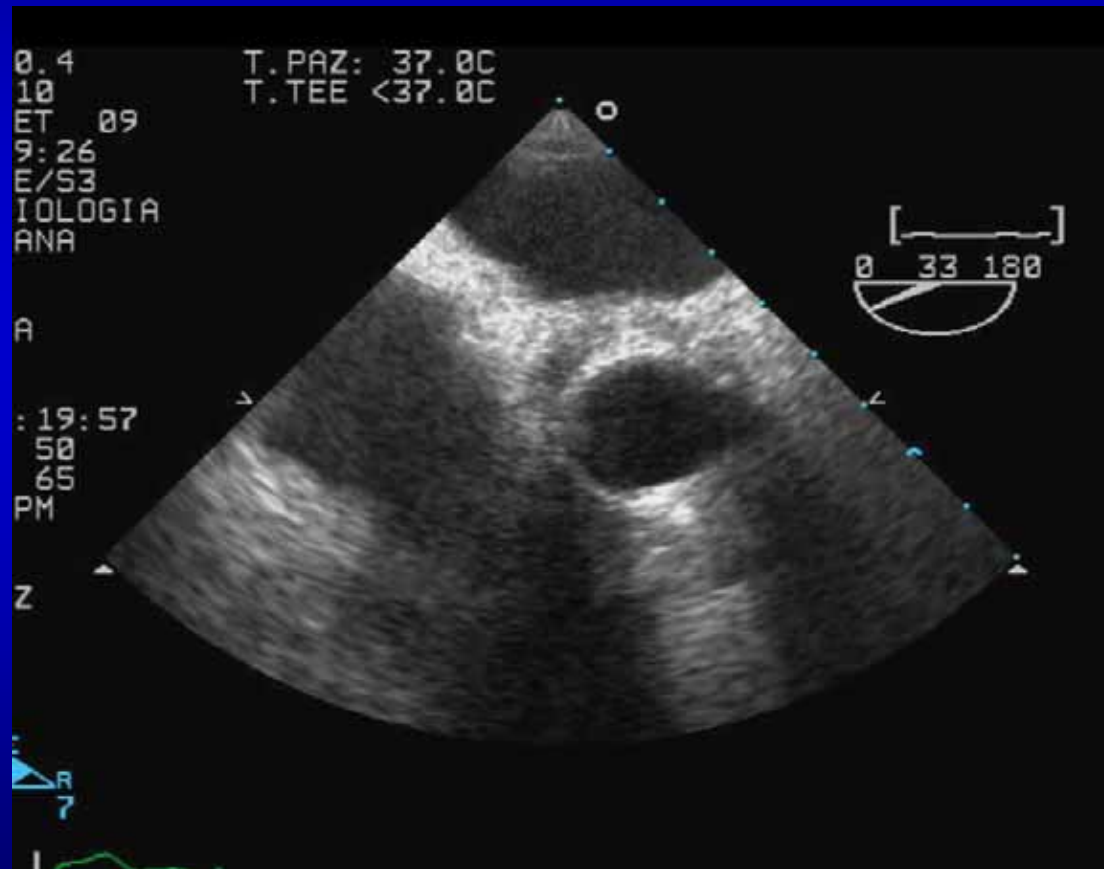
Protesi aortiche



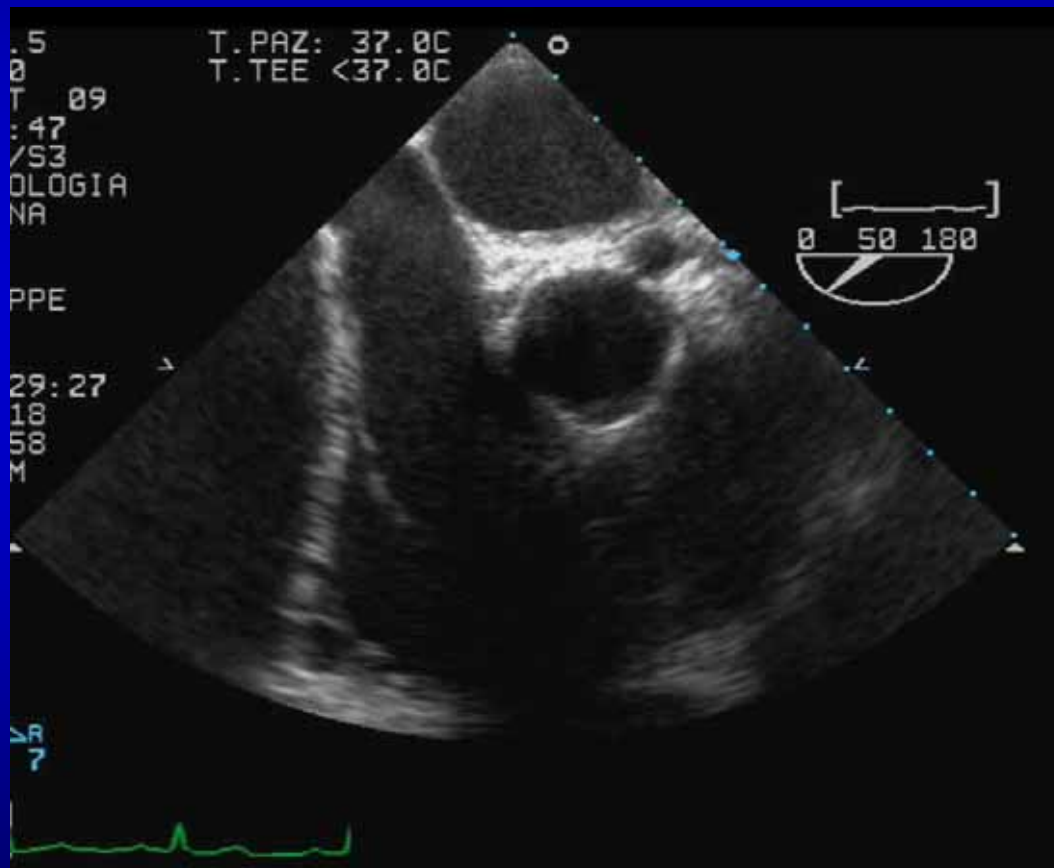
Laas J et al. Orientation of tilting disc and bileaflet aortic valve substitutes for optimal hemodynamics. *Ann Thorac Surg* 1999;68:1096–1099



Protesi aortica bileaflet



Protesi aortica bileaflet



Valutazione Doppler

- Velocità massima e media
- Gradiente massimo e medio (attenzione ad applicare l'equazione di Bernoulli non modificata sottraendo la velocità preprotesica !)
- Area valvolare (equazione di continuità)
- PHT
- Rigurgito



Parametri Doppler e limiti di “normalità”

Dipendono da:

- Posizione (mitralica o aortica)
- Modello e taglia della protesi
- Rapporto protesi/paziente
- Momento della valutazione (“clinica”)

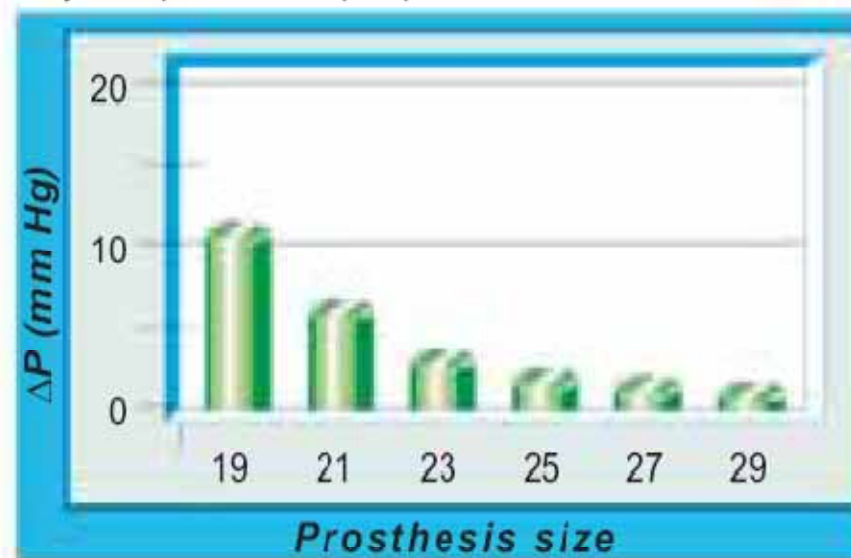


GRADIENTE e TAGLIA in vitro

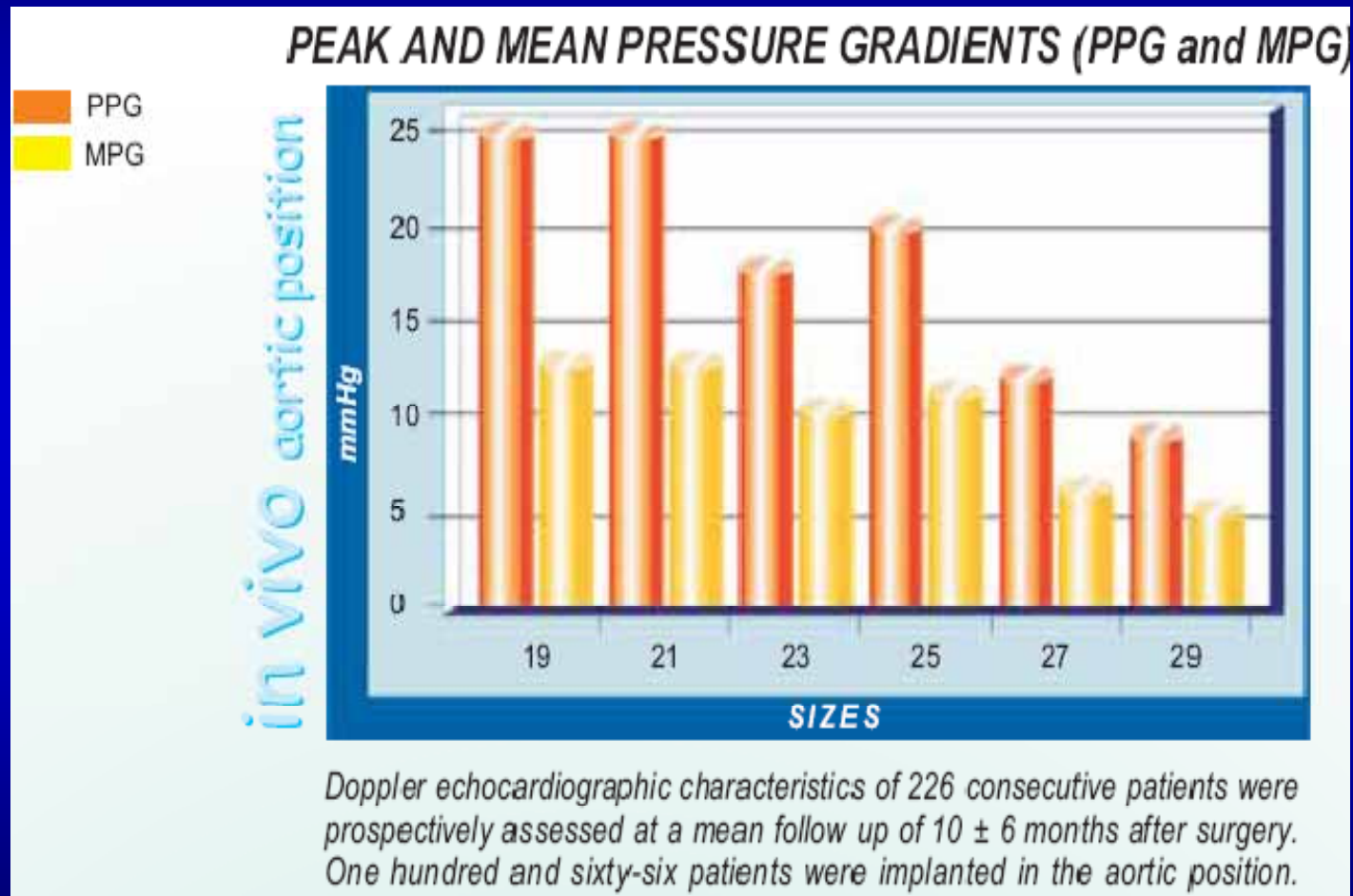
SORIN IN VITRO DATA

frequency: 70 bpm; mean aortic pressure: 100 mmHg; aortic position

Systolic pressure drop in pulsatile flow at 4.5 l/min C.O.



GRADIENTE e TAGLIA (in vivo)



GRADIENTE, FLUSSO e MODELLO (in vitro)

MEAN SYSTOLIC PRESSURE DIFFERENCE at 3.0 - 4.5 - 6.5 - 8.0 L/min C.O.
PULSATILE CONDITIONS

■ SJM = ST. JUDE MEDICAL
■ CM = CAREOMEDICS
■ SO = SORIN BICARBON™

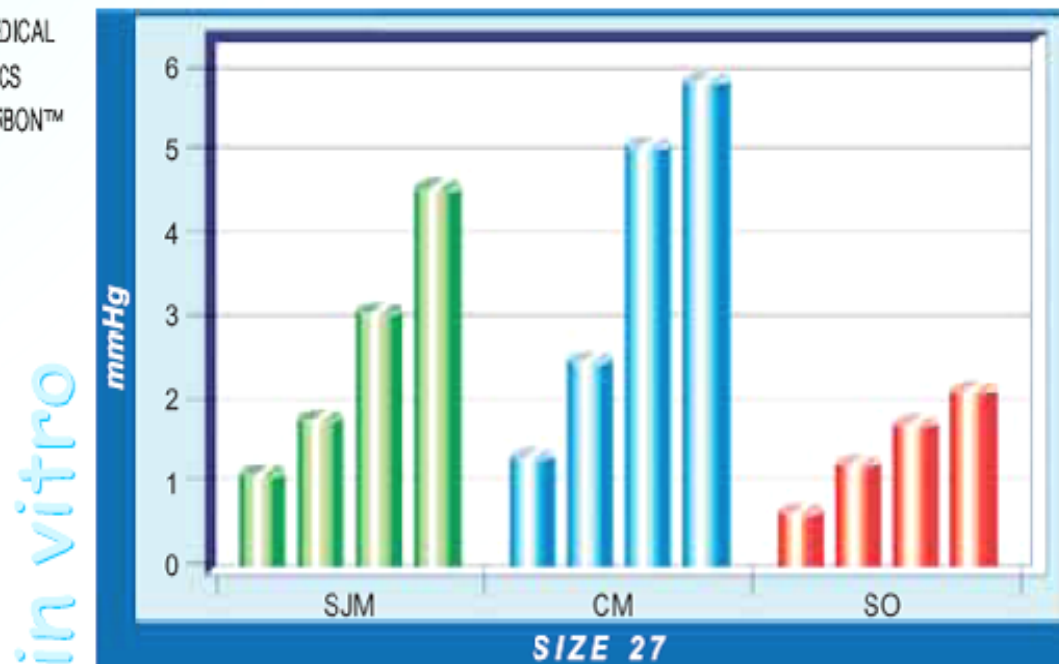
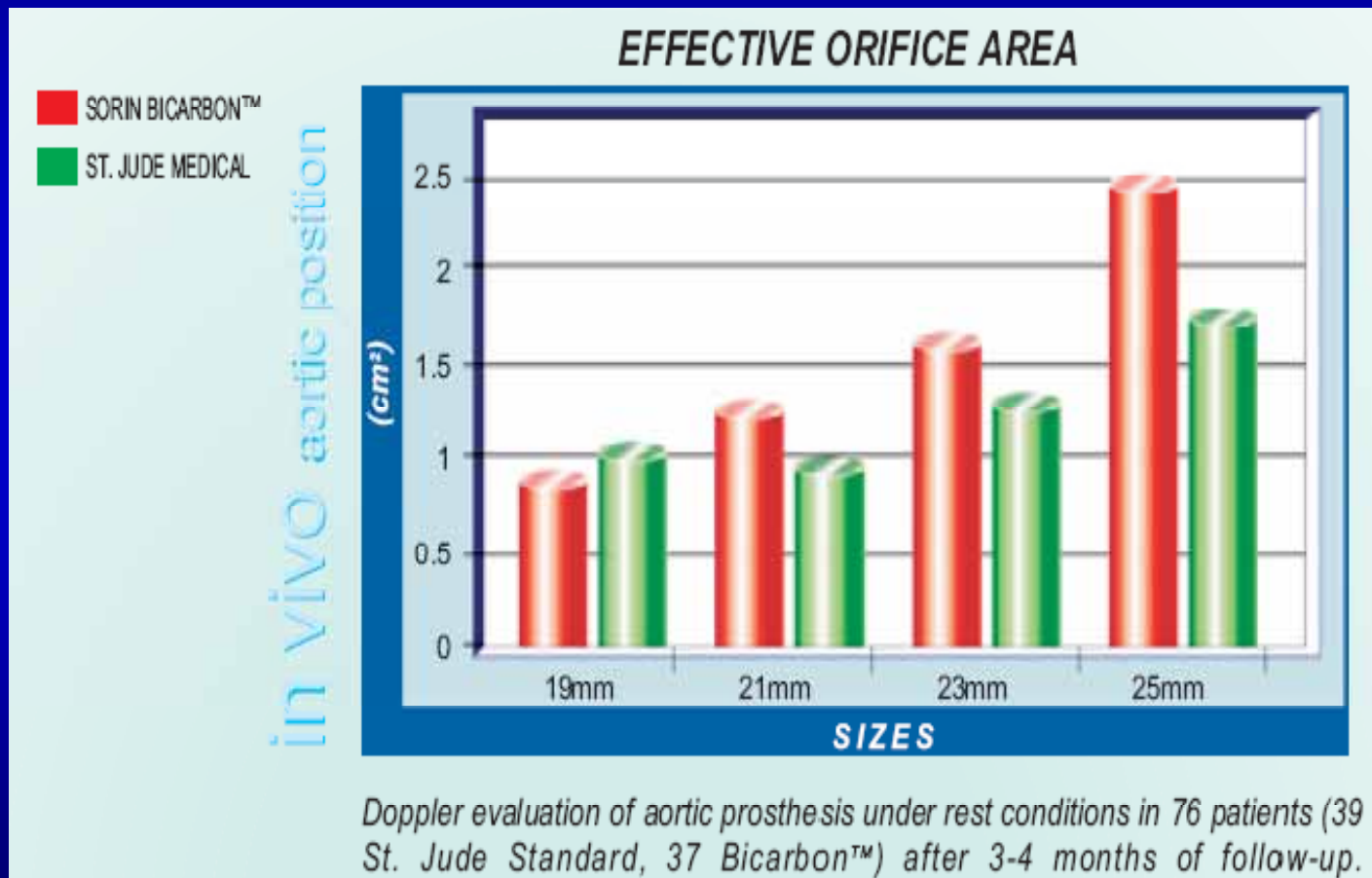


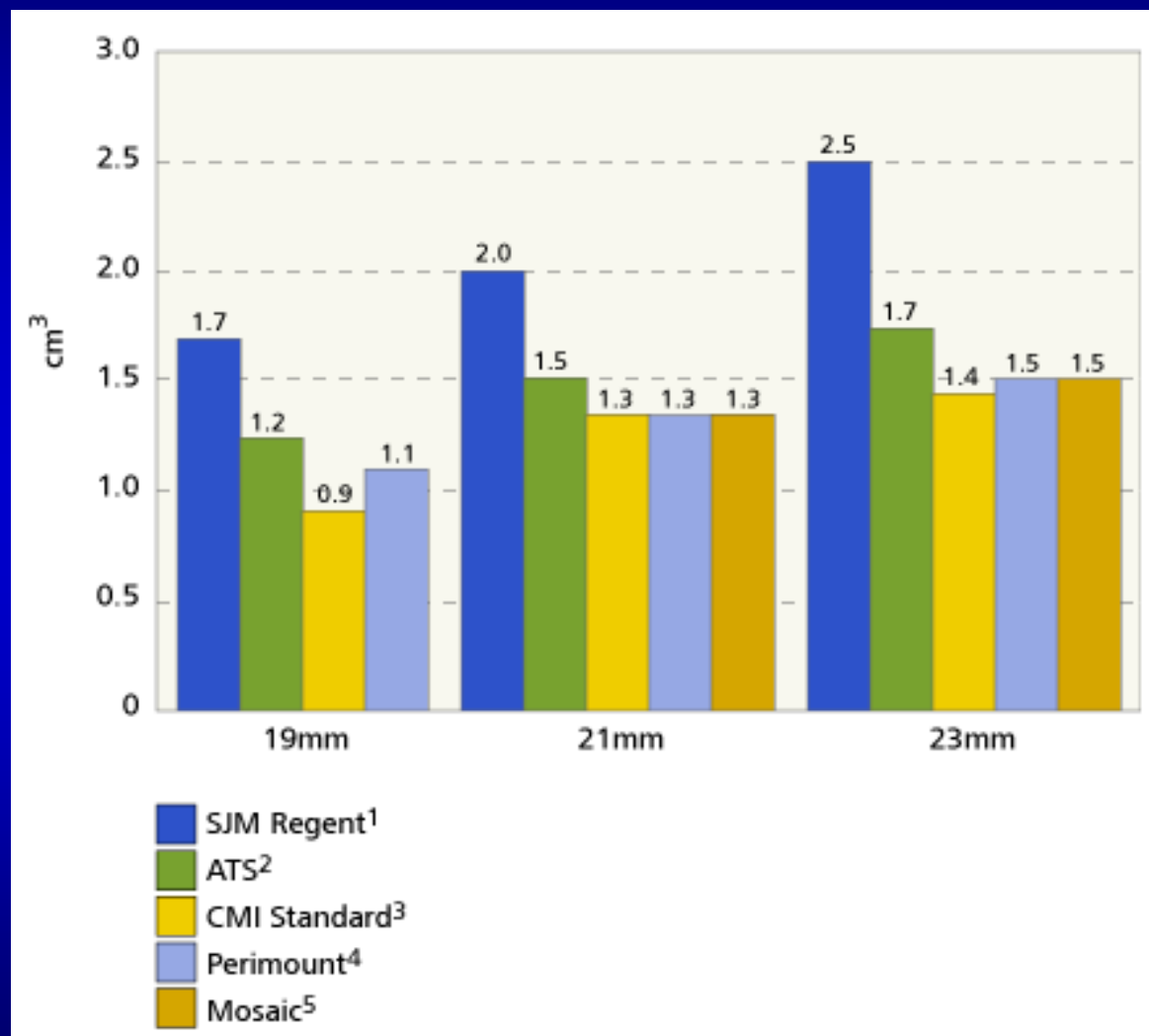
fig.1



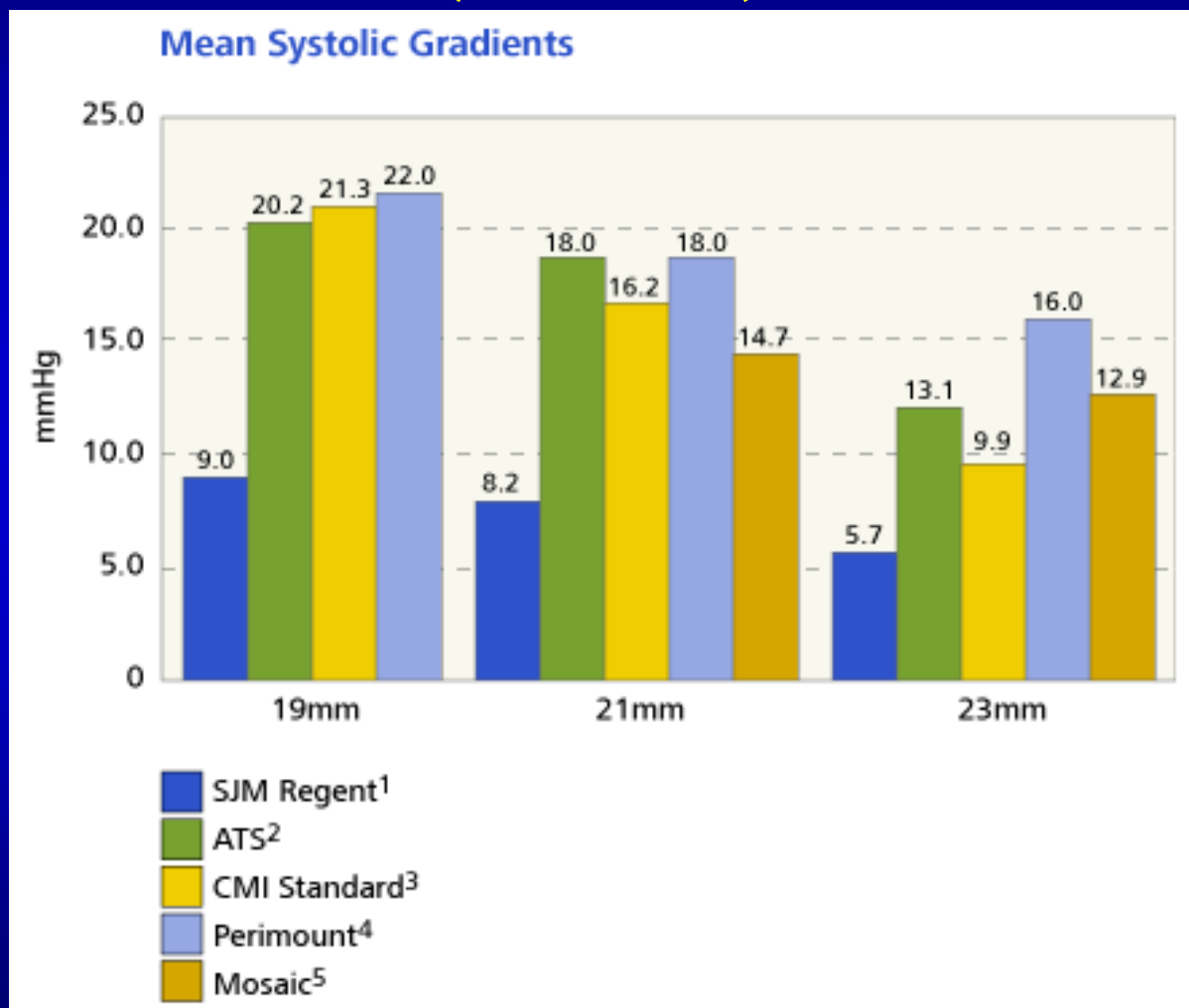
EOA, TAGLIA e MODELLO (in vivo)



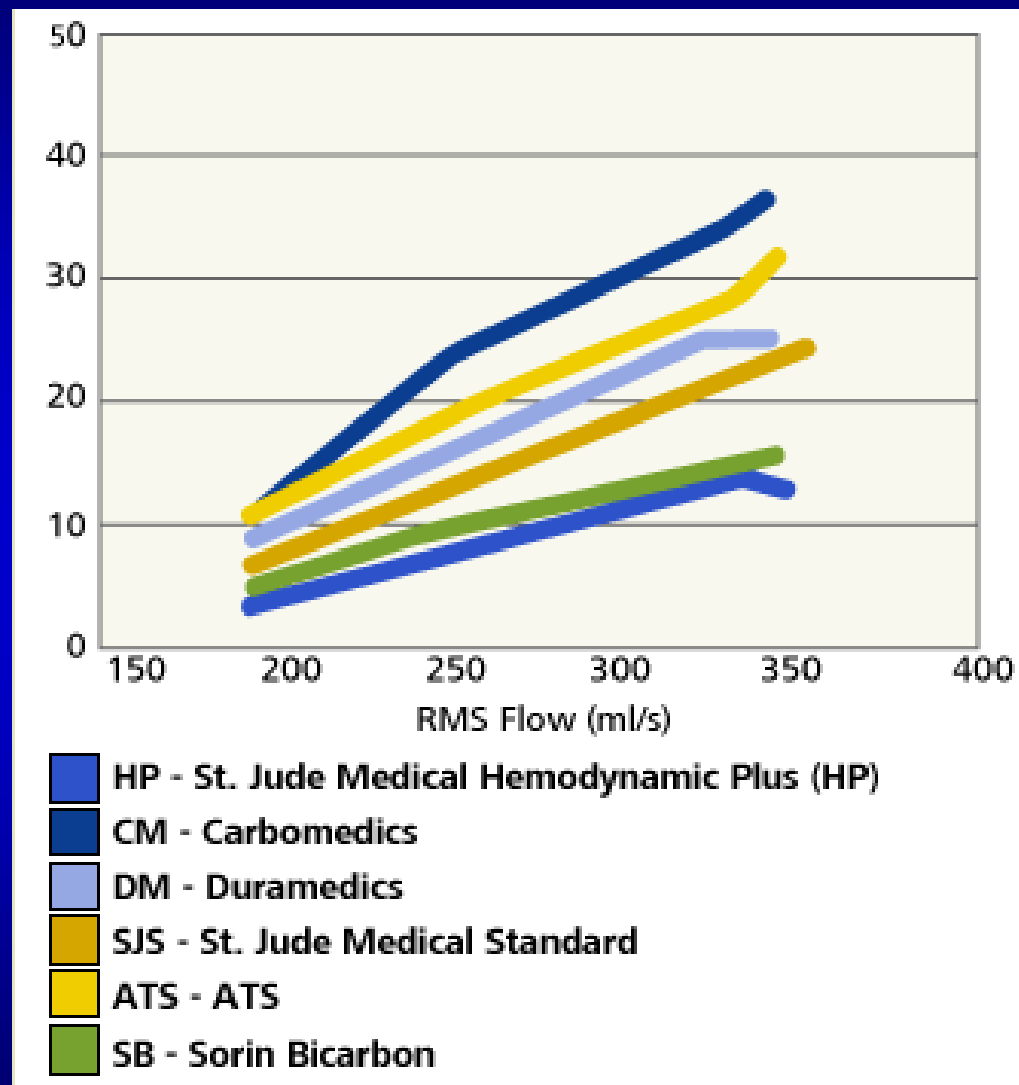
EOA, TAGLIA e MODELLO (in vivo)

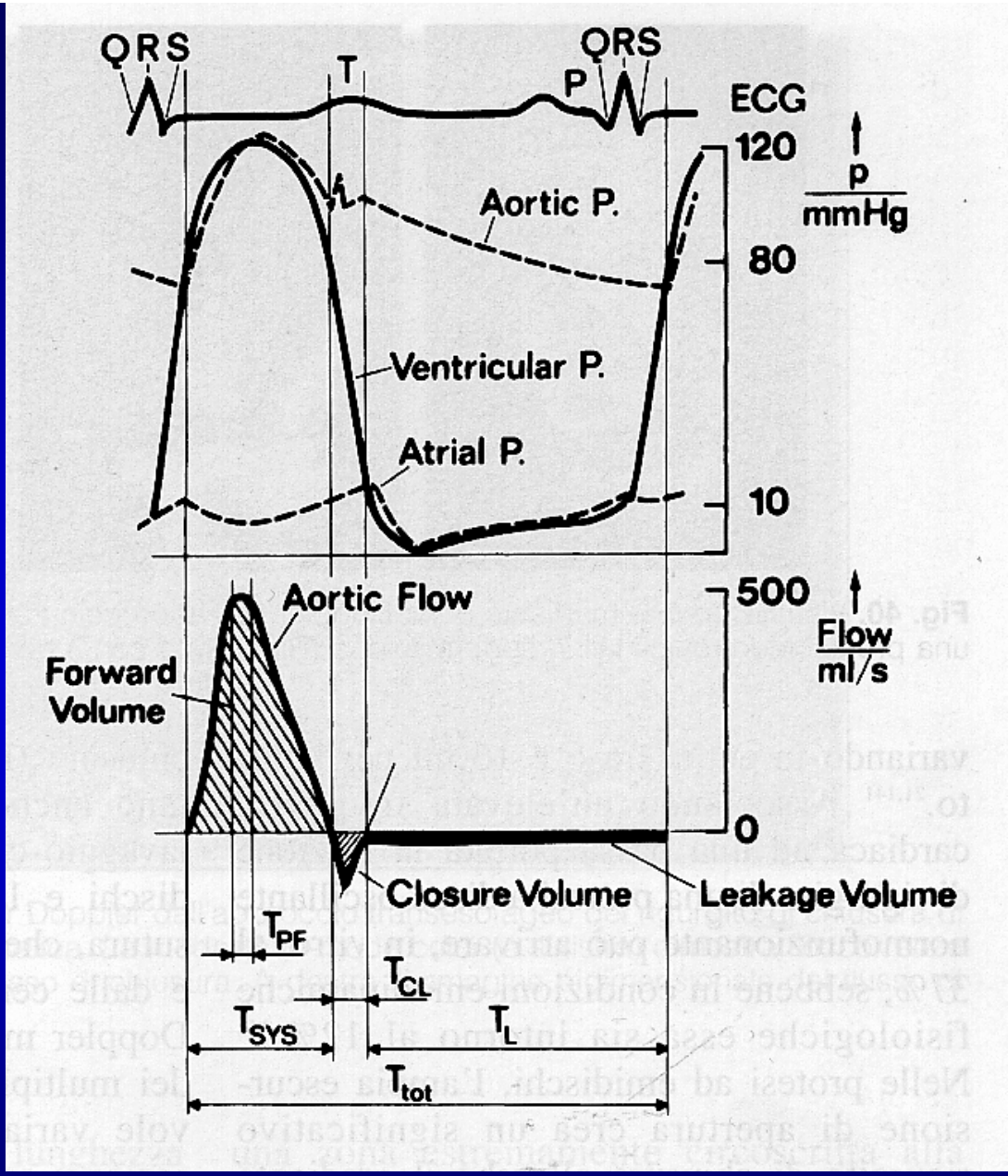


GRADIENTE, TAGLIA e MODELLO (in vivo)



GRADIENTE, FLUSSO e MODELLO

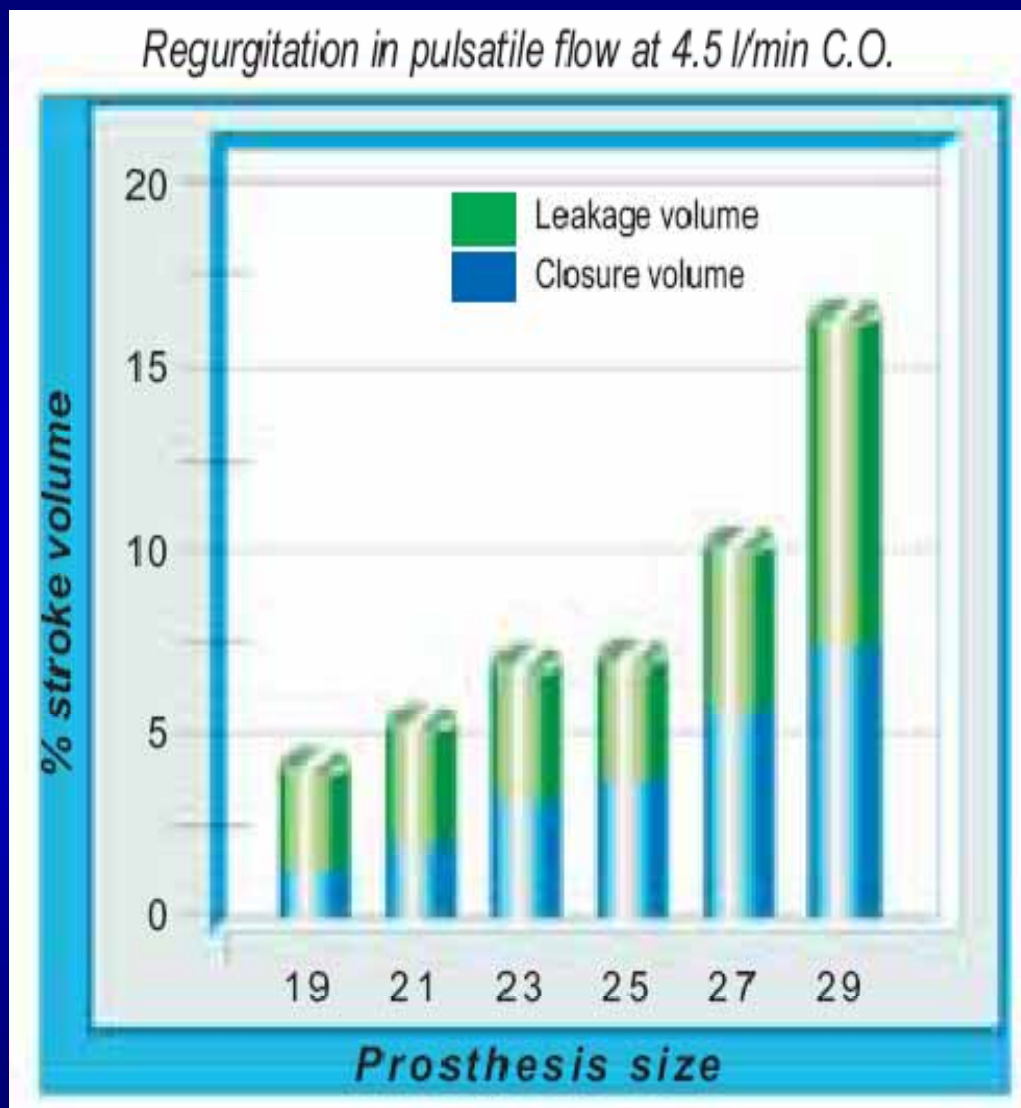




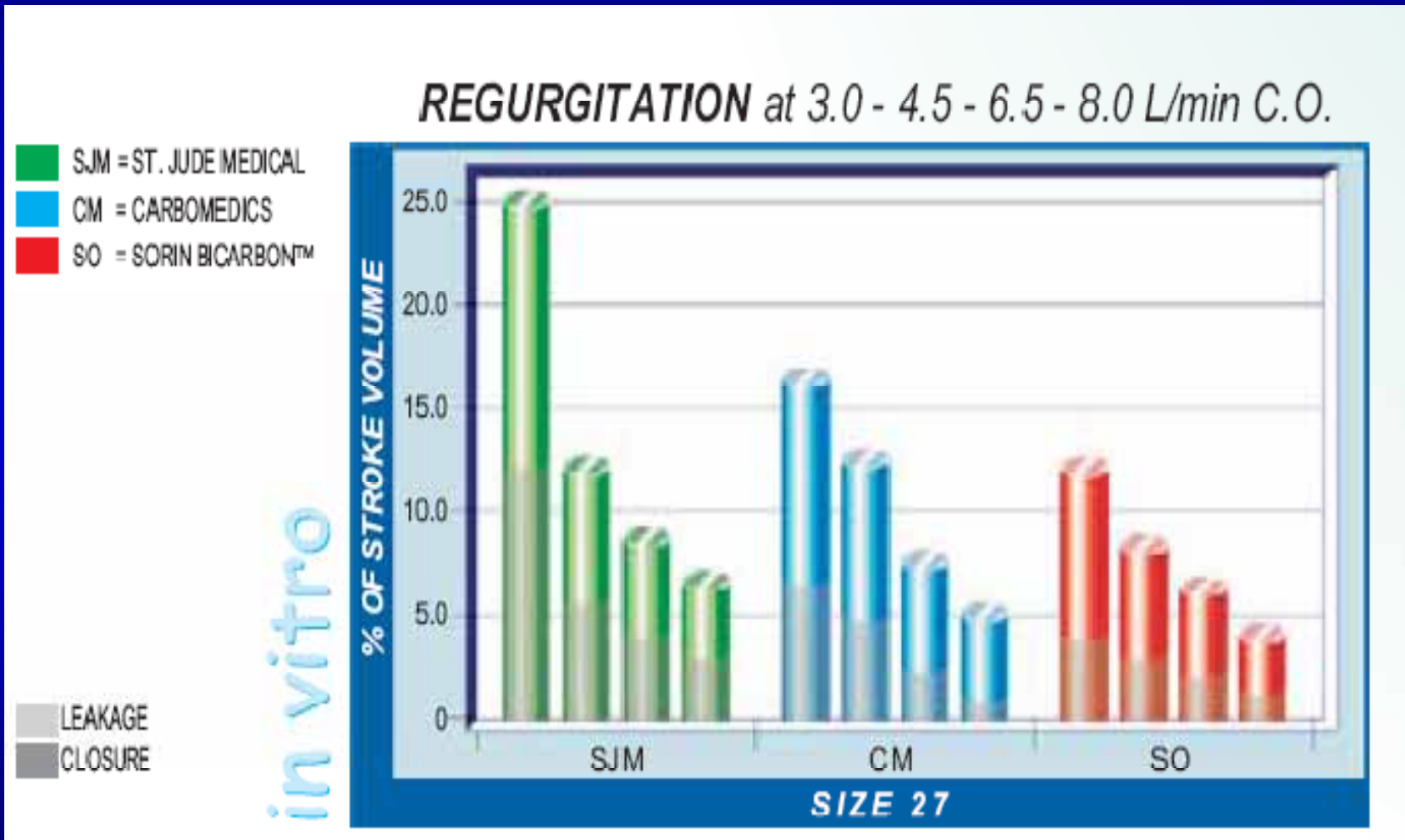
Rigurgito di lavaggio



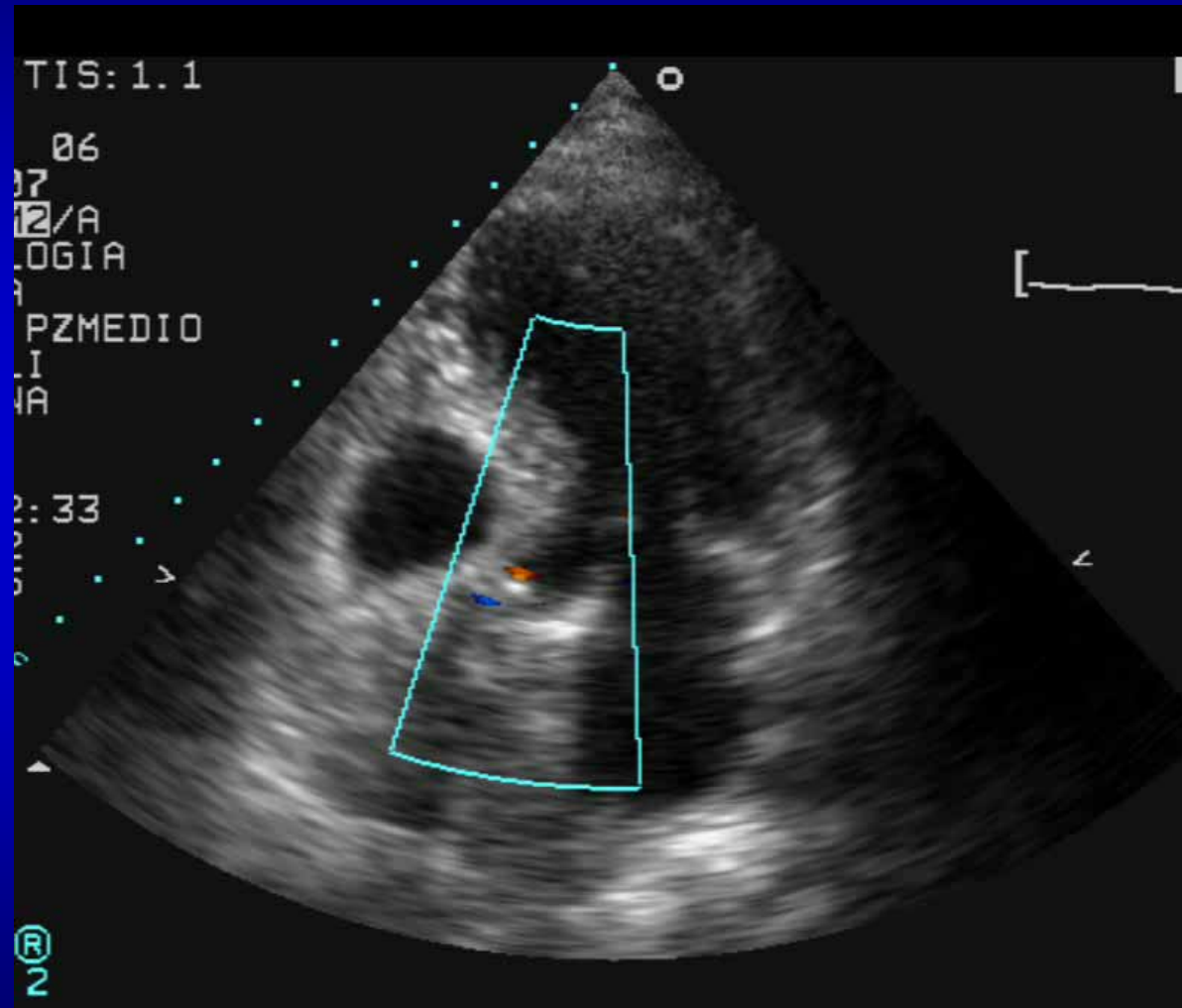
RIGURGITO E TAGLIA



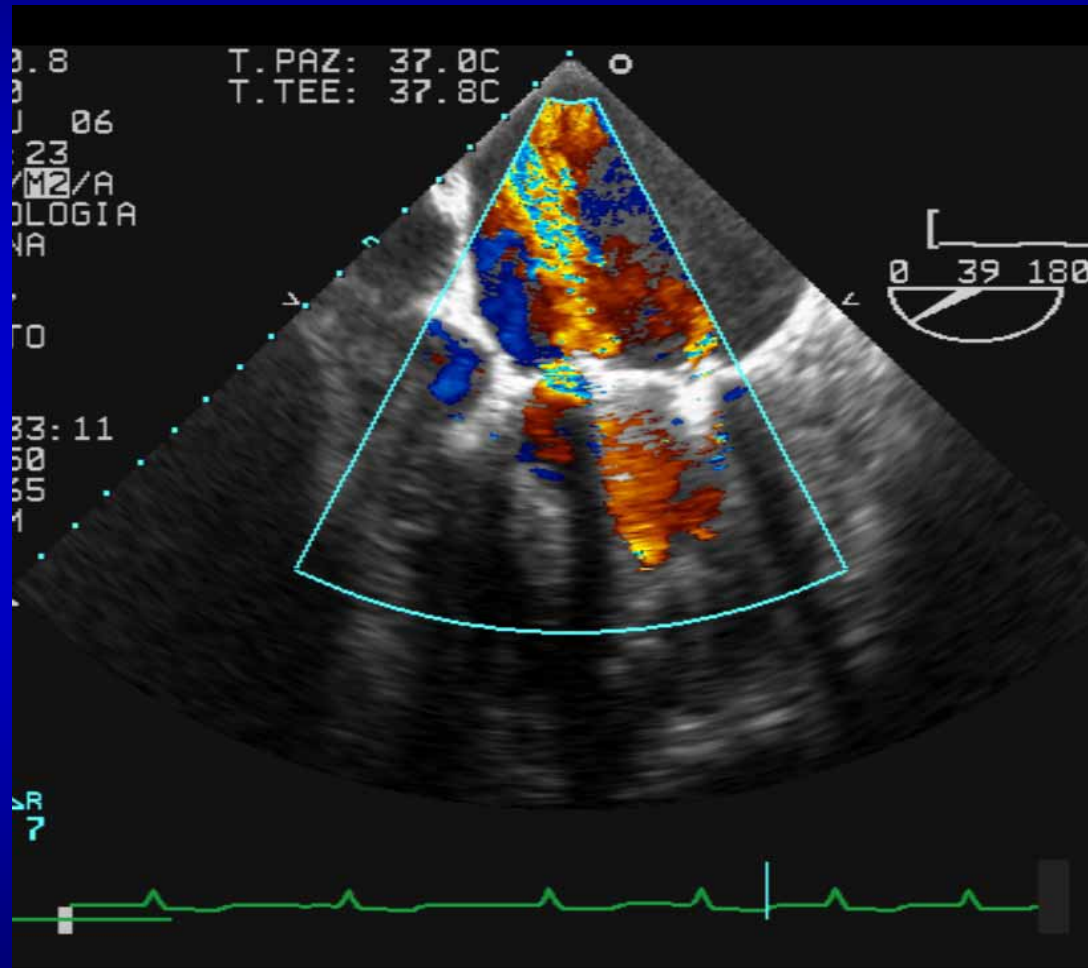
RIGURGITO, FLUSSO e MODELLO



Sorin Bicarbon Aortica



Rigurgito di lavaggio e paraprotetico



Parametri Doppler e limiti di “normalità”

Dipendono da:

- Modello e taglia della protesi
- Posizione (mitralica o aortica)
- **Rapporto protesi/paziente**
- Momento della valutazione (“clinica”)



Mismatch protesi/paziente (rapporto EOA/BSA o indexed EOA)



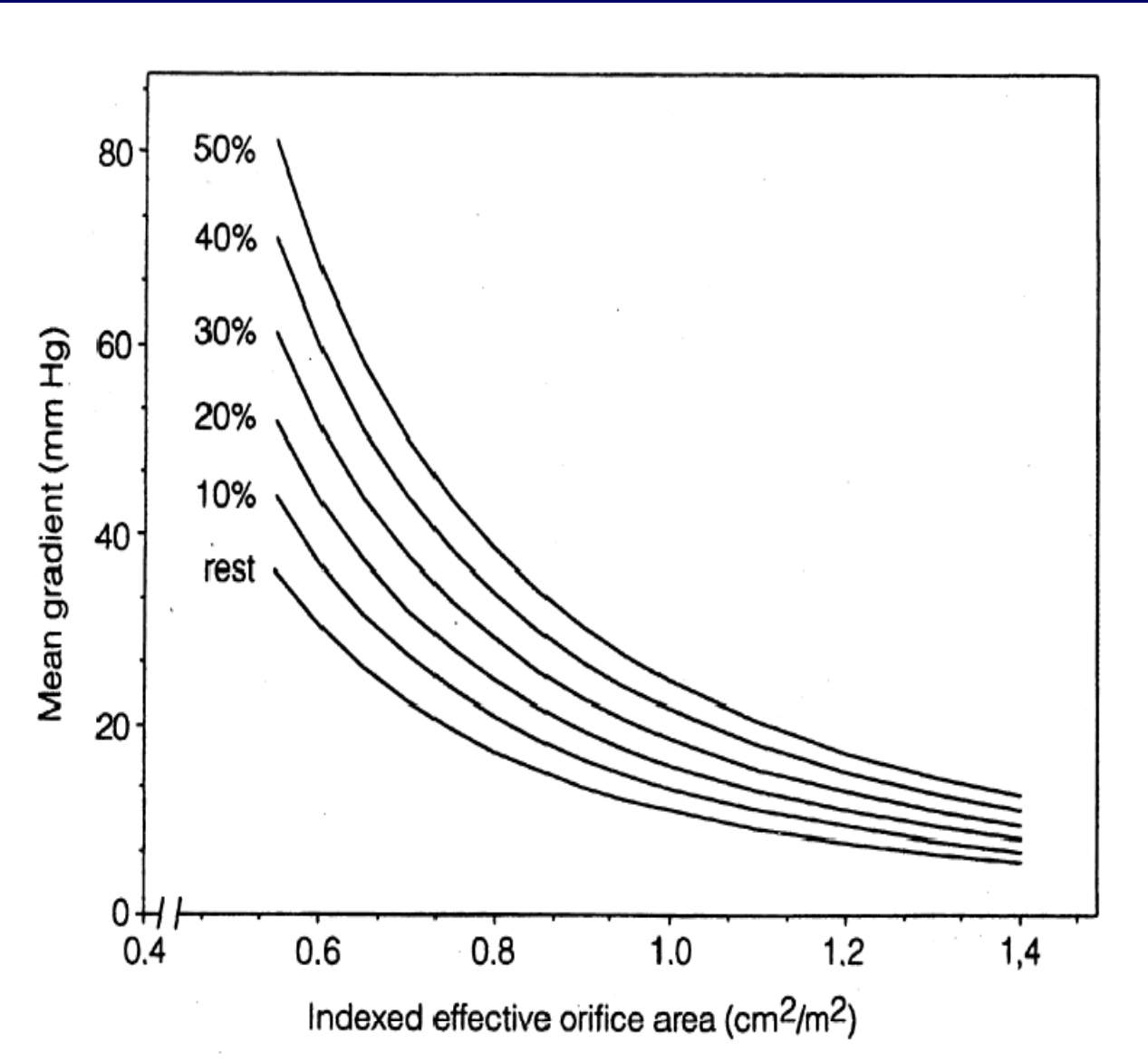
PROTESI AORTICHE

- not clinically significant > 0.85 cm^2/m^2 ,
- moderato tra 0.65 e 0.85 cm^2/m^2 ,
- severo < 0.65 cm^2/m^2

PROTESI MITRALICHE

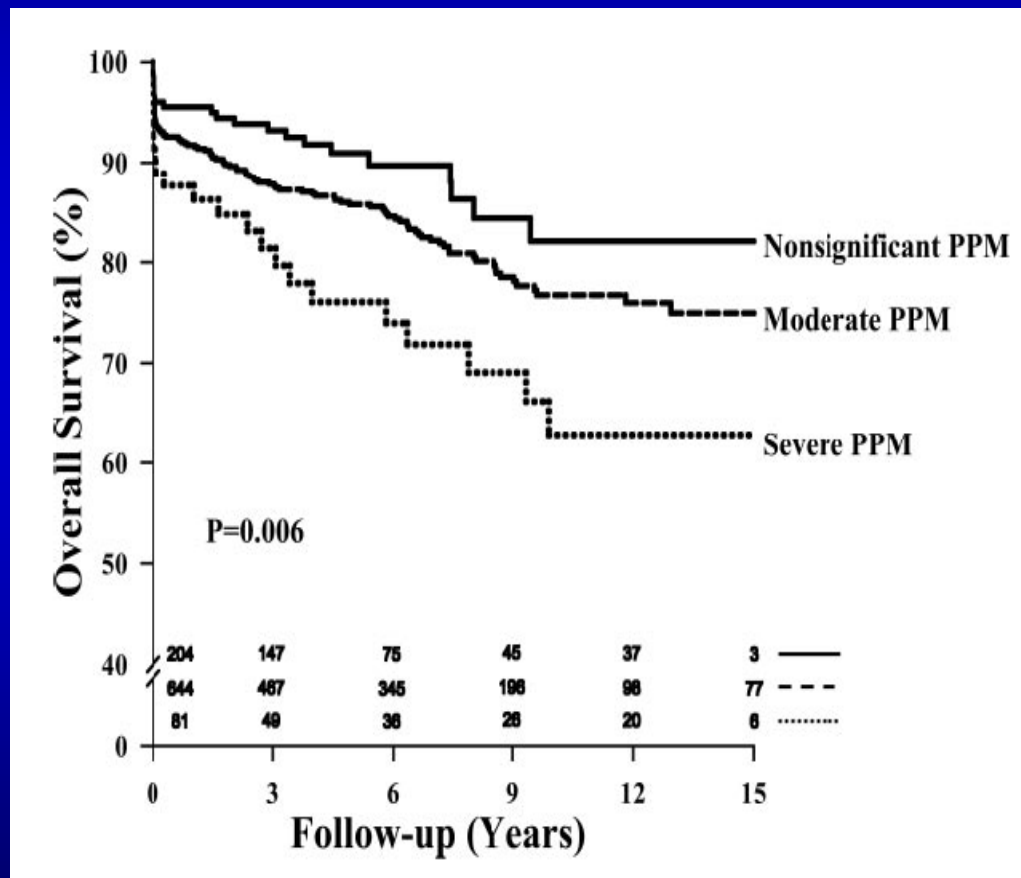
- not clinically significant > 1.2 cm^2/m^2 ,
- moderato tra 0.9 e $1,2$ cm^2/m^2 ,
- severo < 0.9 cm^2/m^2





Impact of Prosthesis-Patient Mismatch on Survival After Mitral Valve Replacement

Julien Magne, MSc; Patrick Mathieu, MD, FRCPC; Jean G. Dumesnil, MD, FRCPC; David Tanné, Eng;
François Dagenais, MD, FRCPC; Daniel Doyle, MD, FRCPC; Philippe Pibarot, DVM, PhD



Valve Size (mm)	19		21				23			
Reference EOA (cm ²)	1.7	1.0	2.0	1.2	1.3	1.4	2.5	1.5	1.5	1.3
BSA	SJM Regent ^A	Perimount ^B	SJM Regent ^A	Perimount ^B	Mosaic ^C	Hancock II ^D	SJM Regent ^A	Perimount ^B	Mosaic ^C	Hancock II ^D
0.6	2.83	1.67	3.33	2.00	2.17	2.33	4.17	2.50	2.50	2.17
0.7	2.43	1.43	2.86	1.71	1.86	2.00	3.57	2.14	2.14	1.86
0.8	2.13	1.25	2.50	1.50	1.63	1.75	3.13	1.88	1.88	1.63
0.9	1.89	1.11	2.22	1.33	1.44	1.56	2.78	1.67	1.67	1.44
1.0	1.70	1.00	2.00	1.20	1.30	1.40	2.50	1.50	1.50	1.30
1.1	1.55	0.91	1.82	1.09	1.18	1.27	2.27	1.36	1.36	1.18
1.2	1.42	0.83	1.67	1.00	1.08	1.17	2.08	1.25	1.25	1.08
1.3	1.31	0.77	1.54	0.92	1.00	1.08	1.92	1.15	1.15	1.00
1.4	1.21	0.71	1.43	0.86	0.93	1.00	1.79	1.07	1.07	0.93
1.5	1.13	0.67	1.33	0.80	0.87	0.93	1.67	1.00	1.00	0.87
1.6	1.06	0.63	1.25	0.75	0.81	0.88	1.56	0.94	0.94	0.81
1.7	1.00	0.59	1.18	0.71	0.76	0.82	1.47	0.88	0.88	0.76
1.8	0.94	0.56	1.11	0.67	0.72	0.78	1.39	0.83	0.83	0.72
1.9	0.89	0.53	1.05	0.63	0.68	0.74	1.32	0.79	0.79	0.68
2.0	0.85	0.50	1.00	0.60	0.65	0.70	1.25	0.75	0.75	0.65
2.1	0.81	0.48	0.95	0.57	0.62	0.67	1.19	0.71	0.71	0.62
2.2	0.77	0.45	0.91	0.55	0.59	0.64	1.14	0.68	0.68	0.59
2.3	0.74	0.43	0.87	0.52	0.57	0.61	1.09	0.65	0.65	0.57
2.4	0.71	0.42	0.83	0.50	0.54	0.58	1.04	0.63	0.63	0.54
2.5	0.68	0.40	0.80	0.48	0.52	0.56	1.00	0.60	0.60	0.52



Valve Size (mm)	19				21				23			
Reference EOA (cm ²)	1.7	1.2	0.9	1.0	2.0	1.5	1.3	1.1	2.5	1.7	1.4	1.1
BSA	SJM Regent ^A	ATS Std ^B	CMI Std/R ^C	Med Hall ^D (20 mm)	SJM Regent ^A	ATS Std ^B	CMI Std/R ^C	Med Hall ^D	SJM Regent ^A	ATS Std ^B	CMI Std/R ^C	Med Hall ^D
0.6	2.83	2.00	1.50	1.67	3.33	2.50	2.17	1.83	4.17	2.83	2.33	1.83
0.7	2.43	1.71	1.29	1.43	2.86	2.14	1.86	1.57	3.57	2.43	2.00	1.57
0.8	2.13	1.50	1.13	1.25	2.50	1.88	1.63	1.38	3.13	2.13	1.75	1.38
0.9	1.89	1.33	1.00	1.11	2.22	1.67	1.44	1.22	2.78	1.89	1.56	1.22
1.0	1.70	1.20	0.90	1.00	2.00	1.50	1.30	1.10	2.50	1.70	1.40	1.10
1.1	1.55	1.09	0.82	0.91	1.82	1.36	1.18	1.00	2.27	1.55	1.27	1.00
1.2	1.42	1.00	0.75	0.83	1.67	1.25	1.08	0.92	2.08	1.42	1.17	0.92
1.3	1.31	0.92	0.69	0.77	1.54	1.15	1.00	0.85	1.92	1.31	1.08	0.85
1.4	1.21	0.86	0.64	0.71	1.43	1.07	0.93	0.79	1.79	1.21	1.00	0.79
1.5	1.13	0.80	0.60	0.67	1.33	1.00	0.87	0.73	1.67	1.13	0.93	0.73
1.6	1.06	0.75	0.56	0.63	1.25	0.94	0.81	0.69	1.56	1.06	0.88	0.69
1.7	1.00	0.71	0.53	0.59	1.18	0.88	0.76	0.65	1.47	1.00	0.82	0.65
1.8	0.94	0.67	0.50	0.56	1.11	0.83	0.72	0.61	1.39	0.94	0.78	0.61
1.9	0.89	0.63	0.47	0.53	1.05	0.79	0.68	0.58	1.32	0.89	0.74	0.58
2.0	0.85	0.60	0.45	0.50	1.00	0.75	0.65	0.55	1.25	0.85	0.70	0.55
2.1	0.81	0.57	0.43	0.48	0.95	0.71	0.62	0.52	1.19	0.81	0.67	0.52
2.2	0.77	0.55	0.41	0.45	0.91	0.68	0.59	0.50	1.14	0.77	0.64	0.50
2.3	0.74	0.52	0.39	0.43	0.87	0.65	0.57	0.48	1.09	0.74	0.61	0.48
2.4	0.71	0.50	0.38	0.42	0.83	0.63	0.54	0.46	1.04	0.71	0.58	0.46
2.5	0.68	0.48	0.36	0.40	0.80	0.60	0.52	0.44	1.00	0.68	0.56	0.44



Parametri Doppler e limiti di “normalità”

Dipendono da:

- Posizione (mitralica o aortica)
- Modello e taglia della protesi
- Rapporto protesi/paziente
- **Momento della valutazione**
(“clinica”)



Quando eseguire l'ecocardiogramma

- Precocemente dopo l'impianto (ma non troppo precocemente !)
- La valutazione pre-dimissione può essere inaffidabile per:
 - Anemia
 - Rapido unloading del VS
 - Decondizionamento del paziente
 - Edema e/o ematoma aortico



Come refertare l'esame ecocardiografico

- Frequenza Cardiaca e ritmo
- Modello e taglia
- Data di impianto e tecnica
- Gradienti massimo e medio
- Area protesica effettiva ed indicizzata
- Rigurgiti
- Spessore e mobilità degli elementi mobili
- Dimensioni e funzione delle cavità cardiache
- Pressione polmonare



CONCLUSIONI (1)

- Lo studio ecocardiografico richiede conoscenze precise circa il modello e la taglia della protesi
- I parametri di “normalità” sono diversi da quelli delle valvole native e sono diversi a seconda del tipo di protesi e della sua taglia
- E' di fondamentale importanza disporre di dati “basali” di riferimento (ogni paziente è controllo di se stesso)



CONCLUSIONI (2)

- Variazioni dei parametri Doppler nel tempo devono essere interpretati in relazione alle mutate condizioni emodinamiche e cliniche
- Il follow-up ecocardiografico deve essere impostato basandosi sull'insieme dei dati eco (funzione VS, dimensioni aortiche, valvulopatie associate, etc) e clinici del paziente e non su scadenze fisse dettate dalla presenza della protesi valvolare





OSPEDALE SAN BARTOLOMEO DI SARZANA



Divisione di Cardiologia Clinica Riabilitativa
Sarzana

82/82
db 28/10/2010