Dispositivos de comunicación interatrial indicaciones y resultados

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Objectives

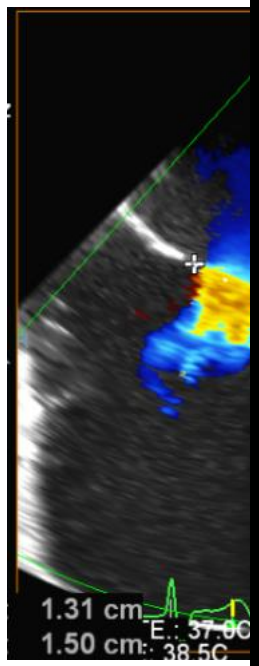
Physiopathology interatrial shunts

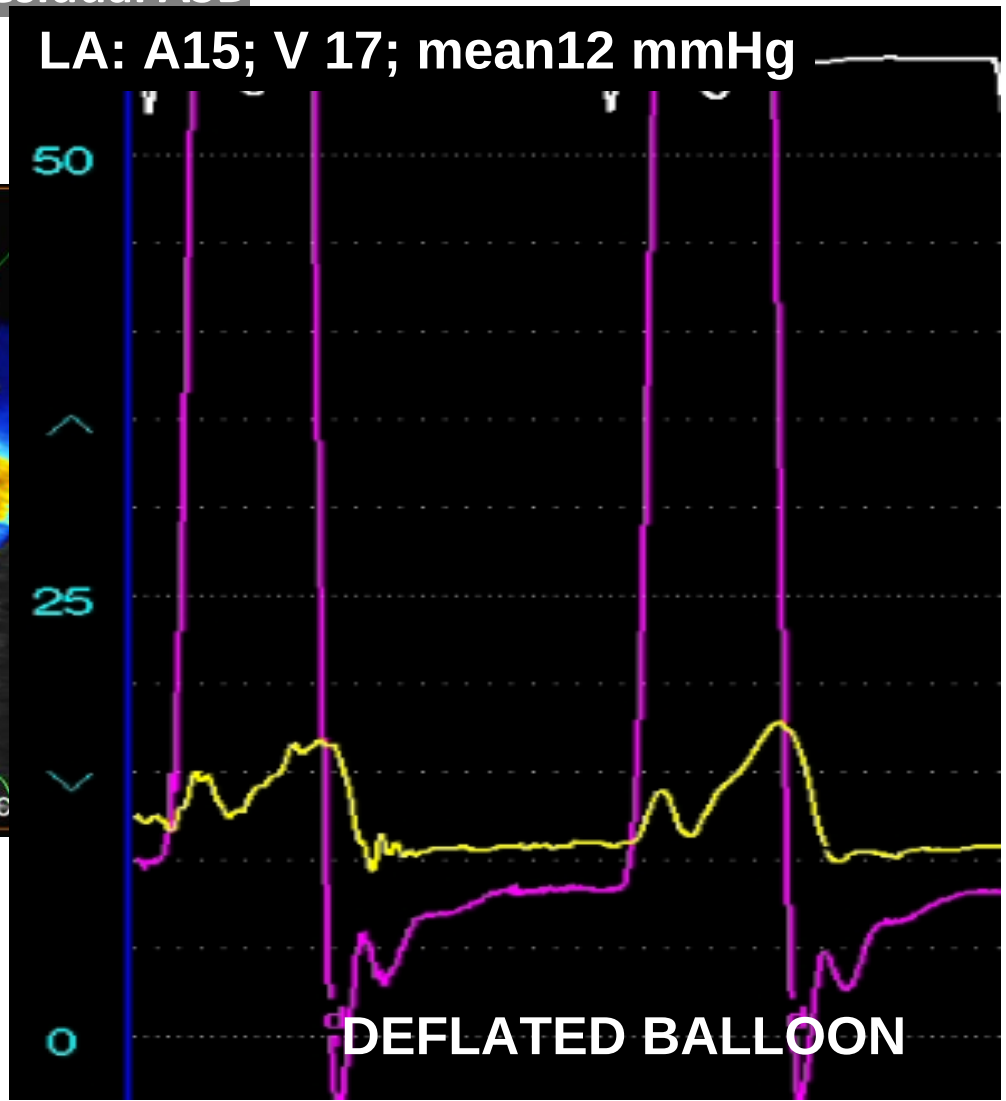
Different interatrial shunts devices

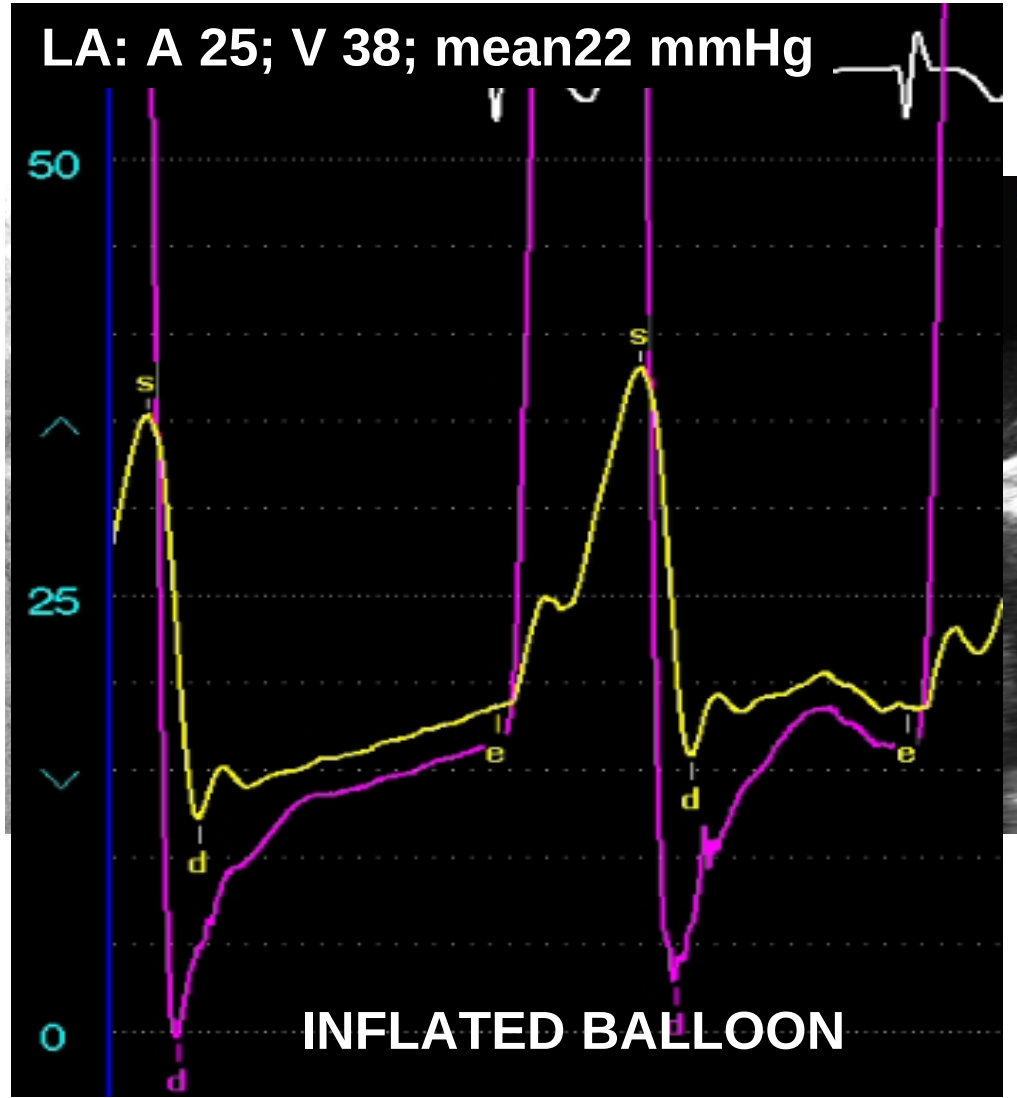
Selection of patients for HF

Current clinical evidence

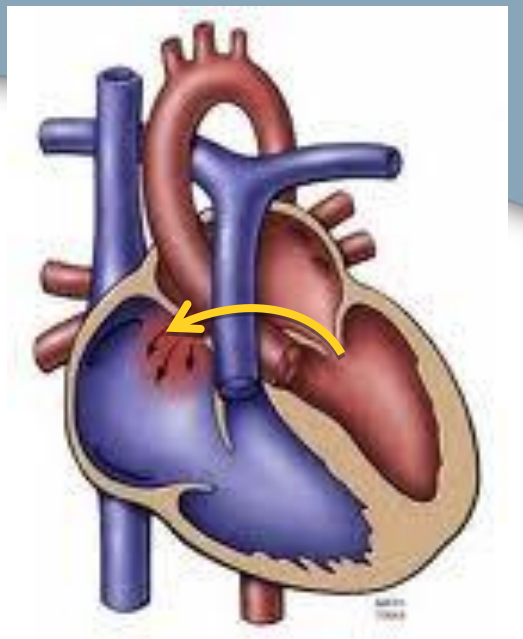
80-year-old female. HYP, DM, CKF. Atrial fibrillation. Dyspnea of exertion.
Surgery (70 years old): mitral comisurotomy + tricuspid anuloplasty + surgical ASD closure. Several admissions for decompensated HF
TTE: Mod MS (Area: 1.9 cm2). Normal LVEF. RV dilatation with systolic dysfunction. Moderate TR. PAP 70 mmHg. Residual ASD







Before closing ASD

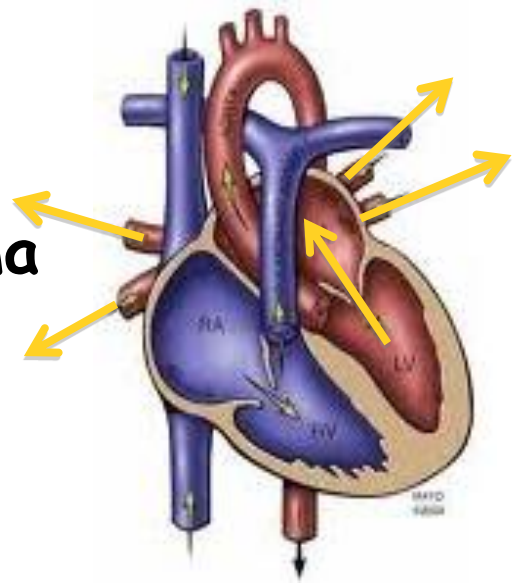


LV diastolic dysfunction (↓ elasticity)

- aging-dependancy
- associated with: hypertension, ischemic artery disease…

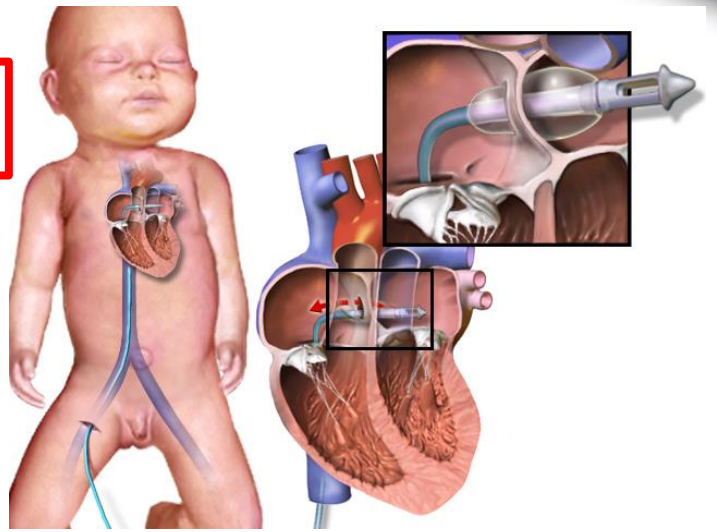
Restrictive physiology masked by ASD (overflow mechanism)

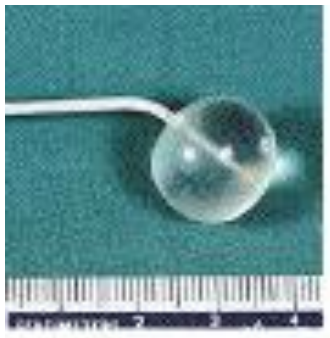
ASD closure - acute ↑ LA pressure→ acute pulmonary edema



Story of atrial septal opening

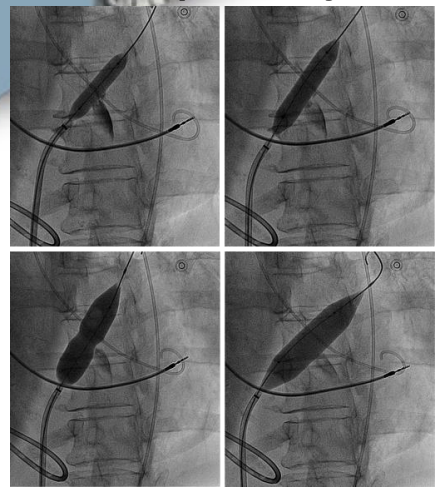
1. Balloon atrial septostomy 1966
2. Blade septostomy 1975
3. Transseptal puncture 1978
4. Atrial septal stenting 1999
5. Modified technique of stent fenestration 2003
6. Radiofrequency wave based atrial septostomy 2008
7. V-wave device 2014
8. Atrial Flow Regulator 2014





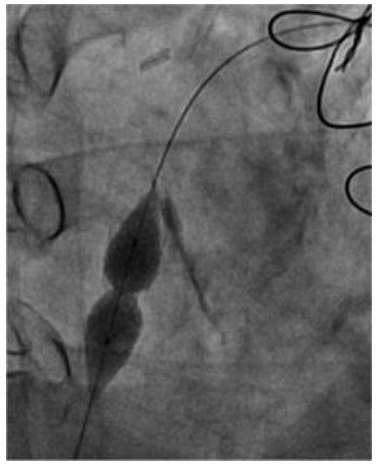
Atrial Decompression Devices

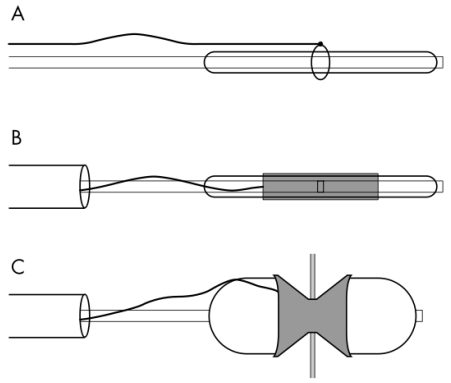
1966
Balloon atrial septostomy



1999
Stent fenestration

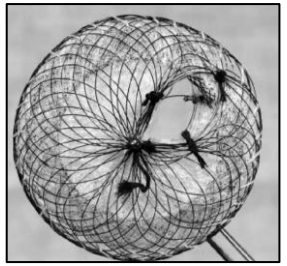
2003
Modified stent fenestration



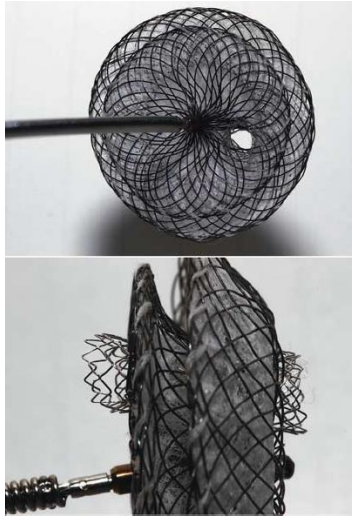


Device fenestration

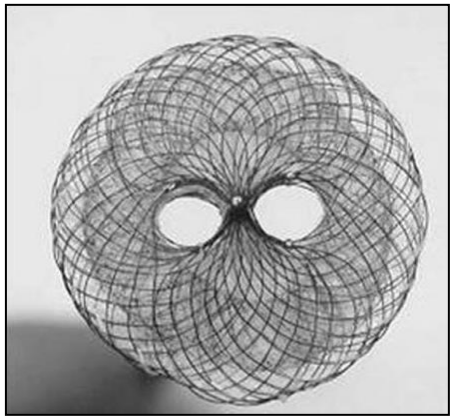
Suturing fenestration



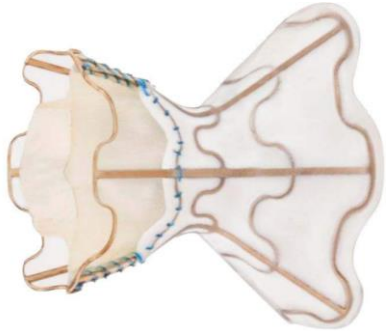
Device Stent fenestration



Manufactured fenestrated devices



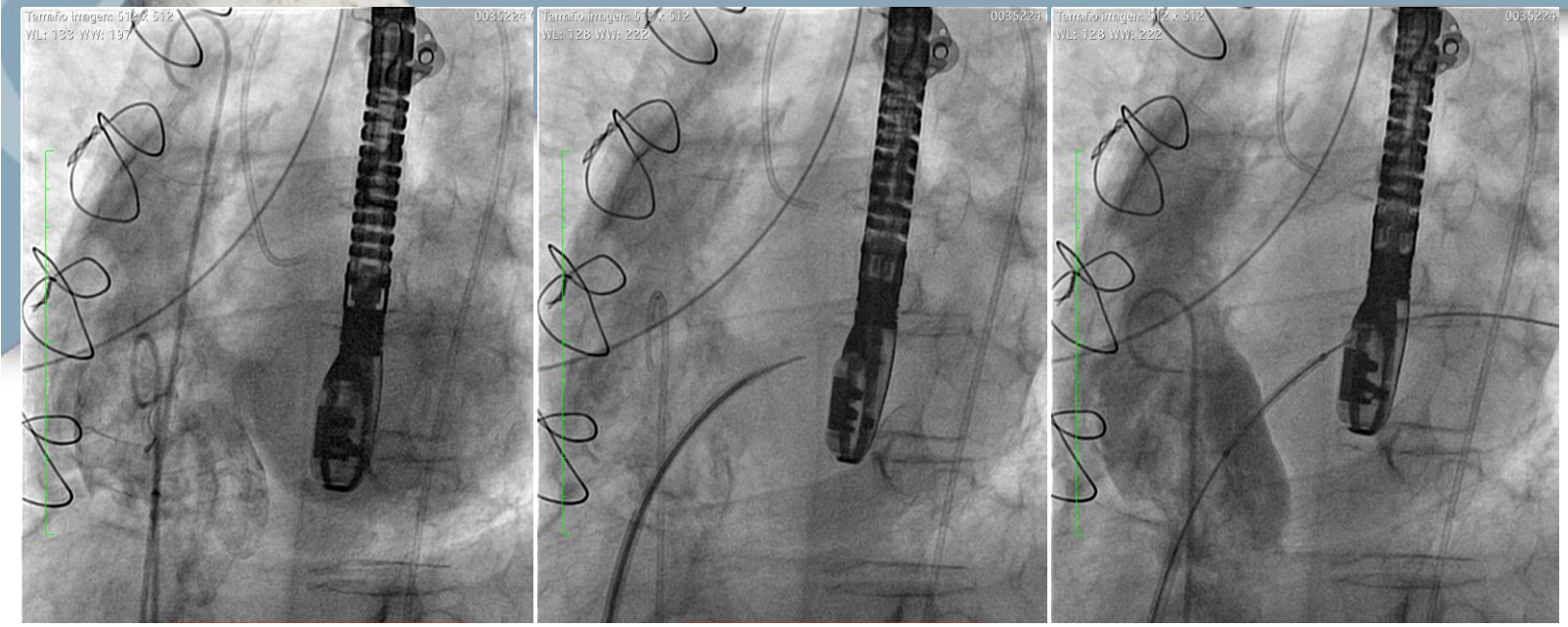
2014
Specific devices

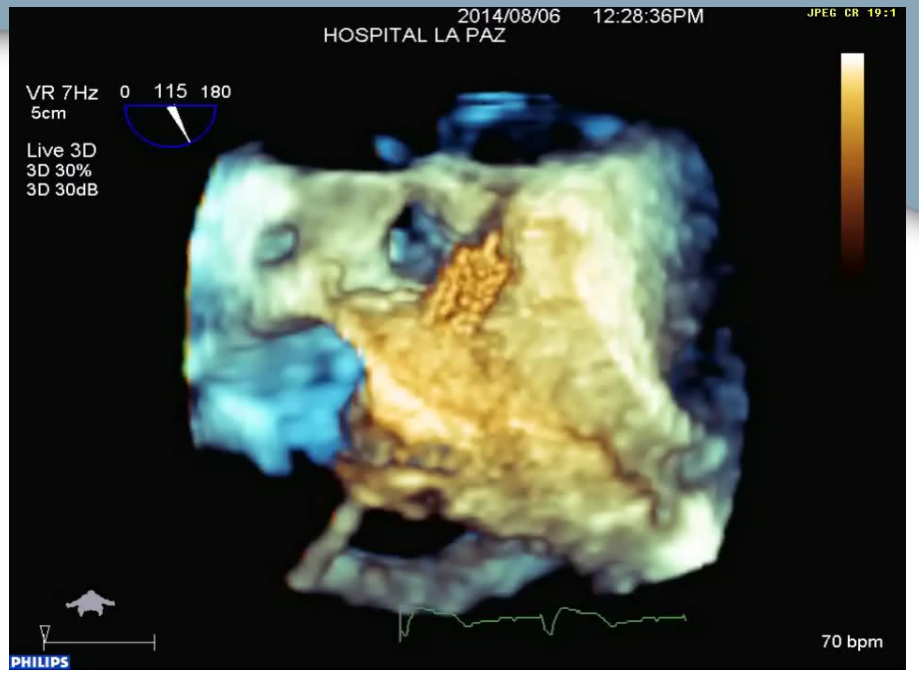


V-Wave® (V-Wave)

IASD® (Corvia)

AFR® (Occlutech)

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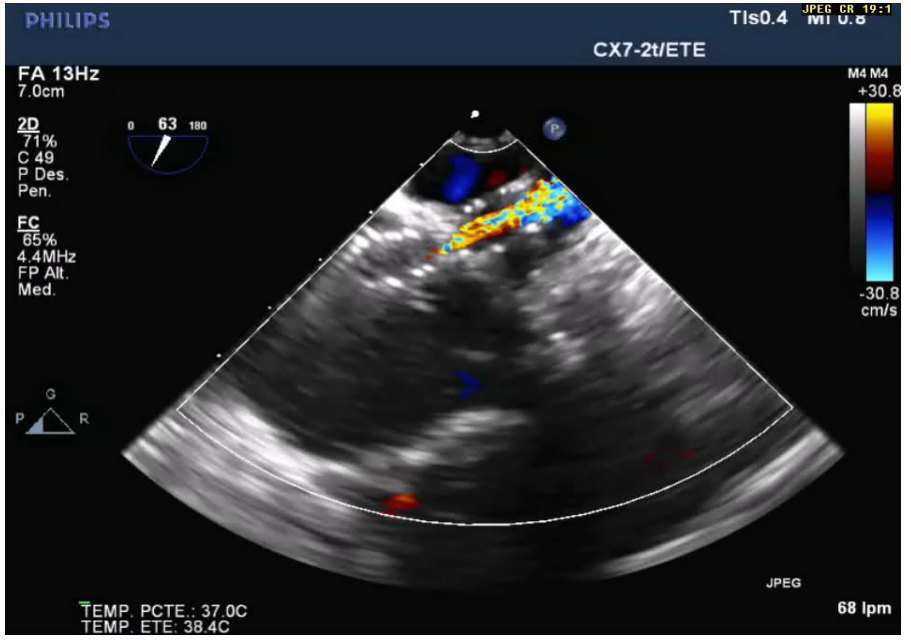
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+30.8
-30.8
cm/s
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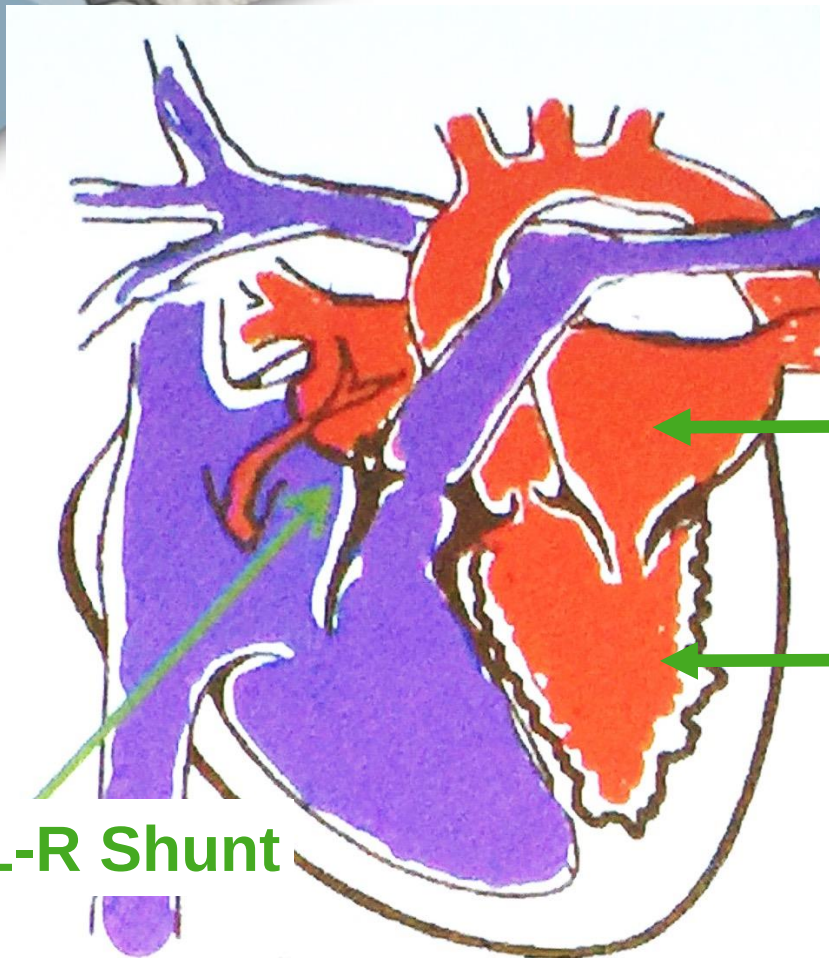
68 lpm

Atrial Septal Opening…How does it work ?

Diastolic/Systolic Left Heart Failure



Decompression LA/LV chambers

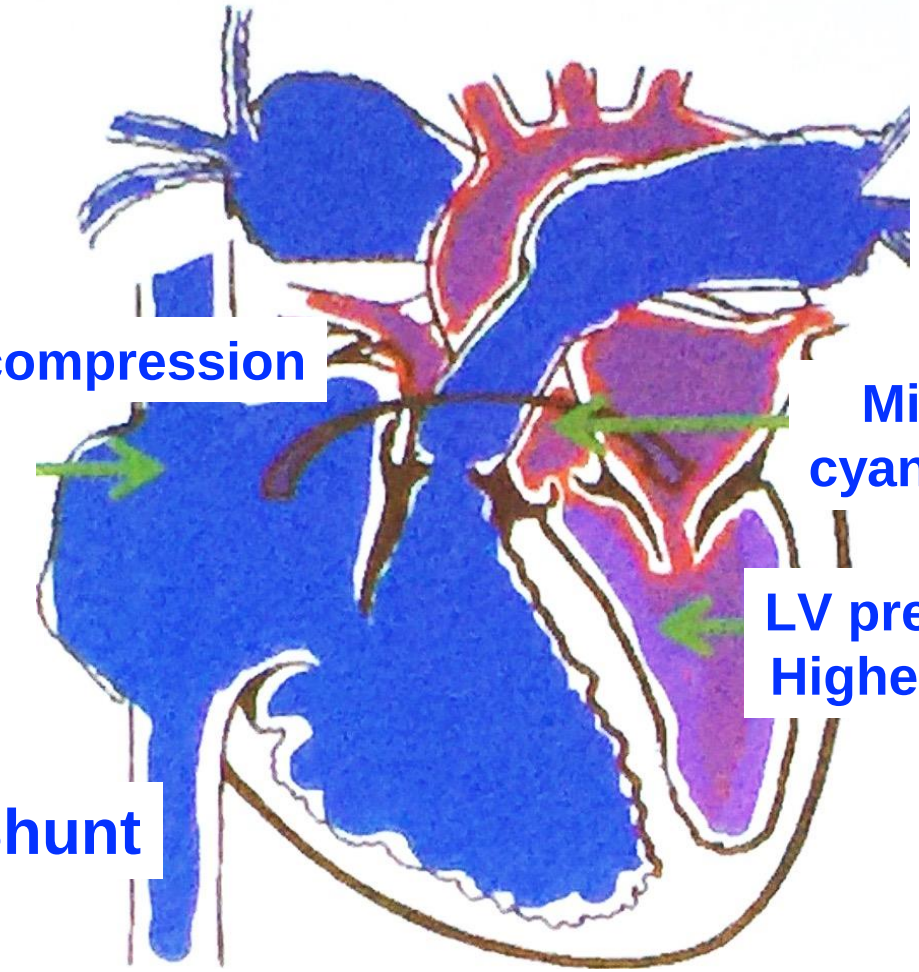
Regression Pulmonary Cogestion

Improved Shortness of breath

L-R Shunt

Reduce pulmonary venous congestion

Pulmonary Artery Hypertension



RA decompression

Mild cyanosis

LV preload Higher CO

R-L Shunt

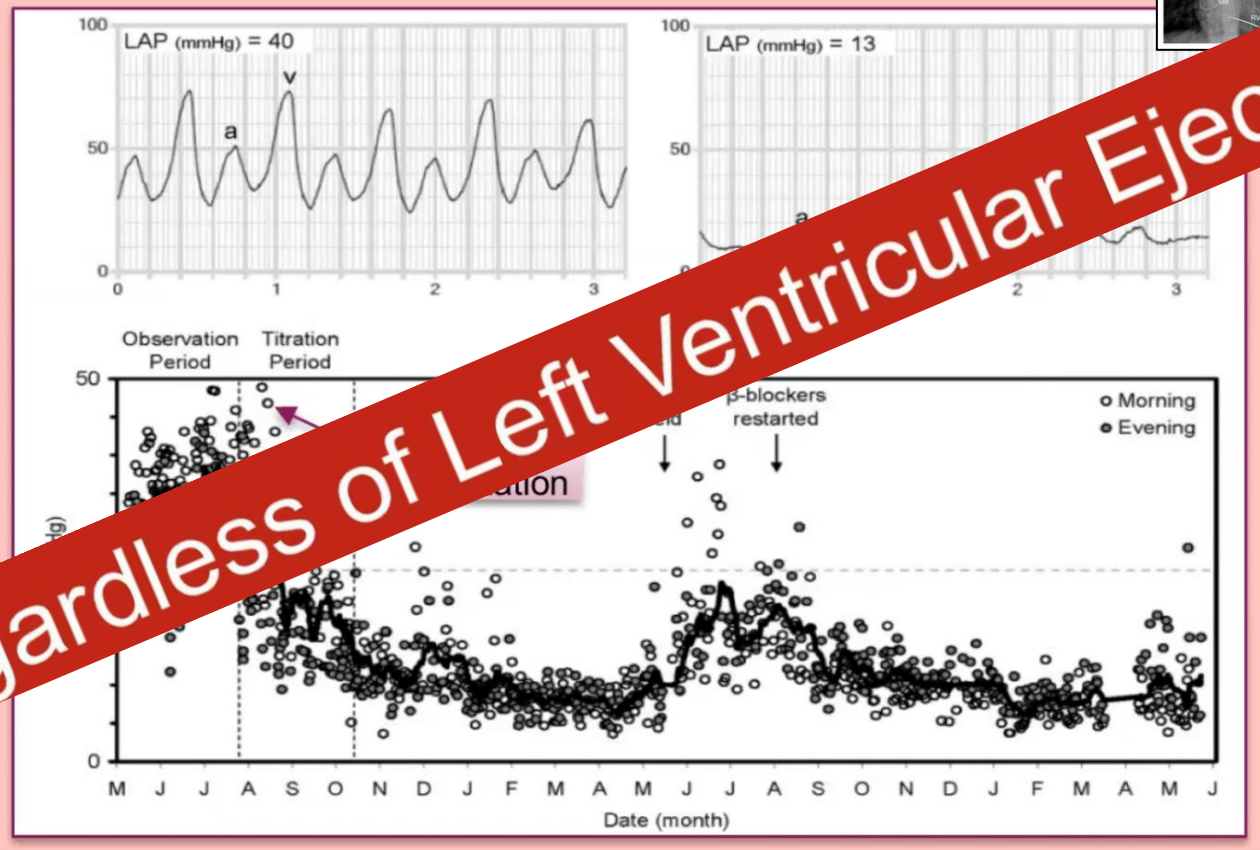
Reduce systemic venous congestion
Higher CO & improved oxygen delivery

Elevated LAP is a target of HF therapy

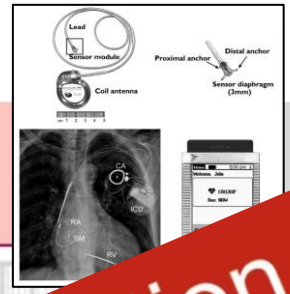
ADHF occurs when LAP is elevated for days to weeks

LAP tracings from single day typically show marked variations

LAP = 40 mmHg AM
LAP = 13 mmHg PM

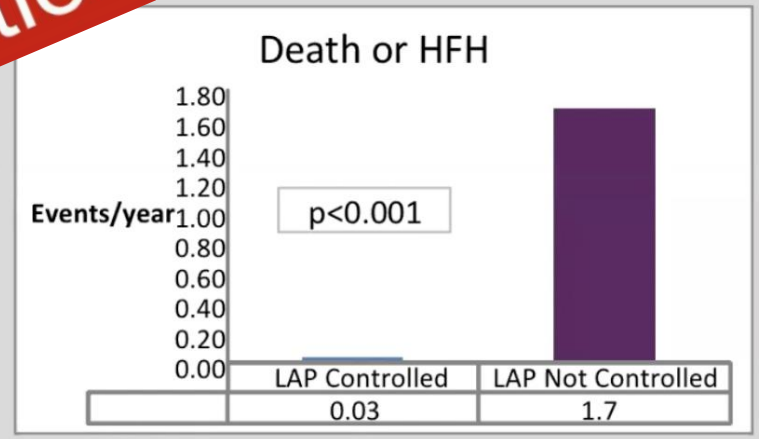


LAP readings over 2 years showing sustained LAP mmHg pre ADHF ever



Regardless of Left Ventricular Ejection Fraction!

C LAP s HF events



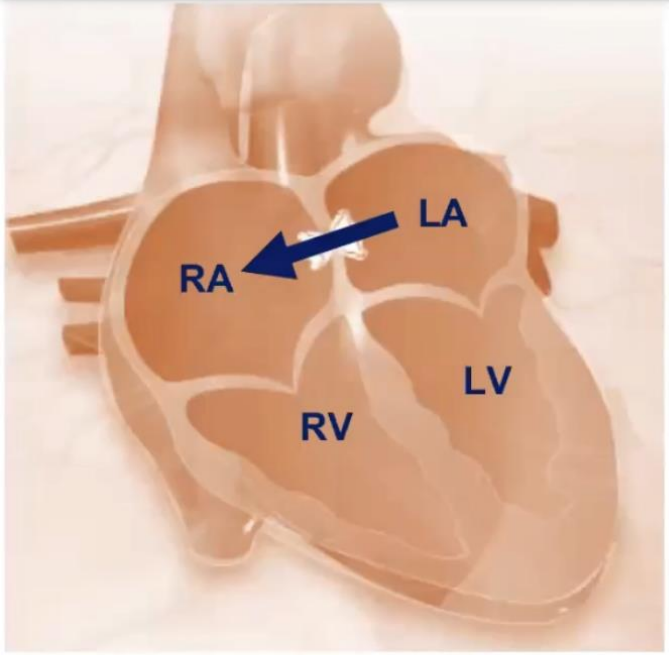
When LAP controlled (trend ≤18 mmHg) by pressure-guided medication adjustment, there were significantly fewer HF events

Ritzema et al. HOMEOSTASIS Trial. Circulation 2010; 121:1086-1095

Interatrial Shunting in HF: How it Works

An on-demand, dynamic, self-regulation LAP lowering therapy

Mechanism of Action



Excess LA volume shunted to RA

↓ Left atrial pressure (LAP)

↓ Pulmonary artery pressure

- Reduced pulmonary congestion and HF events
- Improved functional status and symptom relief
- Signs of reverse LV remodeling
- Maintenance of RV function

Qp/Qs: 1.2-1.3

Eigler, et al. *Structural Heart* 2017

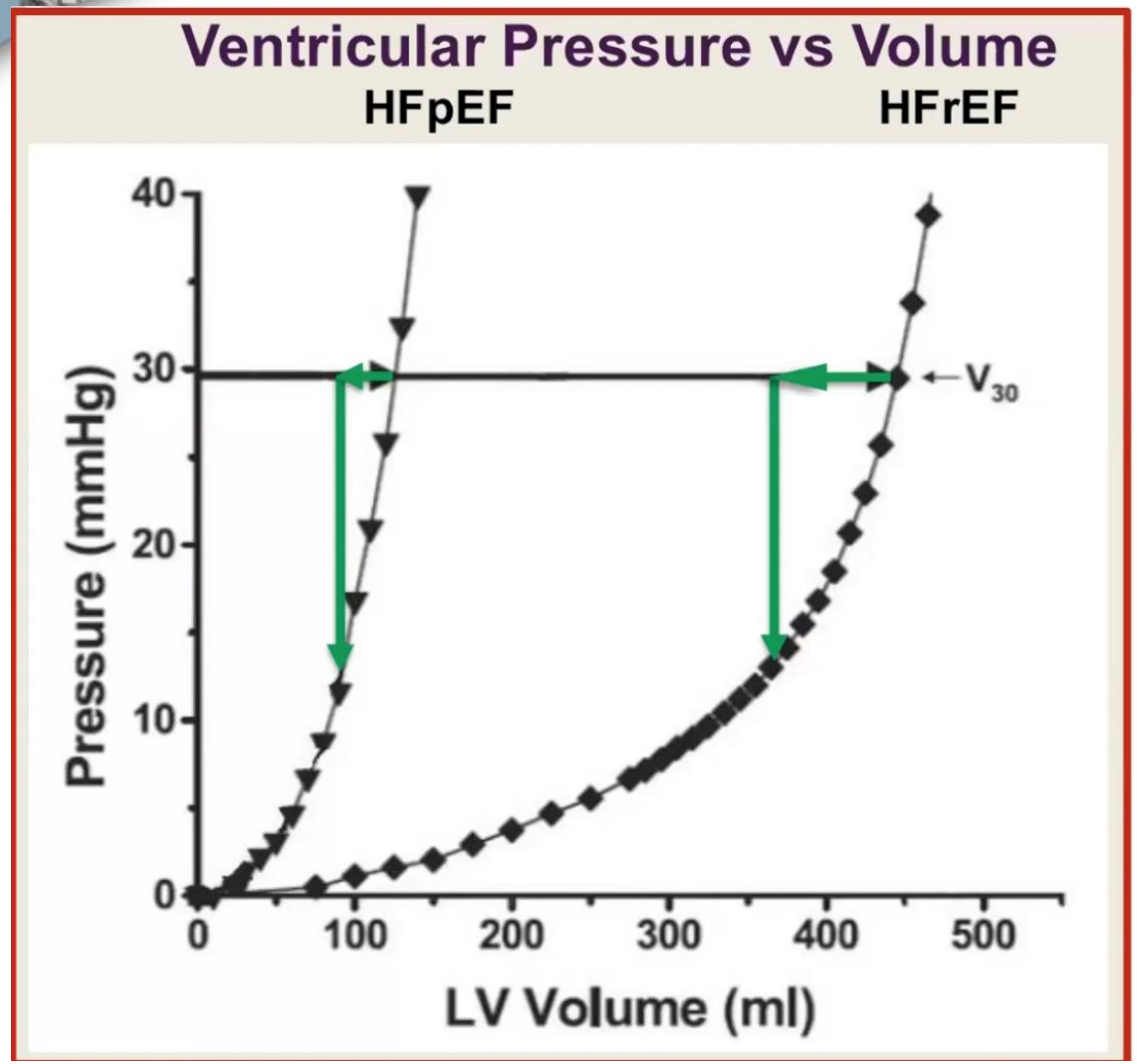
Hasenfuβ, et al. *Lancet* 2016

Rodés-Cabau J, et al. *Lancet* 2016

Rodés-Cabau J, et al. *JACC Intv* 2018; 11:2300-2310

Paitazoglou C, wt al. *EuroInterv* 2019

How a small interatrial shunt reduces LAP In both HFrEF and HFpEF

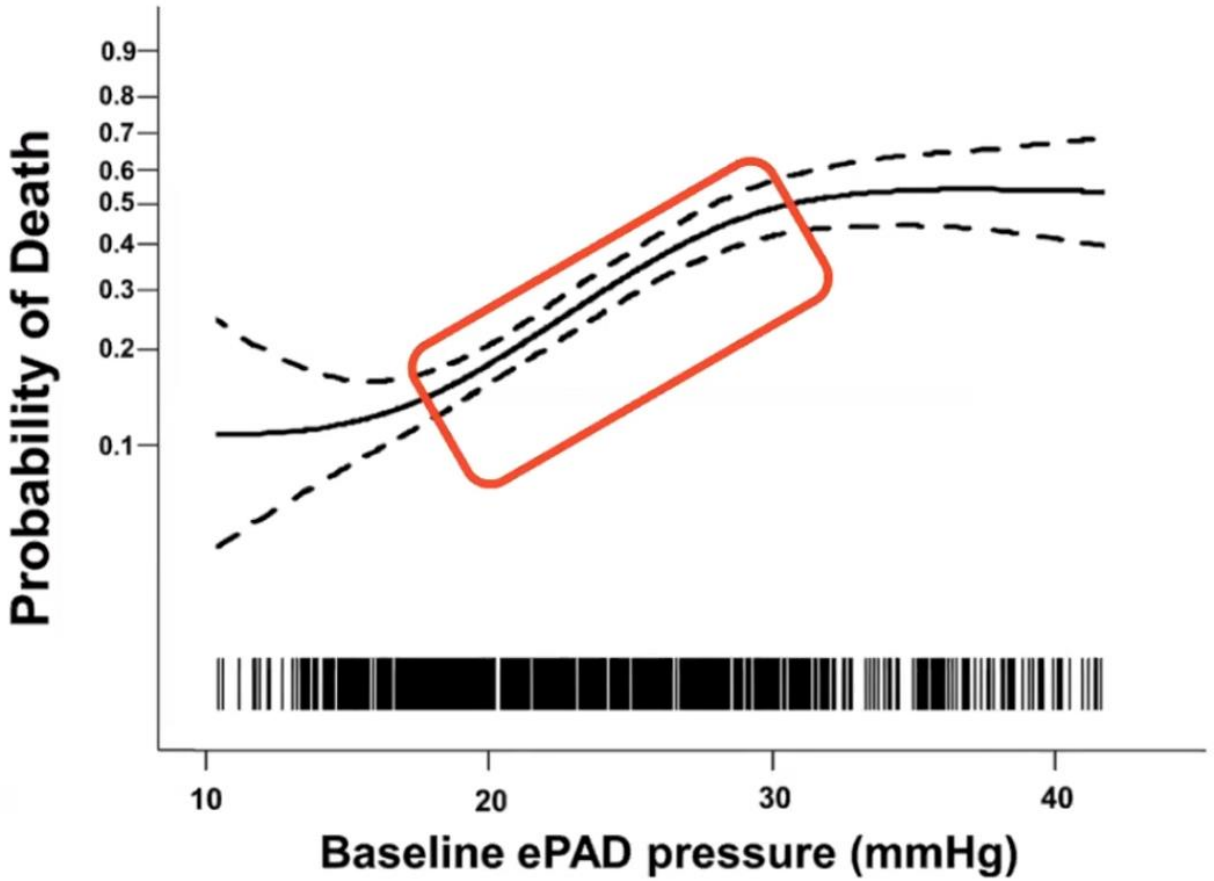


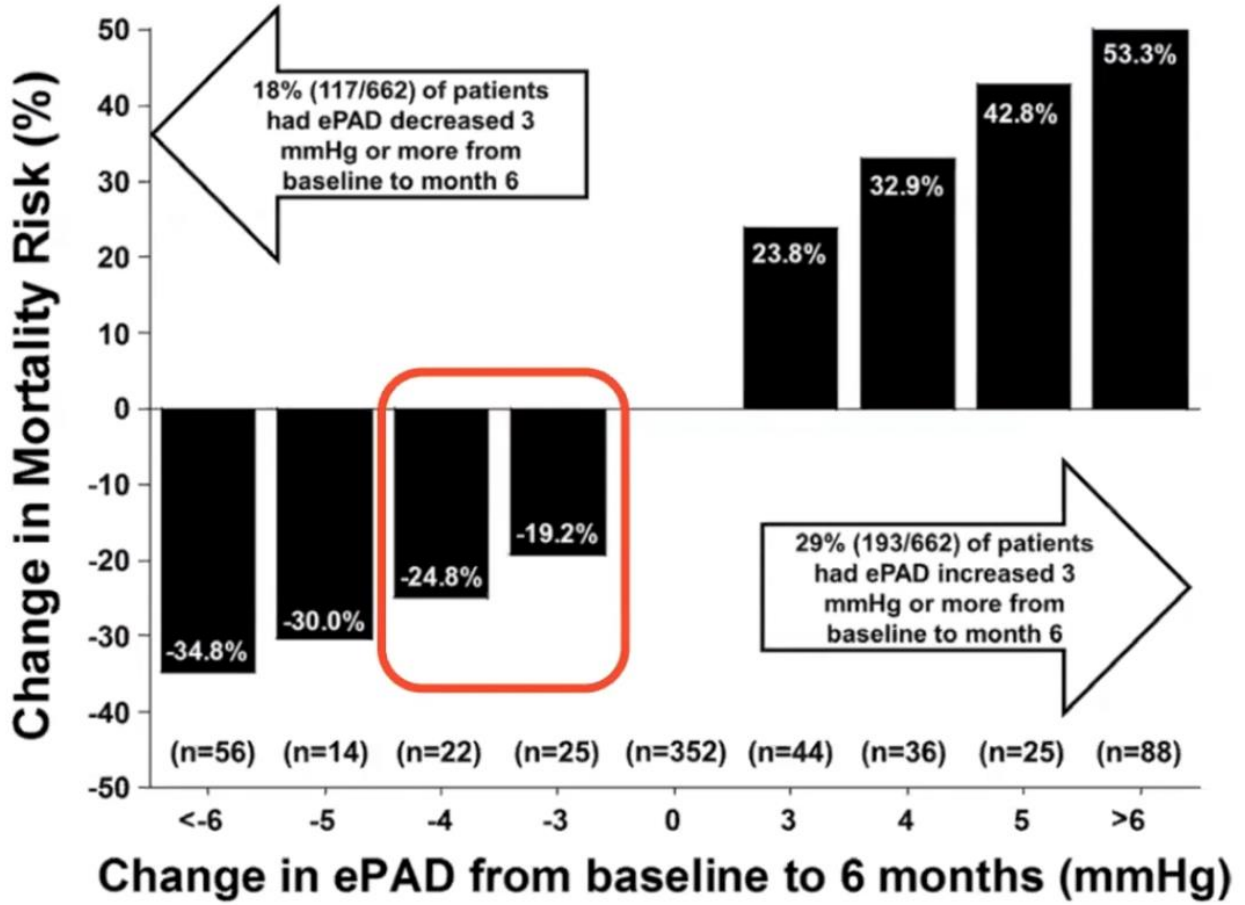
Pressure – Volume Curves of LV

- Shows small volume of blood flow across an interatrial shunt can lead to large pressure decreases in both HFrEF and HFpEF
- Reduction in Left Ventricular and Left Atrial Pressures should reduce acute HF episodes and improve symptoms

Burkhoff D, et al. *Am J Physiol Heart Circ Physiol* 2005; 289:H501–H512

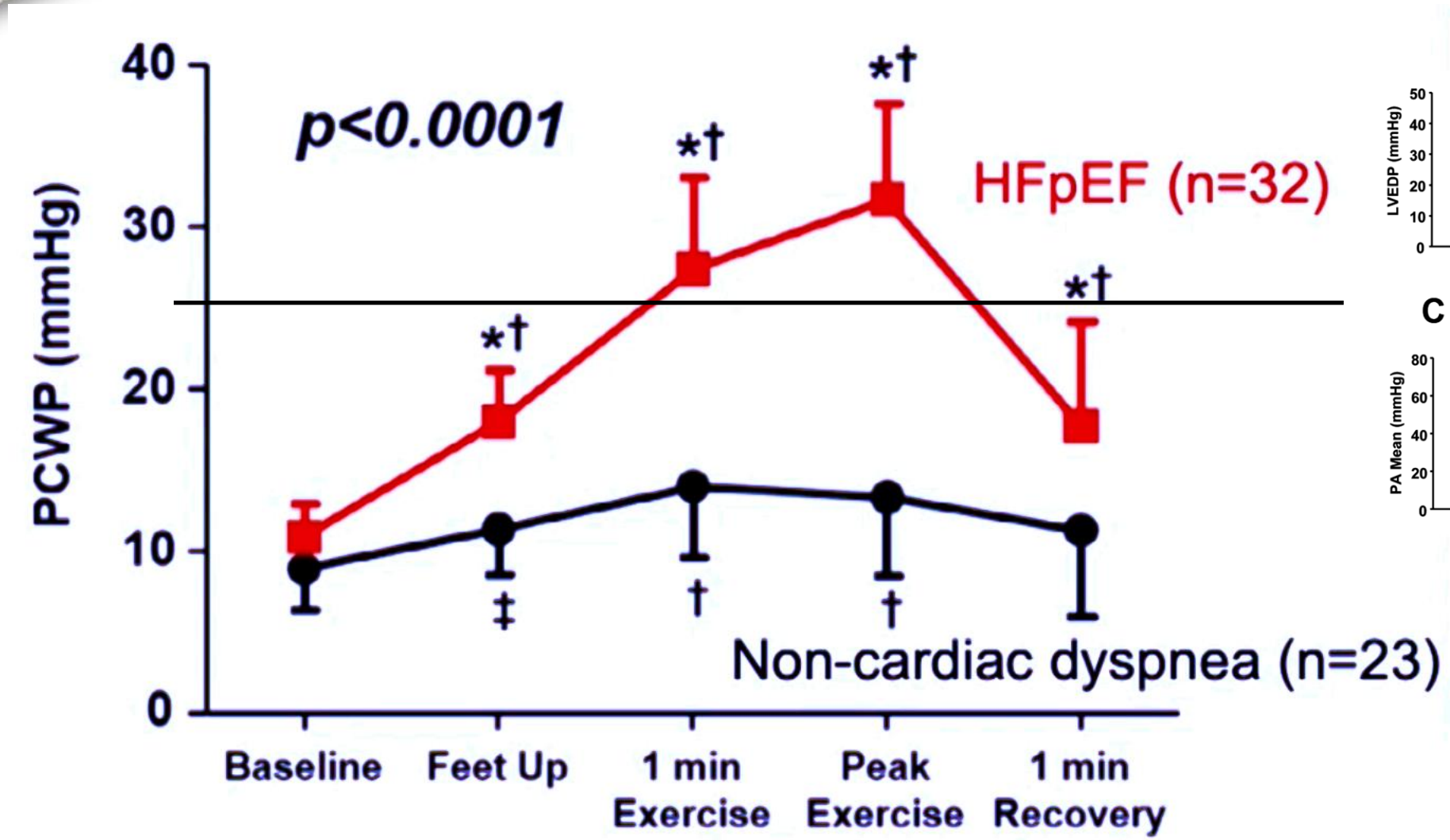
↓LV filling pressure = ↓ mortality

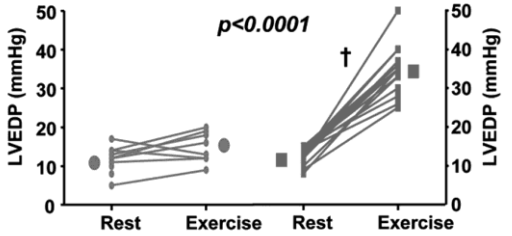




Zile MR, et al. *Circ Heart Fail* 2017

Exercise Hemodynamics Enhance Diagnosis of Early HF-pEF





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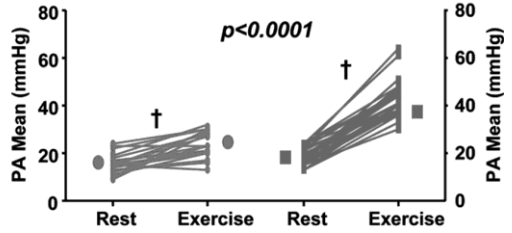
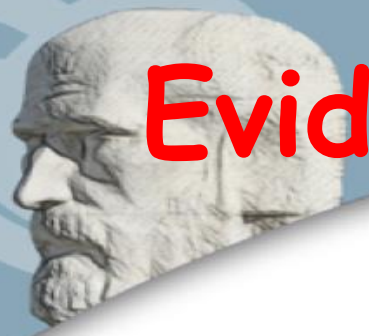


Borlaug et al. Circ Heart Fail. 2010;3:588-595



Evidence supporting interatrial shunt therapy in chronic HF

- Patients with mitral valve stenosis and an atrial septal defect (ASD) have fewer symptoms than patients with an intact septum
- Closure of ASDs in patients with unrecognized left ventricular dysfunction results in elevated LAP and pulmonary edema
- Pre-clinical animal studies demonstrate hemodynamic, echocardiographic, and survival benefits with interatrial shunting
- First-in-human and clinical pilot studies support the safety, feasibility, and potential effectiveness of interatrial shunting in heart failure

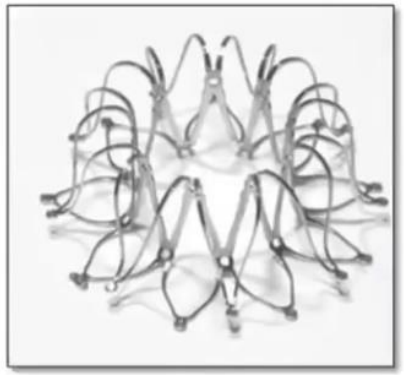
1. Lutembacher R. Arch Mal Coeur 1916
2. Ewert P, et al. Catheter Cardiovasc Interv 2001
3. Eigler N, et al. Structural Heart 2017
4. Søndergaard L, et al. Eur Heart J 2014
5. Hasenfuß, et al. Lancet 2016
6. Feldman et al. Circulation 2017
7. Del Trigo M, et al. Lancet 2016
8. Rodés-Cabau, J, et al. JACC Intv 2018
9. Paitazoglou C, et al. EuroInterv 2019
10. Guimmarães L, et al. EuroInterv 2020

Interatrial shunt devices with completed pilot studies

V-Wave Ventura Interatrial Shunt Device

5 mm venturi orifice and septal footprint diameters

Corvia Interatrial Shunt Device (IASD)



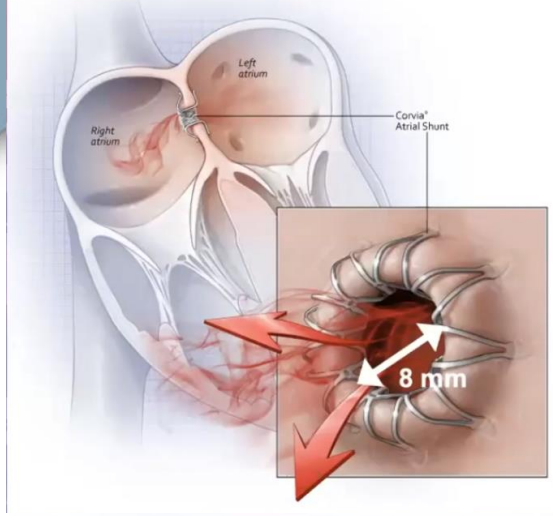
8 mm orifice plate, 19 mm diameter septal footprint

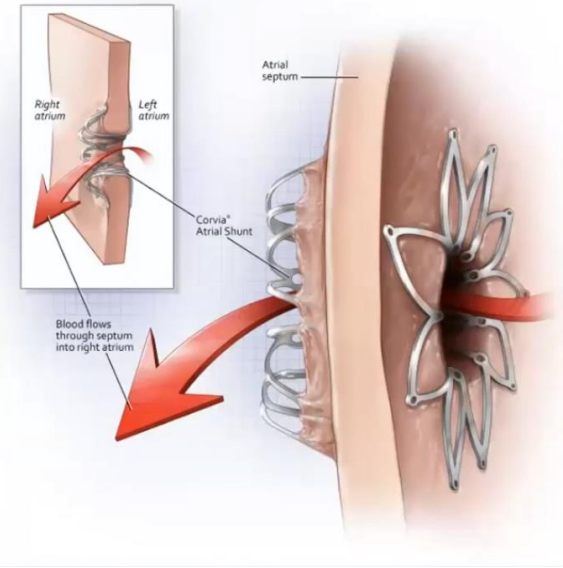
Occlutech Atrial Flow Regulator (AFR)

6-10 mm orifice plate, 22-26 mm diameter septal footprint

Corvia clinical evidence pipeline

Pilot Study --- CE Mark Study --- REDUCE LAP-HF I --- REDUCE-LAP HF III





Pilot Study (n=11): non-randomized, single-arm
Completed (Sondergaard L et al. Eur J Heart Fail 2014)

CE Mark Study (n=64): non-randomized, single-arm
Completed (Hasenfub G et al. Lancet 2016)

REDUCE LAP-HF I (n=44): RCT mechanistic study
Completed (Feldman T et al. Circulation 2018, Shah SJ et al. JAMA Cardiol 2018)

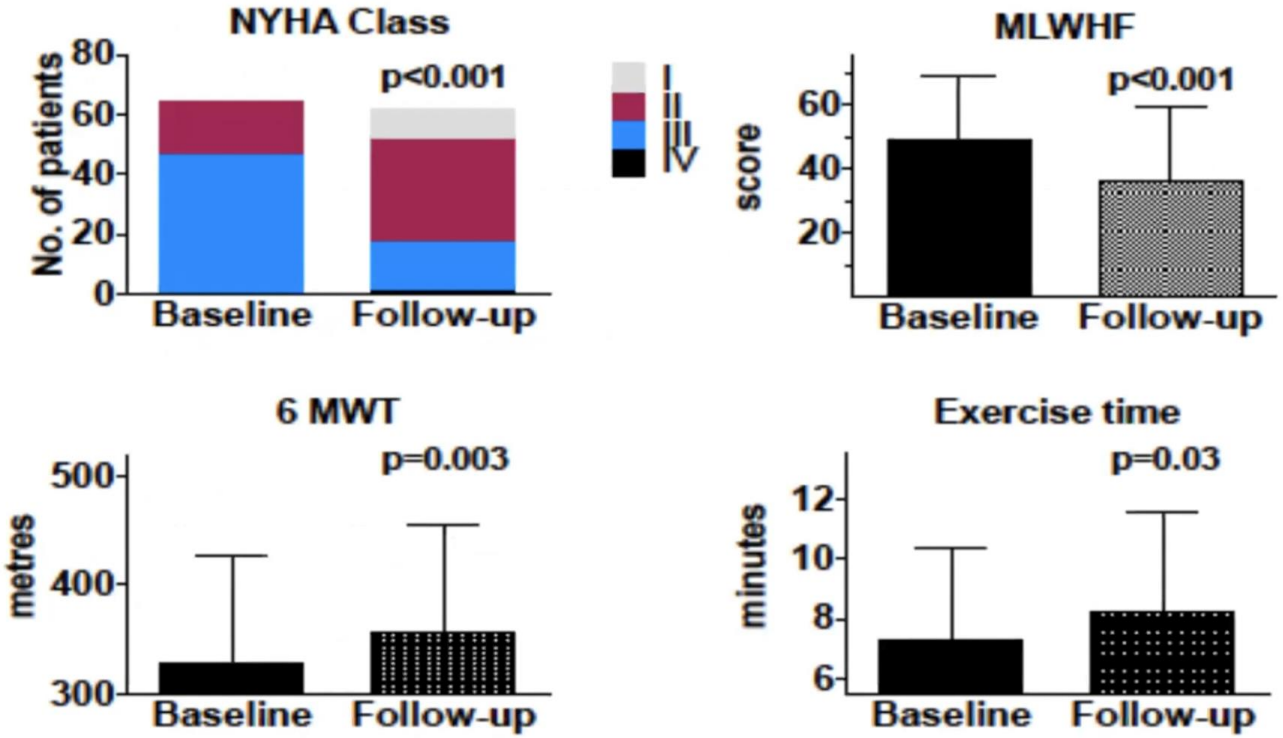
REDUCED LAP-HF II (n=626): RCT pivotal study
Enrollment complete, results expected Q4 2021

~500
Corvia Atrial Shunts implanted globally

7+ years
Longest living patients with Corvia Atrial Shunt

CE Mark Study

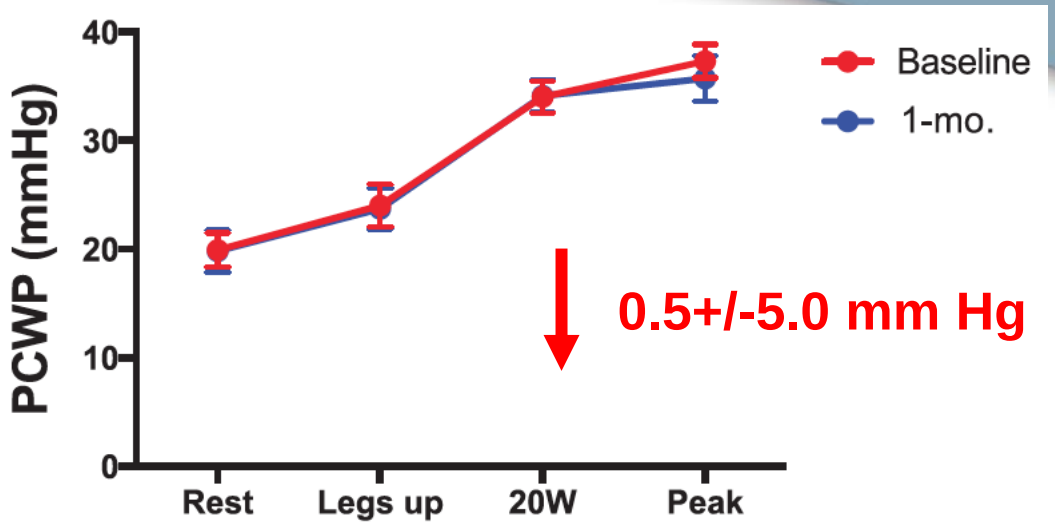
- Prospective, non-randomized study
- Symptomatic HF (N=64)
- **Preserved EF (>40%)**
- Elevated PCWP at rest (>15 mmHg) or during exercise (>25 mmHg)
- Monitored by independent DSMB and CEC
- Assessed by independent Core-Laboratories
  - Echo
  - Hemodynamic
- Three year clinical follow-up
  - One year complete



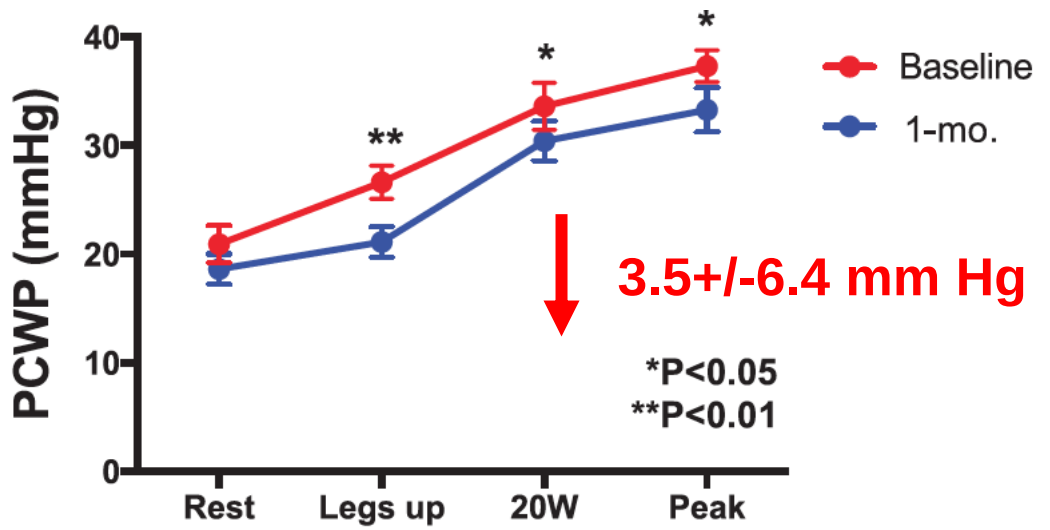
Hasenfub G et al. Lancet 2016

REDUCE LAP-HF I Trial

- RCT (Sham procedure) (n=44)
- III-IV NYHA
- (1) prior hospitalization for HF within prior 12 m, or
  (2) (BNP >70 pg/mL in SR, >200 pg/mL in AF, or NTpro-BNP >200 pg/mL in SR, >600 pg/mL in AF) within past 6 m
- EF ≥40%
- PCWP during supine bike exercise ≥25 mmHg + PCWP-RA pressure gradient ≥5 mm Hg



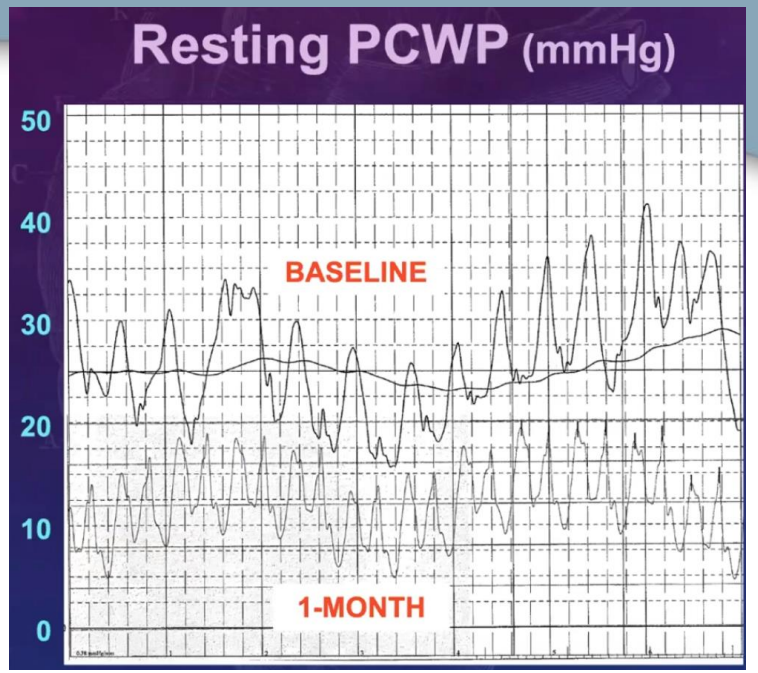
Control group: Baseline vs. 1-month PCWP

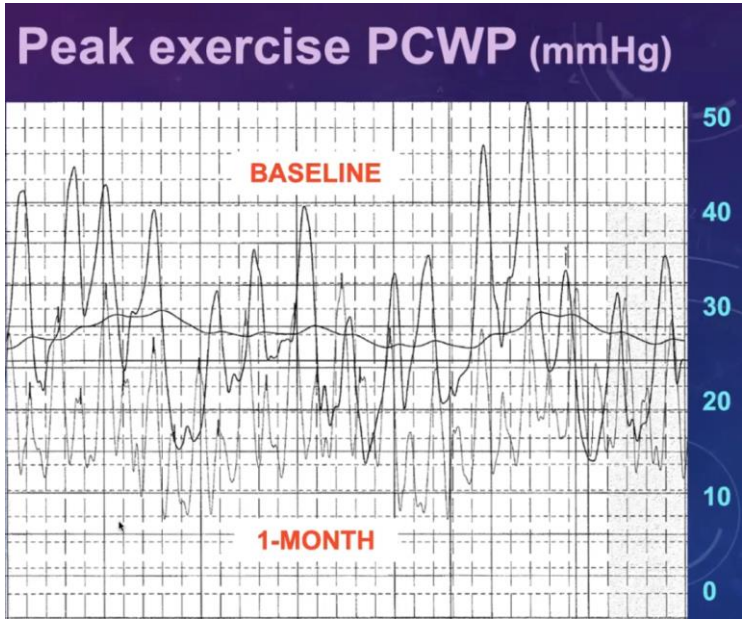


IASD group: Baseline vs. 1-month PCWP

Feldman et al. Circulation. 2018;137:364–375

Adverse Event	IASD Patients (N=22)	Control Patients (N=22)	*P* Value
MACCRE	0.00 (0/21)	4.55 (1/22)	1.000
Cardiovascular death	0.00 (0/21)	0.00 (0/22)	—
Embolic stroke	0.00 (0/21)	0.00 (0/22)	—
Device-/procedure-related MACE*	0.00 (0/21)	0.00 (0/22)	—
New onset or worsening renal dysfunction	0.00 (0/21)	4.55 (1/22)	1.000
MACE	0.00 (0/21)	0.00 (0/22)	—
Cardiac death	0.00 (0/21)	0.00 (0/22)	—
Myocardial infarction	0.00 (0/21)	0.00 (0/22)	—
Emergency cardiac surgery	0.00 (0/21)	0.00 (0/22)	—
Cardiac tamponade	0.00 (0/21)	0.00 (0/22)	—
Death	0.00 (0/21)	0.00 (0/22)	—
Myocardial infarction	0.00 (0/21)	0.00 (0/22)	—
Stroke or transient ischemic attack	0.00 (0/21)	0.00 (0/22)	—
Systemic embolization	0.00 (0/21)	0.00 (0/22)	—
Cardiac perforation	0.00 (0/21)	0.00 (0/22)	—
Newly acquired atrial fibrillation/flutter	0.00 (0/21)	0.00 (0/22)	—
Major vascular complications	0.00 (0/21)	0.00 (0/22)	—
Device embolization	0.00 (0/21)	0.00 (0/22)	—
Device occlusion	0.00 (0/21)	0.00 (0/22)	—
Device-related repeat procedure	0.00 (0/21)	0.00 (0/22)	—
Heart failure event	4.76 (1/21)	13.64 (3/22)	0.607
Heart failure event requiring intravenous treatment	0.00 (0/21)	9.09 (2/22)	0.488
Cardiogenic shock	0.00 (0/21)	0.00 (0/22)	—

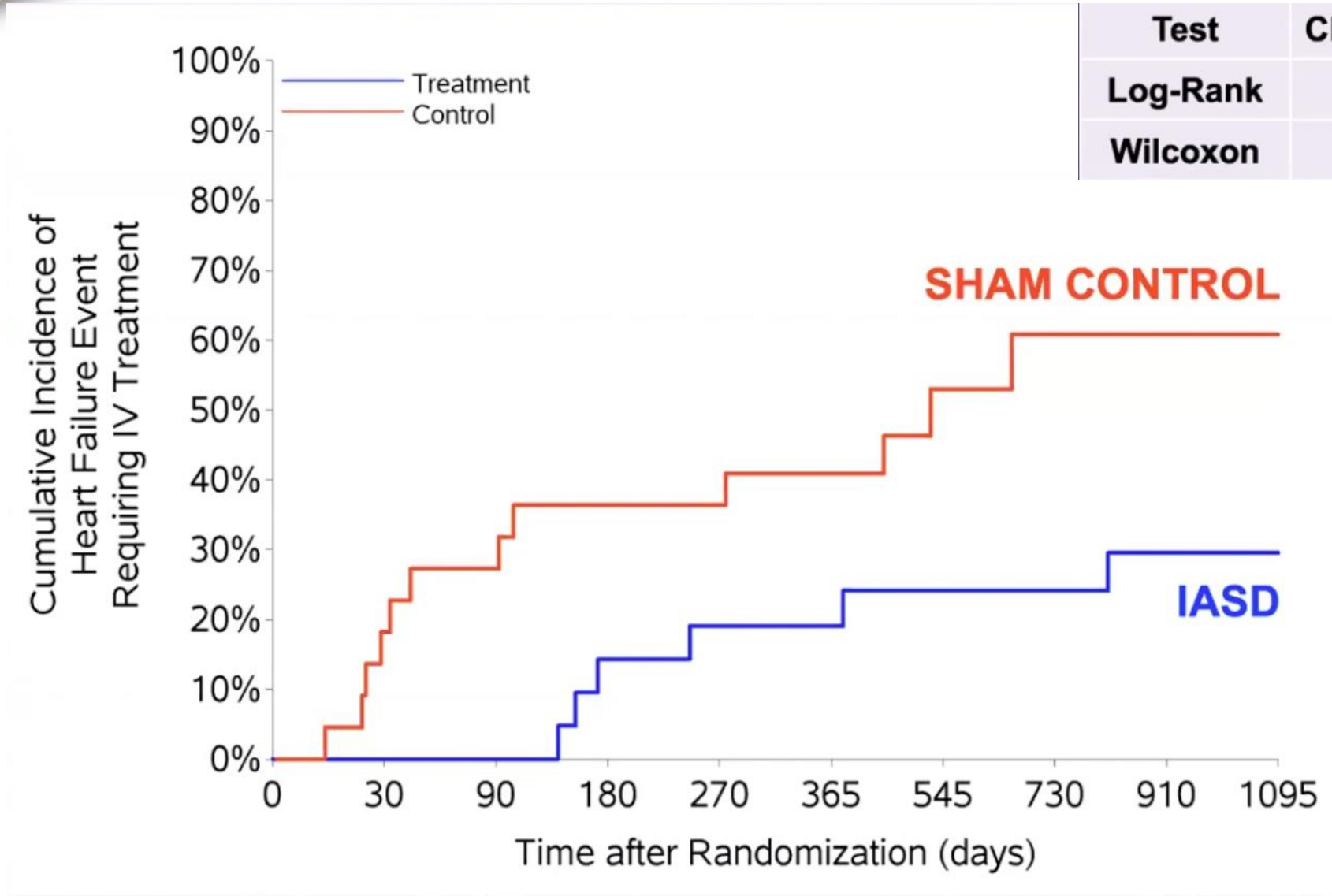




Feldman et al. Circulation. 2018;137:364–375

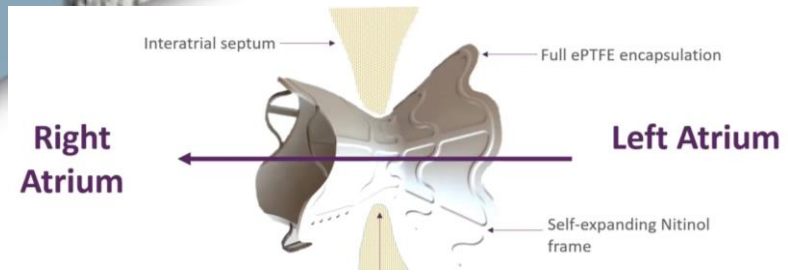
REDUCE LAP-HF I Trial: 3-yr outcome

Test	Chi-Square	P-value
Log-Rank	5.1851	0.034
Wilcoxon	5.1354	0.028



Unpublished

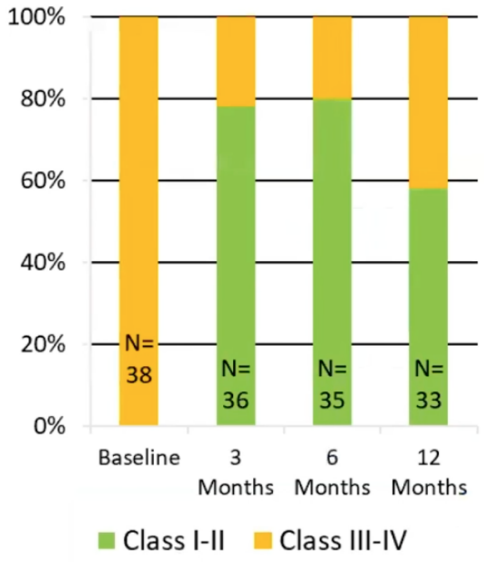
V-Wave FIH Studies HFpEF & HFrEF



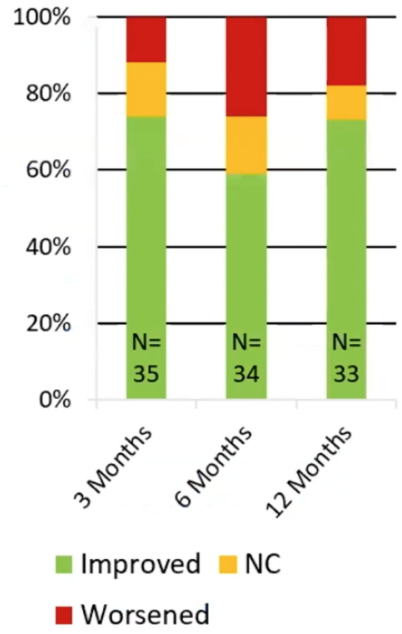
- Chronic HF, ischemic or non-ischemic etiology
- HFrEF and HFpEF
- NYHA class III or ambulatory class IV
- On GDMT and device therapies
- HF-hospitalization or elevated BNP/NT-proBNP

Total 38 pts (30 HFrEF, 8 HFpEF)
6 sites (Canada, EU, Israel)
Median FU 28 months (18-48 months)

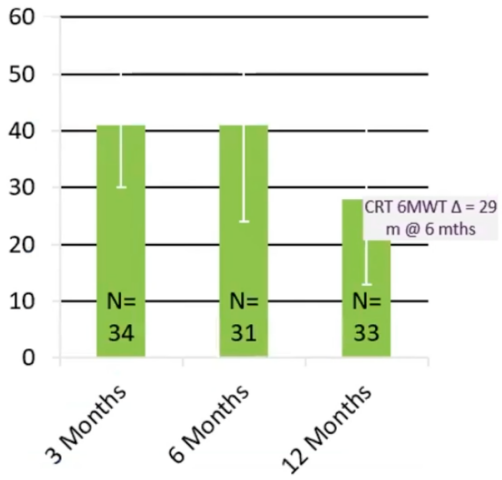
NYHA Class*



QoL Change*



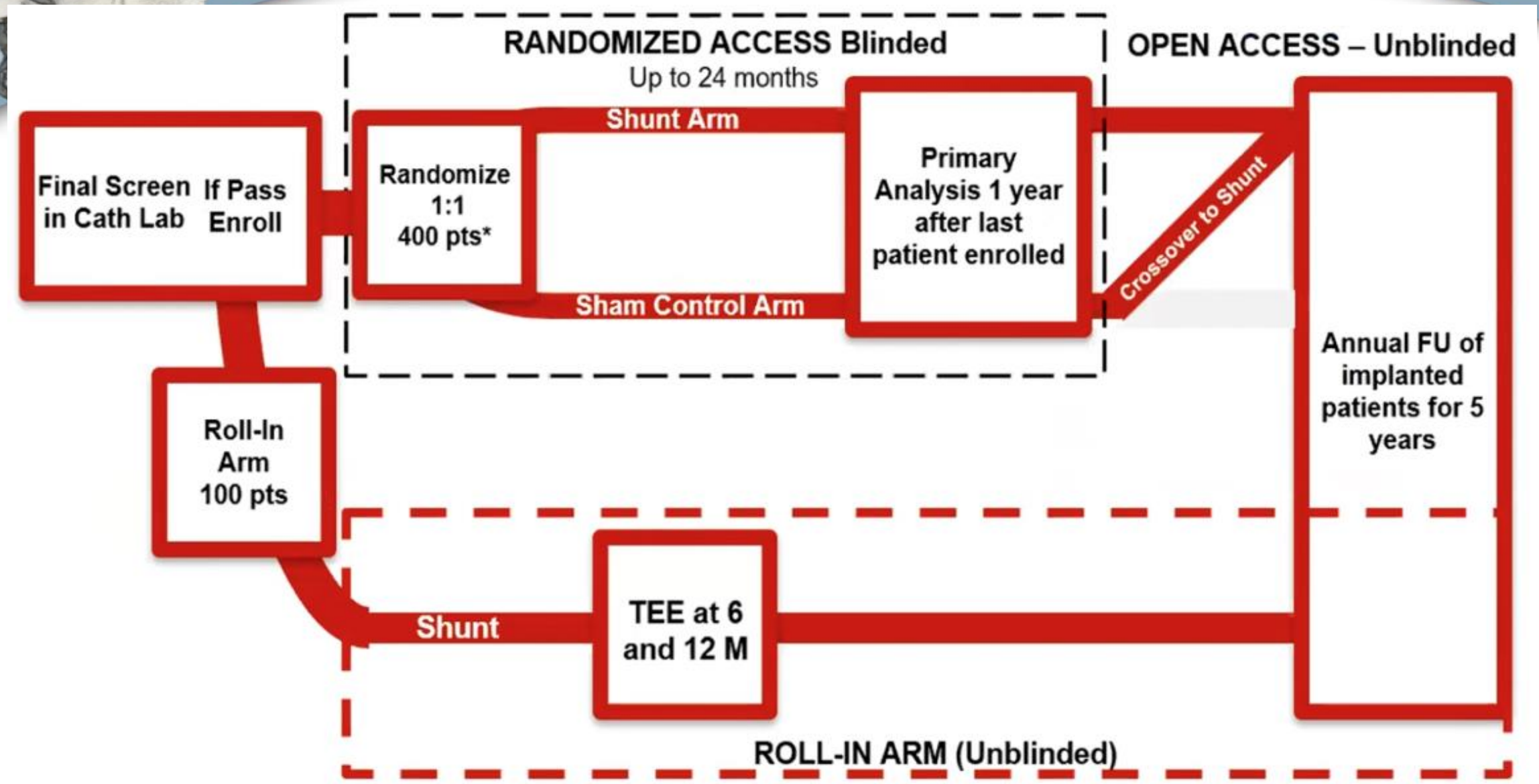
6MWT Change (m)*



*p<0.04 (baseline vs. follow-up)

Rodés-Cabau J, et al. JACC Interv 2018;11:2300–2310.

RELIEVE HF (HFrEF & HFpEF)



RELIEVE-HF Roll-In Cohort Data (n=88)

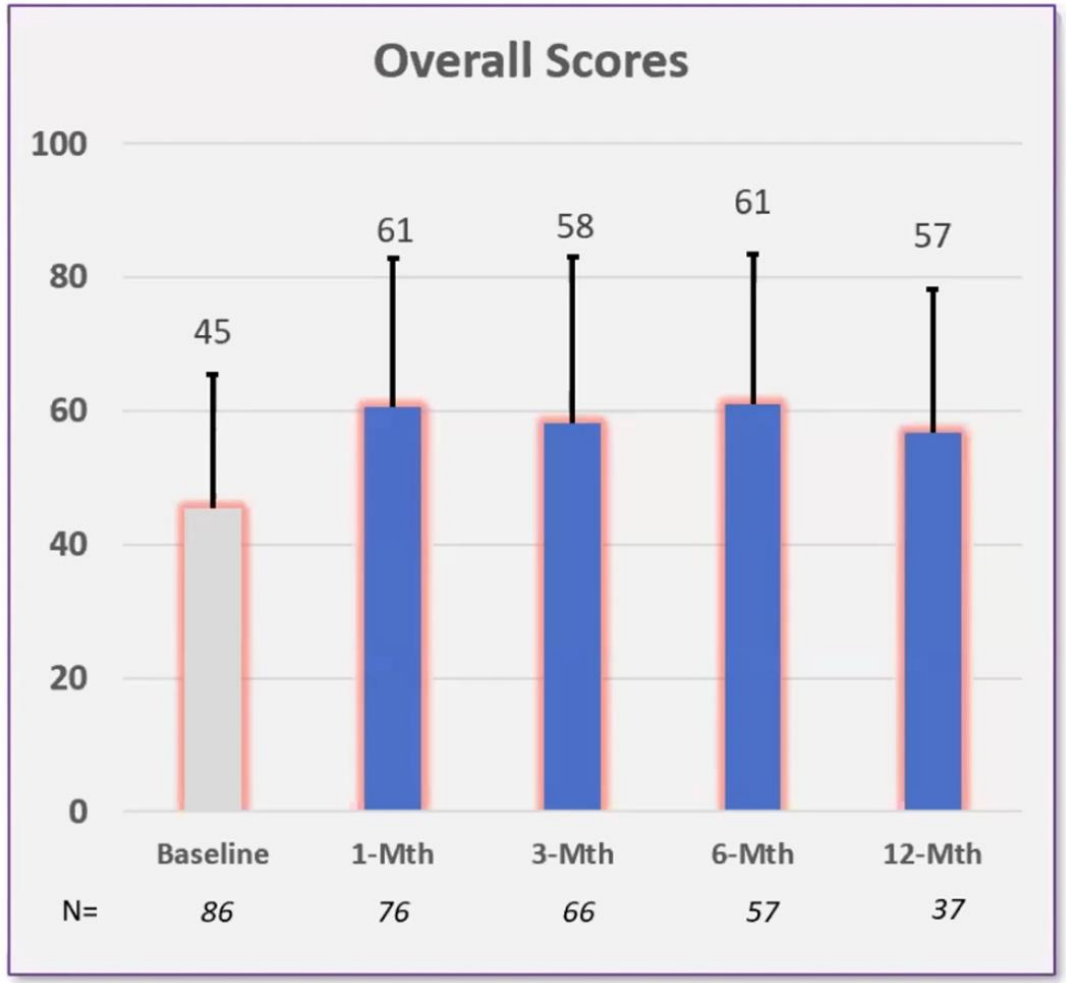
	Male Gender N (%)	Diabetes N (%)	HTN N(%)	Afib N (%)	HFrEF/ HFpEF %	NYHA II/III/IV %	ICD/CRT %	ACEi/ARB/ ARNI N (%)	MRA N (%)	B-Blocker N (%)	Diuretic N (%)
Roll-In: (N=88)	62 (70%)	46 (52%)	76 (86%)	42 (48%)	48 / 52	- / 98 / 2	23 / 24	66 (75%)	50 (57%)	73 (83%)	81 (92%)

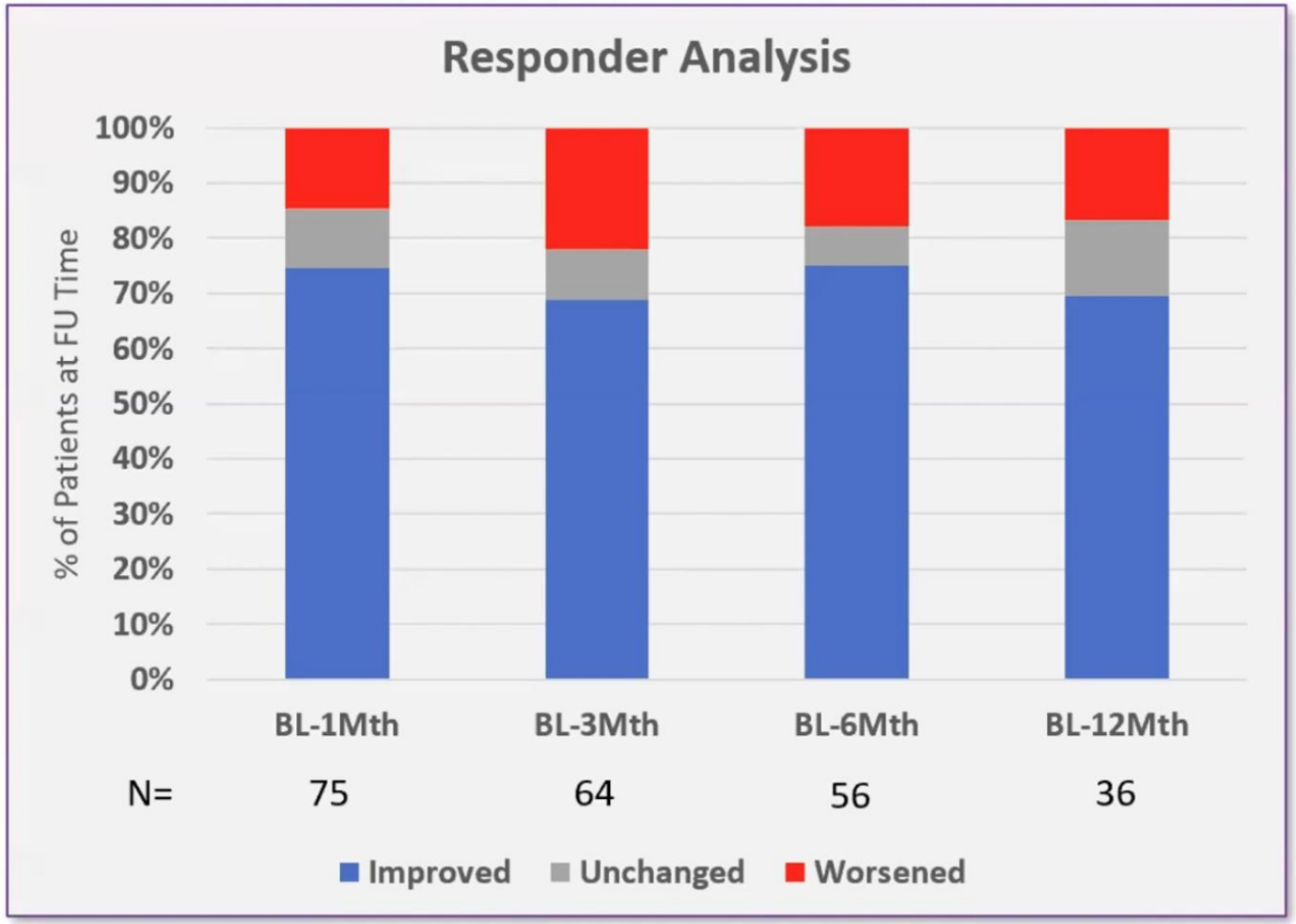
	Age (yrs)	BMI (Kg/m2)	HF Hosp (# in prior year)	eGFR (ml/min/ 1.73 m2)	Ejection Fraction		PCWP (mmHg)	RAP (mmHg)	PAP, sys (mmHg)	Cardiac Index (L/min/m2)	6MWD (m)	KCCQ	NT-proBNP (pg/ml)
					HFrEF (%)	HFpEF (%)							
Roll-In: (N=88)	70±11	31±6	1.0±1.2	51±20	28±7	58±7	20±7	11±4	45±12	2.4±0.9	280±88	46±20	3321±3799

Median Follow-up, months	13.3
Median Procedure time, min	75 (IQR 60-99)
Successful device implantation	99%
Device embolization/dislocation	0
Need for a second device	1
Median Length of stay, days	1 (IQR 1-1)
MACNE[1] at 30 days	0
Device or Procedure Related MACNE[1] (at any time	0
Shunt Patency through 12 months[2]	100%

RELIEVE-HF Roll-In Cohort Data (n=88)

KCCQ Score



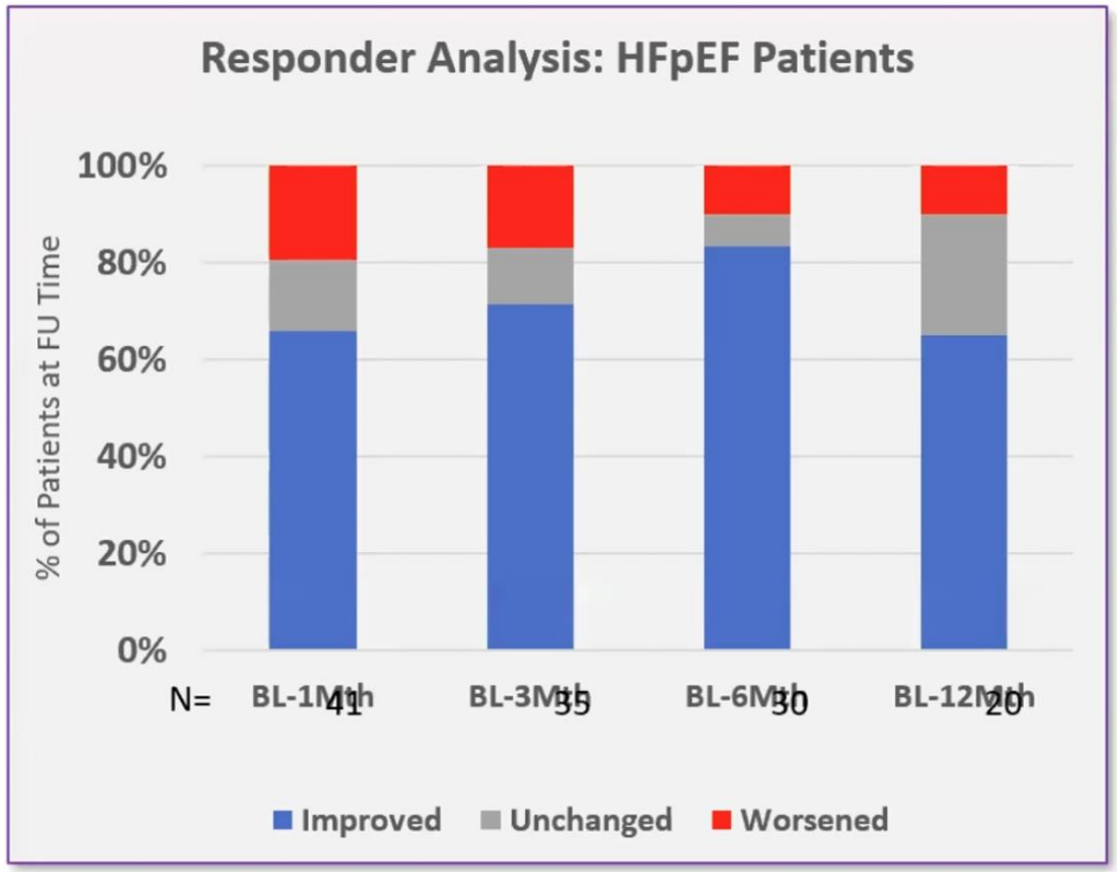


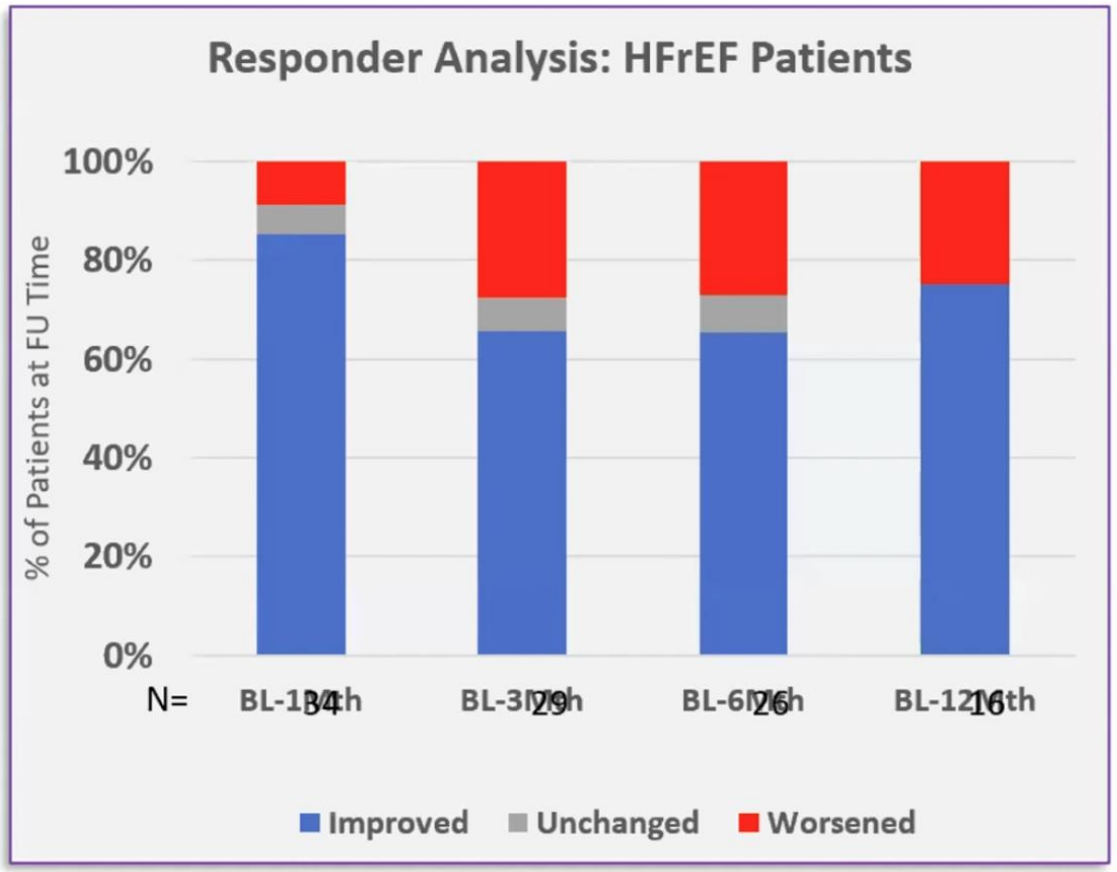
Improved or Worsened requires ≥5-point change from Baseline

V-Wave Unpublished Preliminary Data

RELIEVE-HF Roll-In Cohort Data (n=88)
KCCQ Score

65-80% of patients in both groups show significant improvement through 12 months



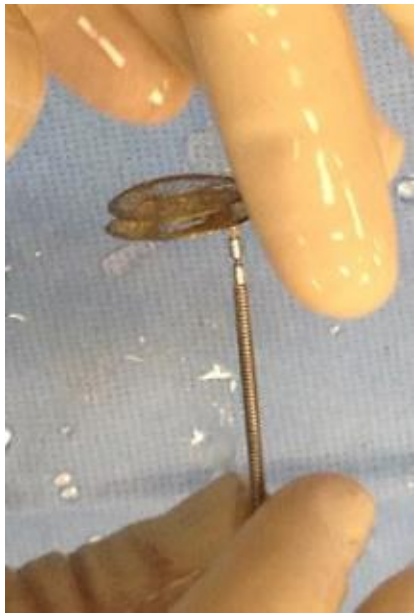


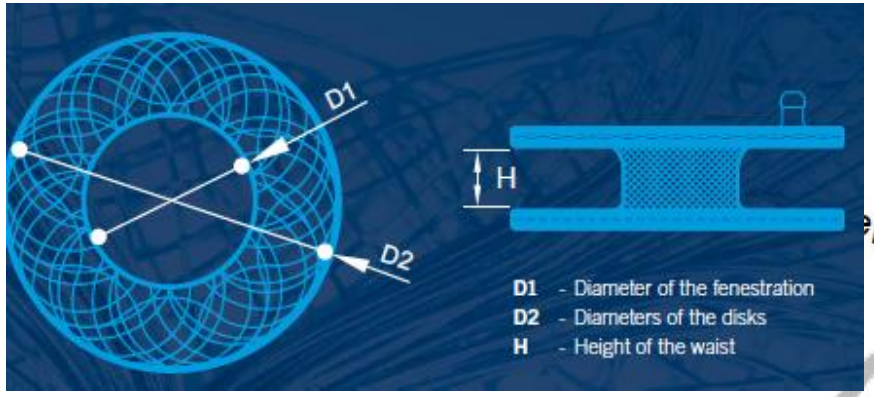
Improved or Worsened requires ≥5-point change from Baseline

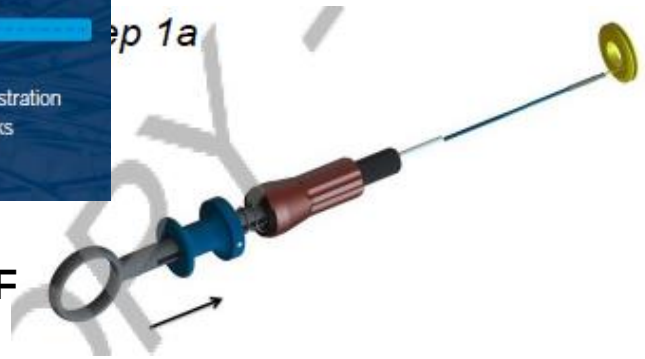
V-Wave Unpublished Preliminary Data

Atrial Flow Regulator (AFR®)

AFR: 4, 6, 8 y 10 mm con 2,5 y 10 mm de cintura

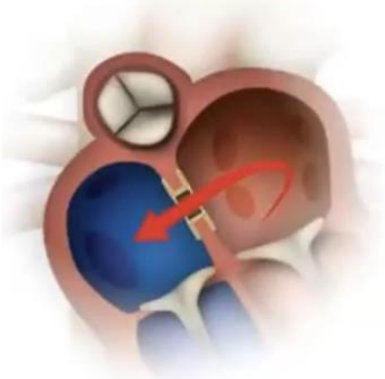






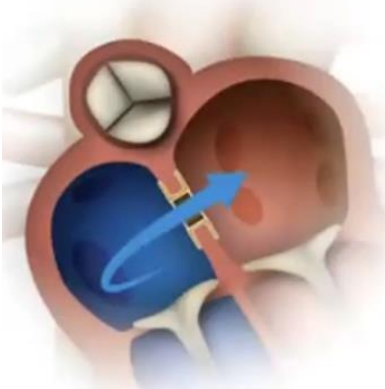
CE-marked for use in HFpEF & HFrEF
Safety & efficacy in PH

Left Heart Failure (HFpEF & HFrEF)[1]



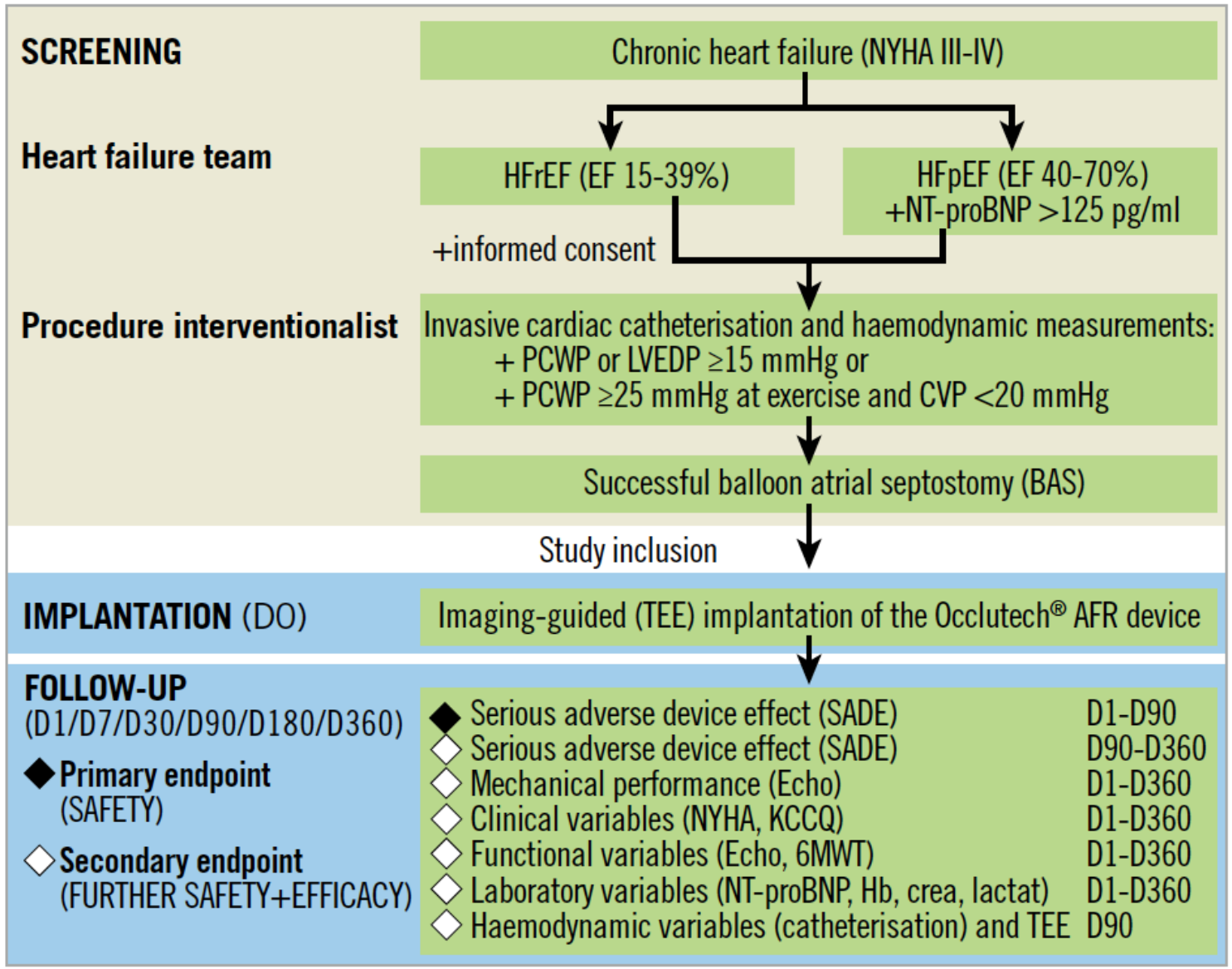
- Left to right shunt
  Decompression of LA
- Regression of PCWP/LAP
- Reduced pulmonary congestion
- Symptomatic improvements

Right Heart Failure (PAH)[1]



- Right to left shunt Right-sided decompression & LV filling
- Improves cardiac output
- Improved oxygen delivery to the body
- Symptomatic improvements

AFR-PRELIEVE Trial



- Objectives
  - Safety and tolerability of the AFR device by assessing the incidence of SADEs between 3- &12-months following implantation
  - Improvement in patient symptoms and of hemodynamic parameters at 3-, 6- & 12-months following implantation

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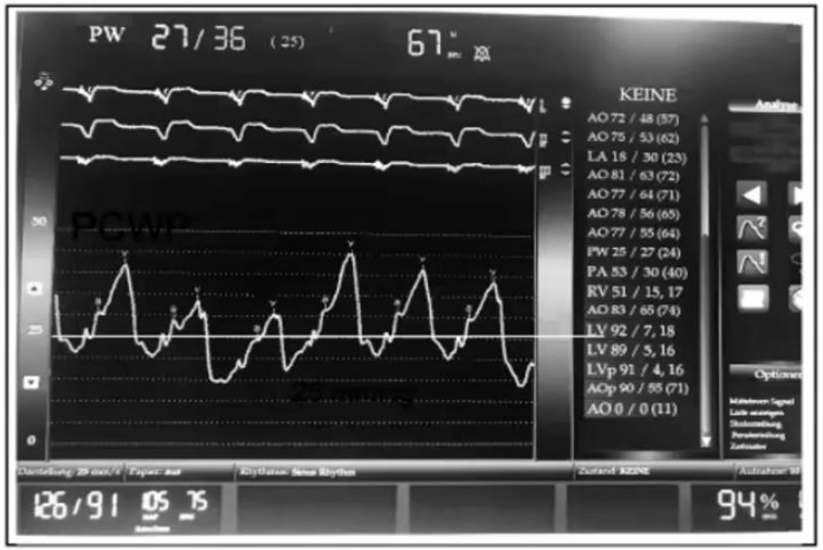
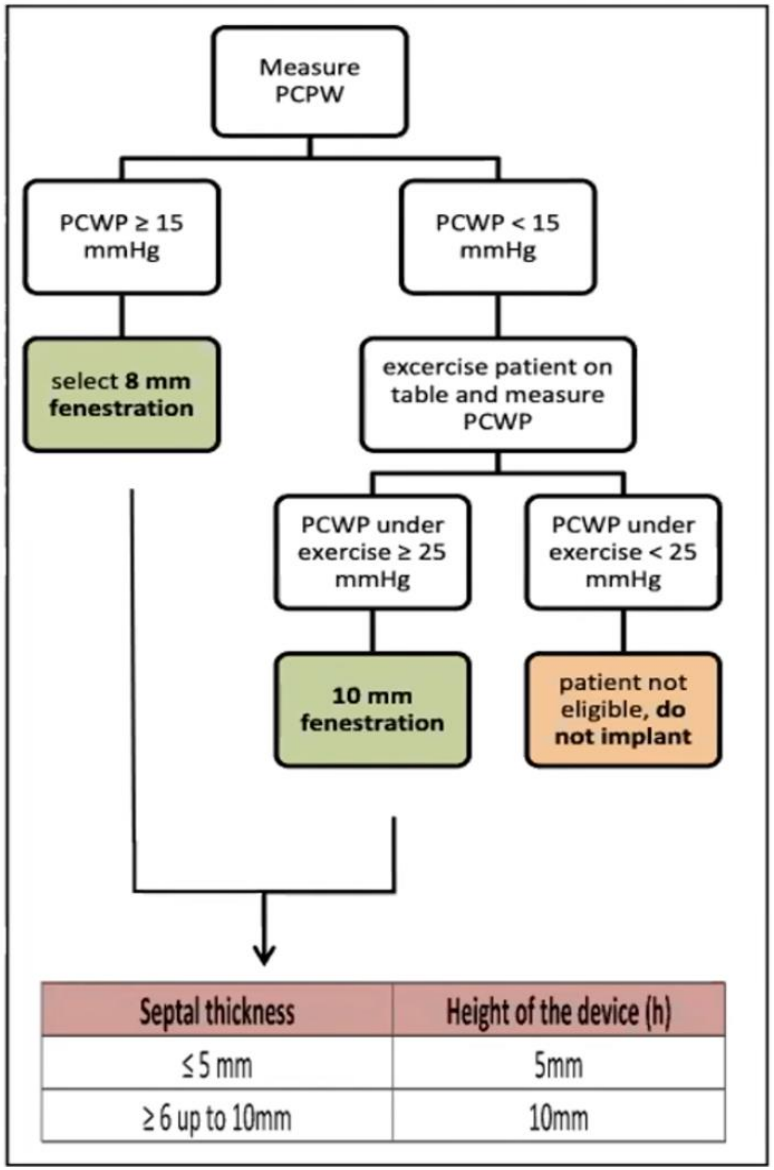
European Journal of Heart Failure (2021)
doi:10.1002/ejhf.2119

AFR-PRELIEVE Trial

PRELIEVE STUDY DEVICE SIZING



AFR device: fenestration
8 mm, height 5 mm



Septal thickness	Height of the device (h)
≤ 5 mm	5mm
≥ 6 up to 10mm	10mm

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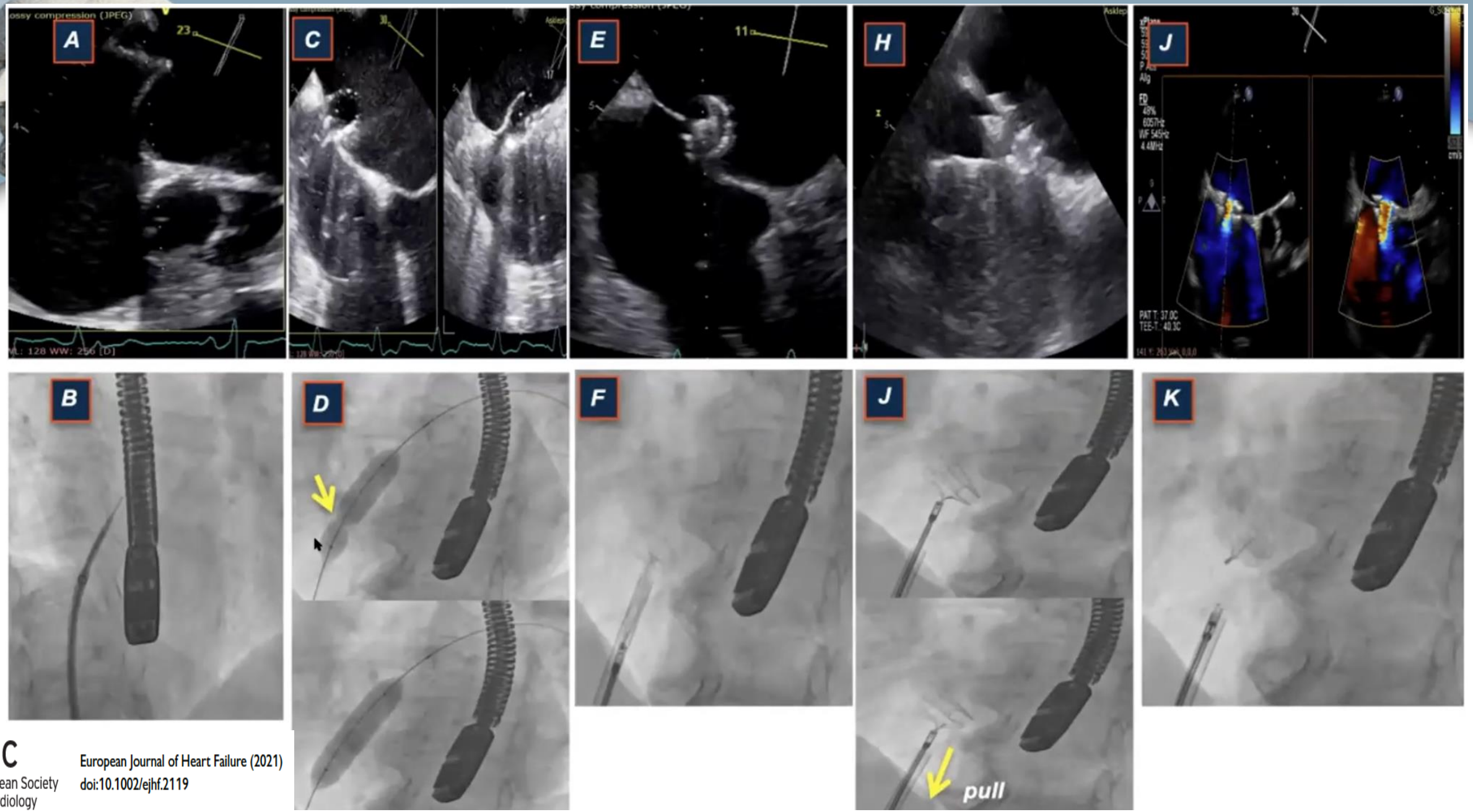

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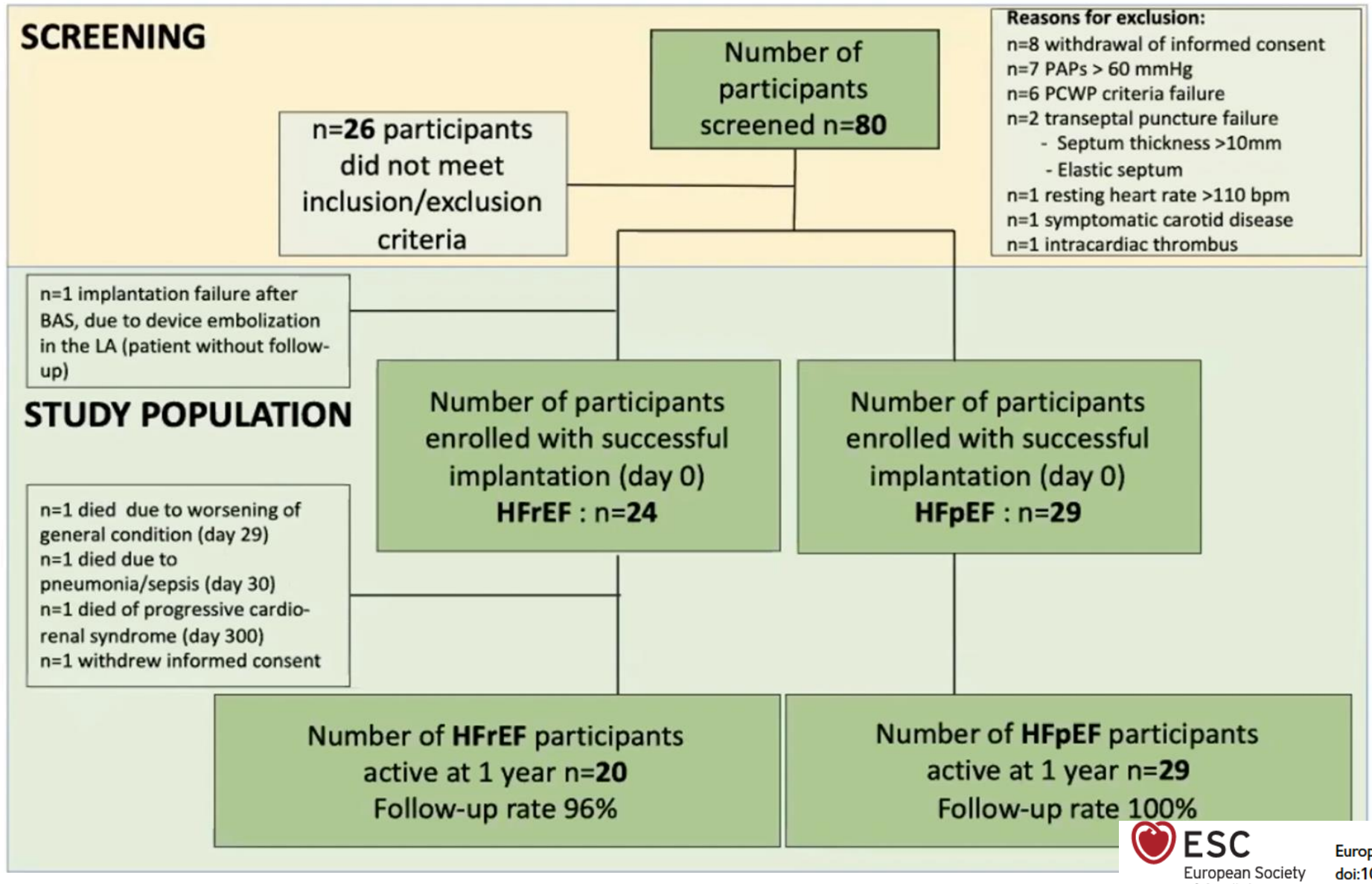
AFR-PRELIEVE Trial



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AFR-PRELIEVE Trial

	HFrEF (n=24)	HFpEF (n=29)
Demographics, mean ± SD		
Age, years	69.3 ±6.2	66.2 ±10.4
Gender male, n (%)	71%	48%
Cardiac status, mean ± SD		
NYHA class III, n (%)	92%	93%
NYHA class IV, n (%)	8%	7%
NT-proBNP, pg/ml	3025 ±4034	850.9 ±1434
6MWD, m	186 ±102	219 ±122
PAP, systolic, mmHg	29.2 ±14.6	37.6 ±12.3
Echocardiographic measurements		
LV-EF, %	31.2 ±7.1	51.1 ±6.3
Left atrial diameter, mm	44.1 ±8.3	43.9 ±7.1
Mitral valve E/E´, ratio	13.2 ±8.5	15.2 ±6.3
LVEDD, mm	61.7 ±8.1	51.7 ±7.3
TAPSE, cm	2.1 ±0.6	4.6 ±6.2

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AFR-PRELIEVE Trial

	HFrEF n=24	HFpEF n=29	Combined n=53
Implantation success, n (%)	100%	100%	100%
Device fenestration diameter			
8 mm, n (%)	79%	72%	75%
10 mm, n (%)	21%	28%	25%
Device waist height			
5 mm, n (%)	100%	90%	94%
10 mm, n (%)	0%	10%	6%
Procedural time in min, mean ± SD			
Balloon atrioseptostomy	13.5 ± 9.5	12.2 ± 11.5	12.7 ± 10.7
Device implantation	6.5 ± 5.2	9.3 ± 8.5	7.7 ± 7.5
Overall catherization	83.5 ± 21.9	81.9 ± 33.8	83.0 ± 29.0
Fluoroscopy	23.9 ± 7.7	18.8 ± 10.9	21.4 ± 9.7

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AFR-PRELIEVE Trial

Safety (12 months)

	Combined n=53
Device removal, n (%)	0
SADEs, n (%)	1 (2%)
Death, n (%)	3 (6%)
Stroke, n (%)	0
Myocardial infarction, n (%)	1 (2%)
Atrial fibrillation (new onset or worsening), n of patients with at least 1 event (%)	11 (20.3)
Renal function worsening or new impairment (no dialysis), n (%)	11 (20.7)
Hospitalizations	
For heart failure, total events	11
For heart failure, patients with at least 1 event (%)	6 (11.1)

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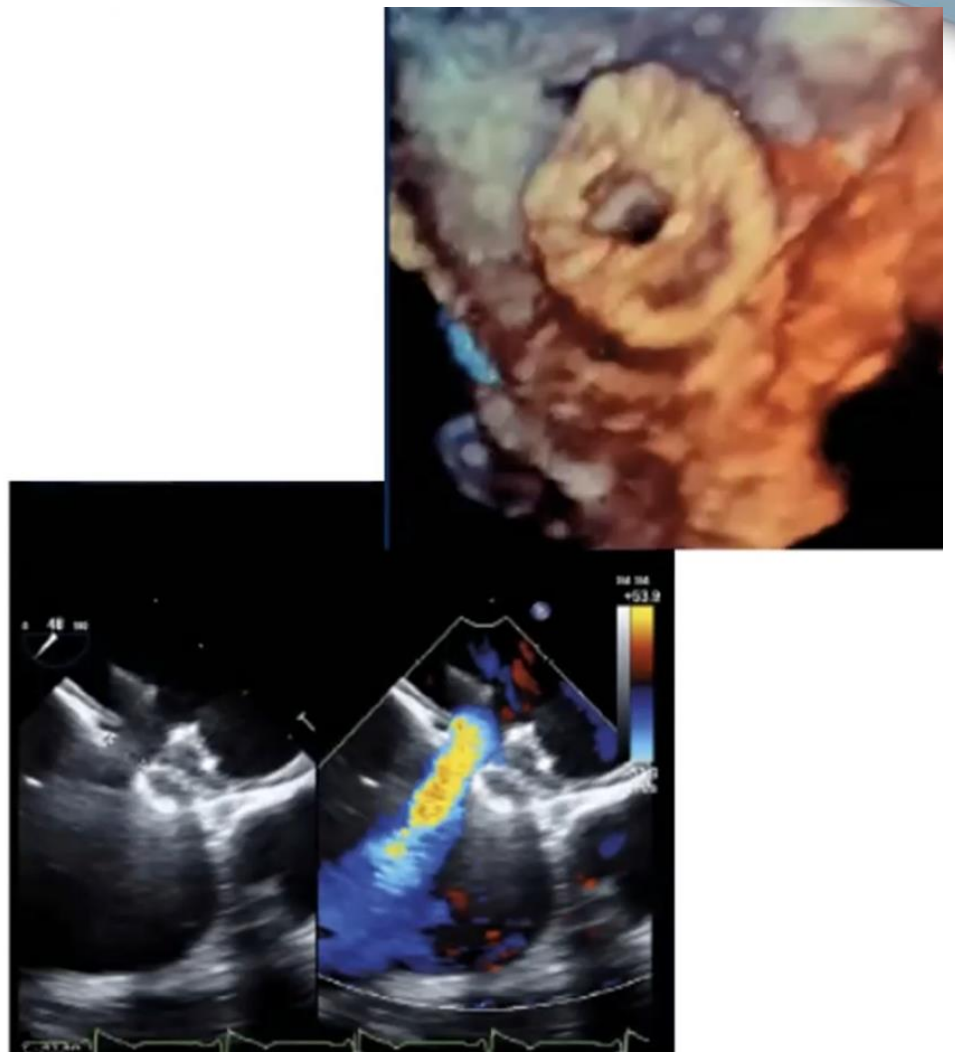
(1) patient with 2 documented SADE after the procedure with bleeding at the puncture site and loss of consciousness, which resolved without sequela

AFR-PRELIEVE Trial

Device patency (12 months)

	HFrEF n=24	HFpEF n=29	Combined n=53
Shunt Patency[1]			
Post-procedure	100%	100%	100%
3 months	88%	90%	89%
12 months	80%	90%	85%
Pulmonary-Systemic Flow Ratio[3]			
Qp/Qs (post procedure)	1.3±0.2	1.1±0.4	1.2±0.3
Qp/Qs (3 months)	1.3±0.2	1.2±0.1	1.2±0.2

n=3 patients died, 1 withdrew patient consent and 5 patient had inadequate TTE quality to assess patency



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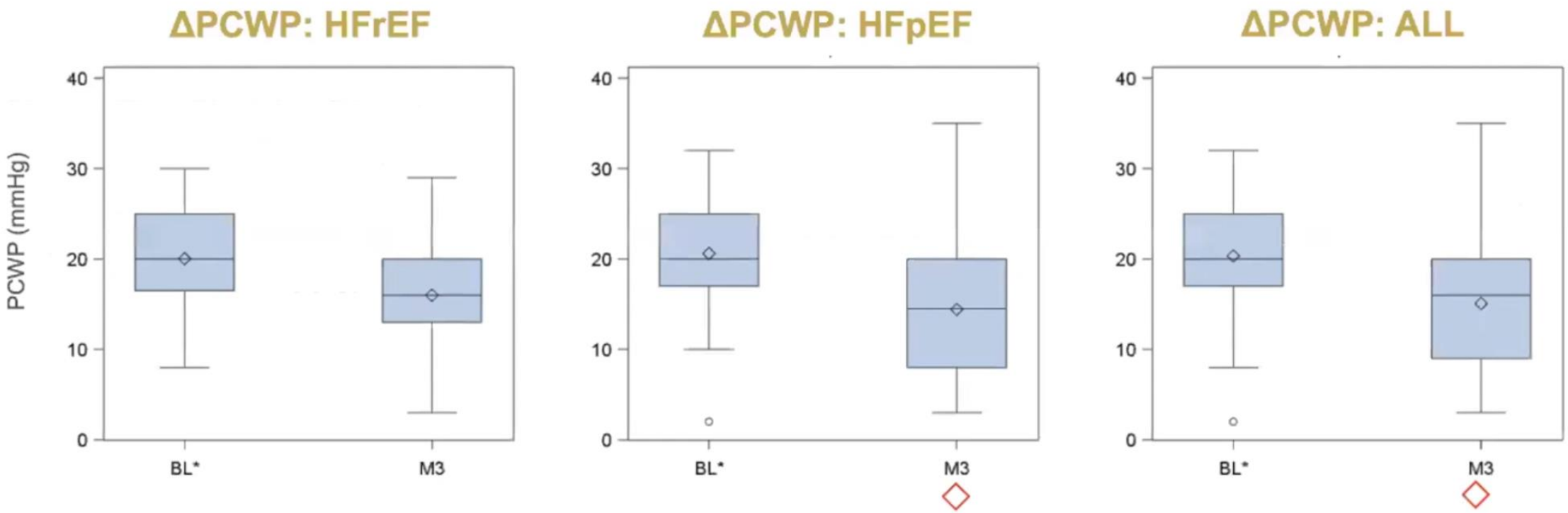
AFR-PRELIEVE Trial

	HFrEF			HFpEF		
	Baseline (n=24)	12 months (n=20)	Δ12 months vs. baseline (n=20)	Baseline (n=29)	12 months (n=29)	l Δ12 months vs. baseline (n=29)
Left Heart Measurements						
LA diameter (mm)	44 ±8.4	44.3 ±6.1	1.3 ±5.2	43.6 ±7.1	43.08 ±6.72	-0.5 ±5.7
LV enddiastolic diameter (mm)	61.7 ±8.1	61.4 ±9.2	0.33 ±9.3	51.7 ±7.3	51.8 ±9.9	-0.0 ±6.8
Mitral valve E/E´	13.2 ±8.5	9.6 ±5.1	-3.1 ±5.8[1] *(p<0.05)*	15.2 ±6.3	12.7 ±5.3	-2.40 ±5.2[1] *(p<0.05)*
MAPSE (cm)	2.2 ±2.5	1.9 ±1.9	-0.3 ±3.5	2.8 ±4.1	3.9 ±5.3	1.1±4.7
Ejection fraction (%)	31.2 ±7	39.6 ±13.8	7.9 ±14.4* *(p<0.05)*	51.1 ±6.3	49.9 ±10.3	-1.1 ±9
Right Heart Measurements						
PAP systolic (mmHg)	29.2 ±14.5	29.3 ±12.9	5.4 ±14.5	37.7 ±12.3	36.5 ±12.3	.3 ±13.3
TAPSE (cm)	2.1 ±0.6	2.2 ±0.4	0.03 ±0.4	4.6 ±6.2	5.4 ±7.6	0.7 ±7.1
Ratio RV/LV size (mm)	0.6 ±0.1	0.6 ±0.2	0.04 ±0.2	0.6 ±0.2	0.7 ±0.1	0.09 ±0.1[1] *(p<0.05)*
RV enddiastolic diameter long axis (mm)	35.7 ±8	38.6 ±8.7	2.6±7.2	30.7 ±9.9	34.5 ±8	4.2 ±8.5[1] *(p<0.05)*
RV enddiastolic diameter short axis (mm)	31.9 ±6.6	36.5 ±9.4	2.7 ±4.5	30.8 ±7.2	34.6 ±8.7	2.8 ±9.4

AFR-PRELIEVE Trial

PCWP (3 months)



◇ *p<0.0005*
**baseline measurements taken on day of procedure*

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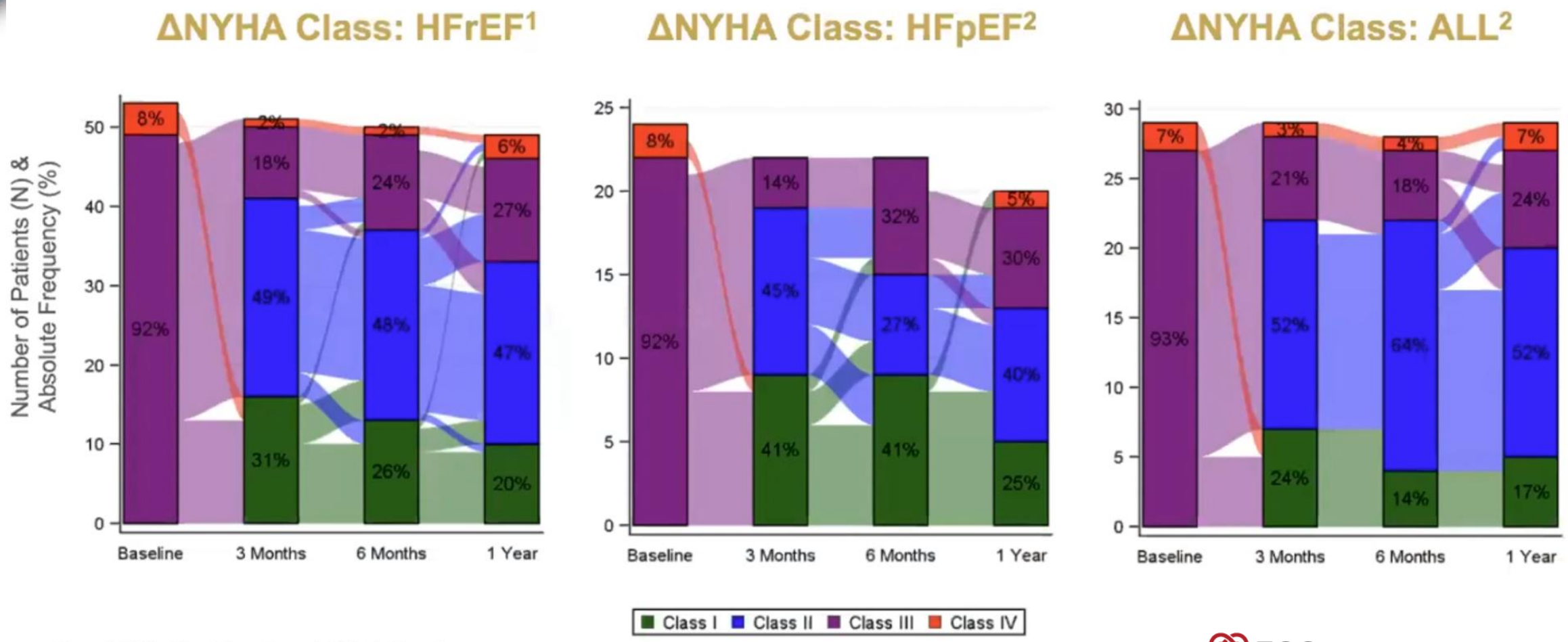
AFR-PRELIEVE Trial

NYHA (12 months)



(1) p<0.0001 at 3 and 6 months; p=0.0012 at 12 months
(2) p<0.0001 at 3, 6 and 12 months

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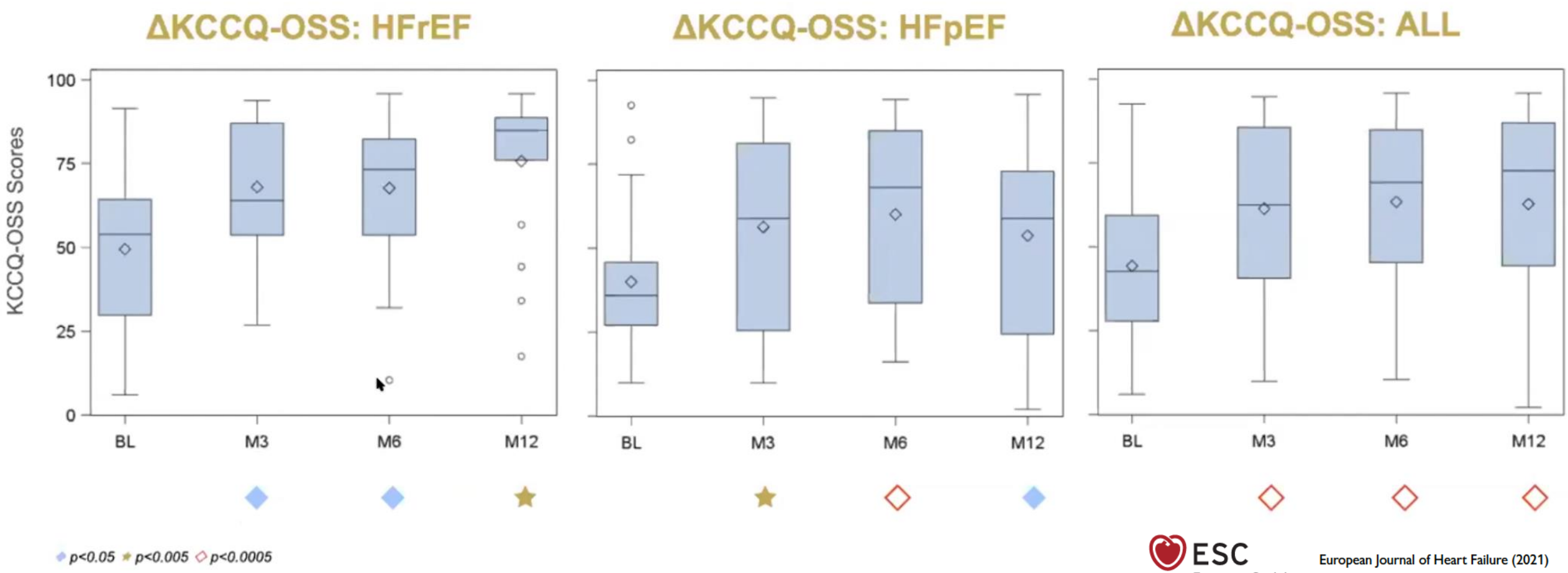
AFR-PRELIEVE Trial

KCCQ-OSS (12 months)



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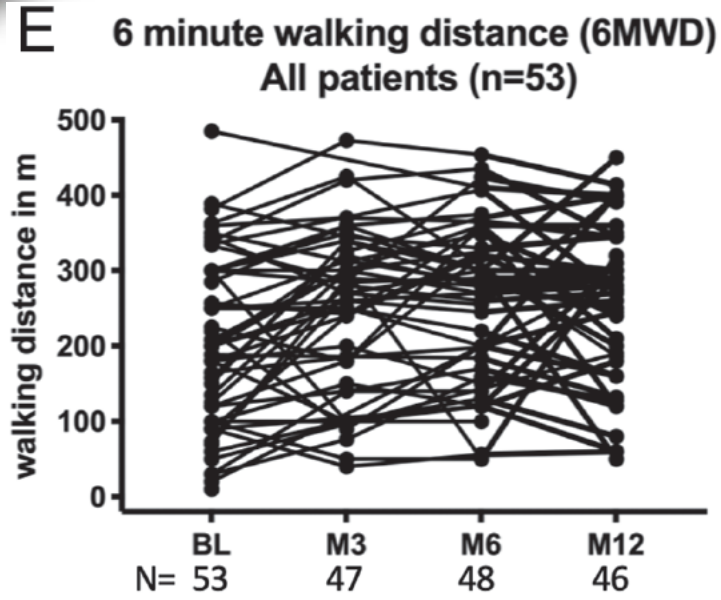
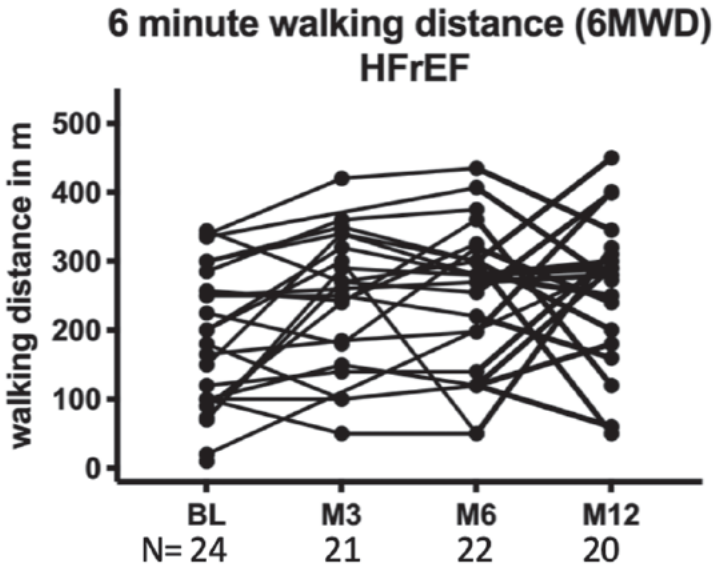
AFR-PRELIEVE Trial

6MWD (12 months)

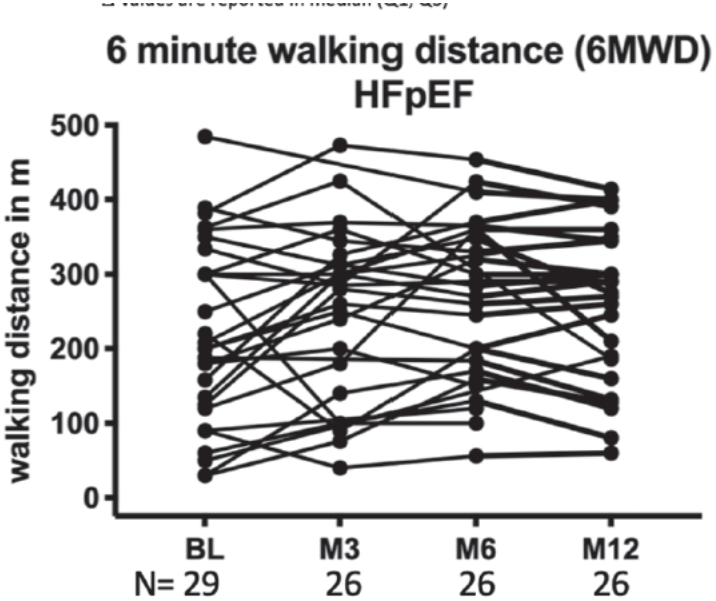
E



Patient level Δ 6MWD (m)
M3–BL: Δ 50 (−14, 92), p 0.0016*
M6–BL: Δ 20 (−20, 96), p 0.0030*
M12–BL: Δ 50 (−33, 113), p 0.0198*



Patient level Δ 6MWD (m)
M3–BL: Δ 40 (−7, 110), p 0.0155*
M6–BL: Δ 27 (−8, 95), p 0.0035*
M12–BL: Δ 60 (−3, 134), p 0.0494*



Patient level Δ 6MWD (m)
M3–BL: Δ 55 (−21, 91), p 0.0416*
M6–BL: Δ 5 (−25, 132), p 0.0425*
M12–BL: Δ 28 (−41, 103), p 0.18

Graphics depict individual patient measurements during follow-up
Δ values are reported in median (Q1, Q3)

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AFR-PRELIEVE Trial

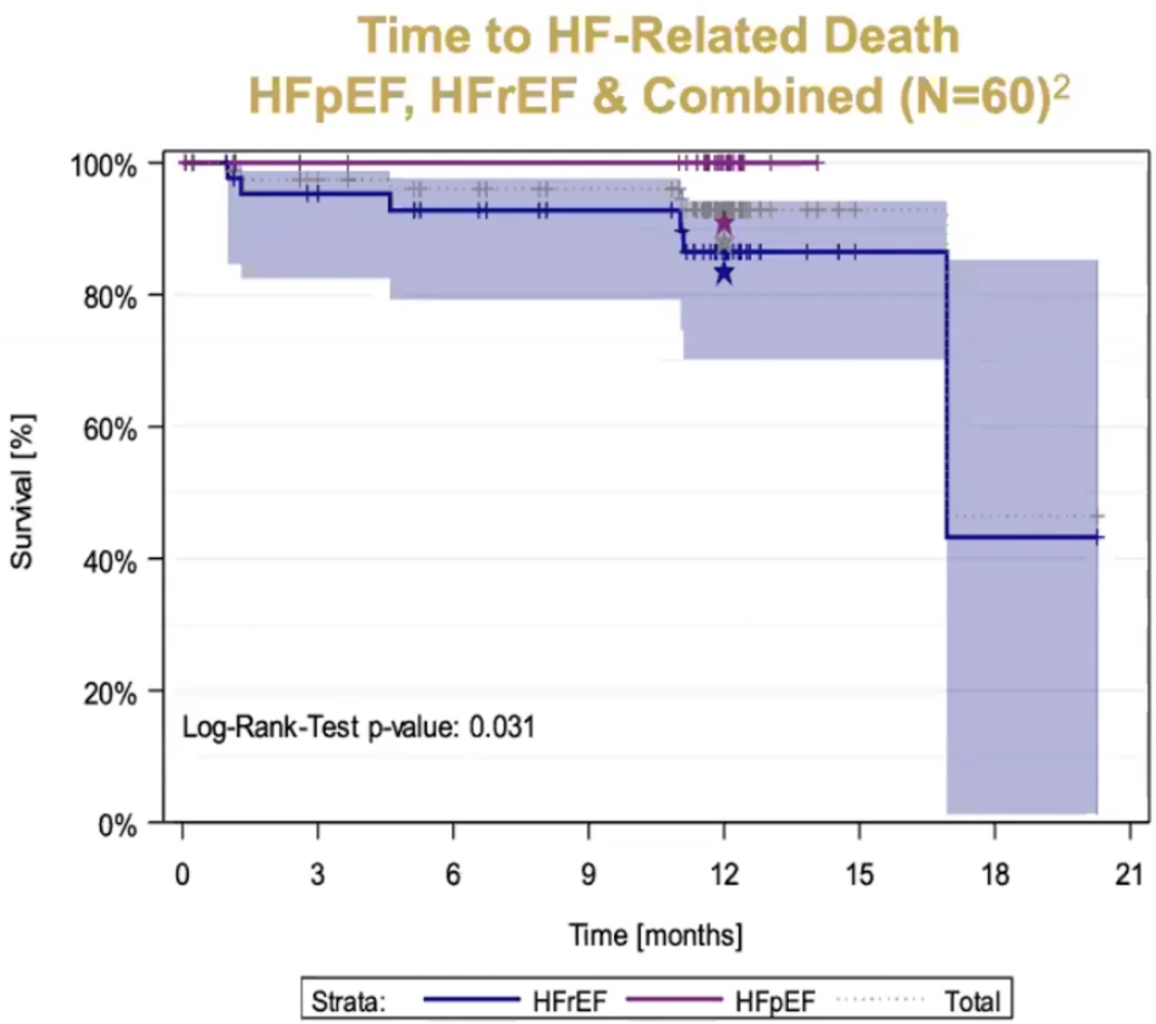
Observed vs Predicted Mortality Rates (AFR patients)

- **All patients (HFrEF & HFpEF):**
  - Predicted mortality: 12.2/100 patient years
  - Observed: 5.7/100 patient year

  -> 53.3% lower rate ($p<0.05$)
- **HFpEF cohort:**
  - predicted mortality: 9.3/100 patient years
  - Observed: 0/100 patient years
- **HFrEF cohort:**
  - predicted mortality: 16.8/100 patient years
  - observed: 10.8/100 patient year

  -> 35.7% lower rate ($p>0.05$)

Median follow-up duration: 353 days



THE PRELIEVE STUDY FLOW CHART

SCREENING
n=80

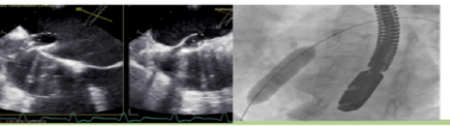
chronic heart failure (NYHA III-IV)

HFrEF (EF 15-39%)

HFpEF (EF ≥ 40%)
+ NT-proBNP > 125 pg/ml

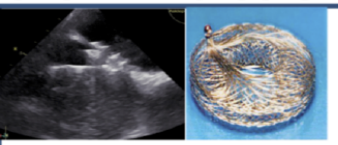
+ informed consent

Invasive cardiac catherization and hemodynamic measurements:
+ PCWD ≥ 15mmHg or
+ PCWP ≥ 25mmHg at exercise and CVP < 20 mmHg



balloon atrioseptostomy

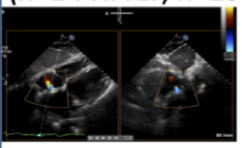
STUDY INCLUSION n=54



SUCCESSFUL IMPLANTATION OF THE AFR DEVICE n=53/54

◆ **Primary endpoint** ✧ **Secondary endpoint**

ONE-YEAR FOLLOW-UP
n=53
(n=24 HFrEF, n=29 HFpEF)



- ◆ Serious adverse device effect (SADE) up to 3 months
- ✧ Serious adverse device effect (SADE) up to 12 months
- ✧ Hemodynamic variables with right heart catherization at 3 months
- ✧ Patency
- ✧ Clinical variables (NYHA, KCCQ, 6MWD)
- ✧ Laboratory variables (NT-proBNP concentration)
- ✧ Echocardiographic measurements

Reasons for screening failure (n=26):

- *n=8 withdrawal of informed consent*
- *n=7 PAPs > 60 mmHg*
- *n=6 PCWP criteria failure*
- *n=2 transseptal puncture failure*
  - *septum thickness >10mm*
  - *elastic septum*
- *n=1 resting heart rate >110 bpm*
- *n=1 symptomatic carotid disease*
- *n=1 intracardiac thrombus*

Results in Summary:

- Implantation of the AFR device was **feasible** **in 98% of the included patients**
- During one-year follow-up:
  - **No shunt occlusions** (92% patients with sufficient echo quality)
  - **No strokes**
  - **No worsening of right heart function**
- Three-month **PCWP reduction** ↓ and **improvement** ↑ **in functional NYHA class, quality of life and exercise capacity** at one-year follow-up suggest potential clinical efficacy

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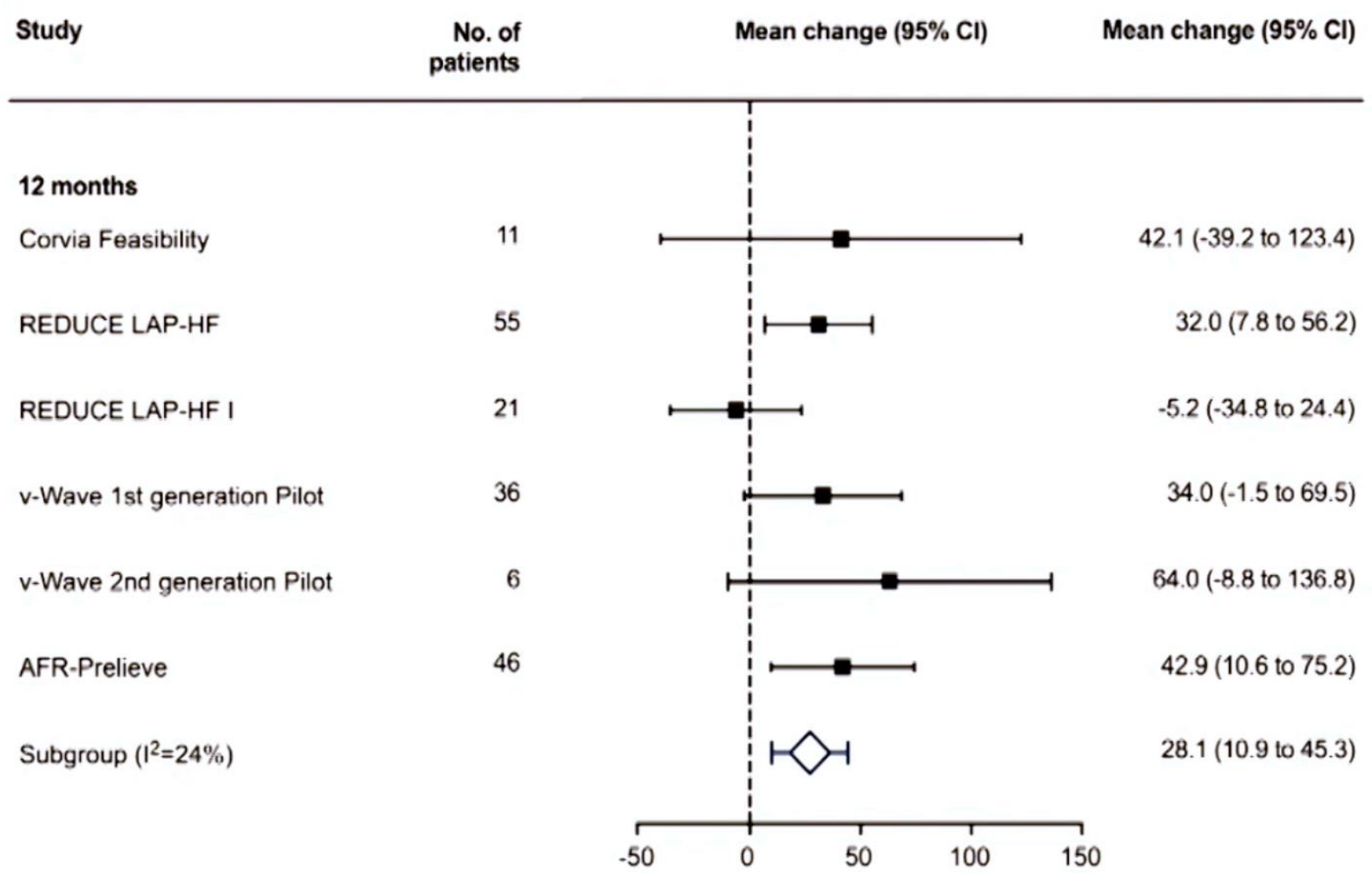
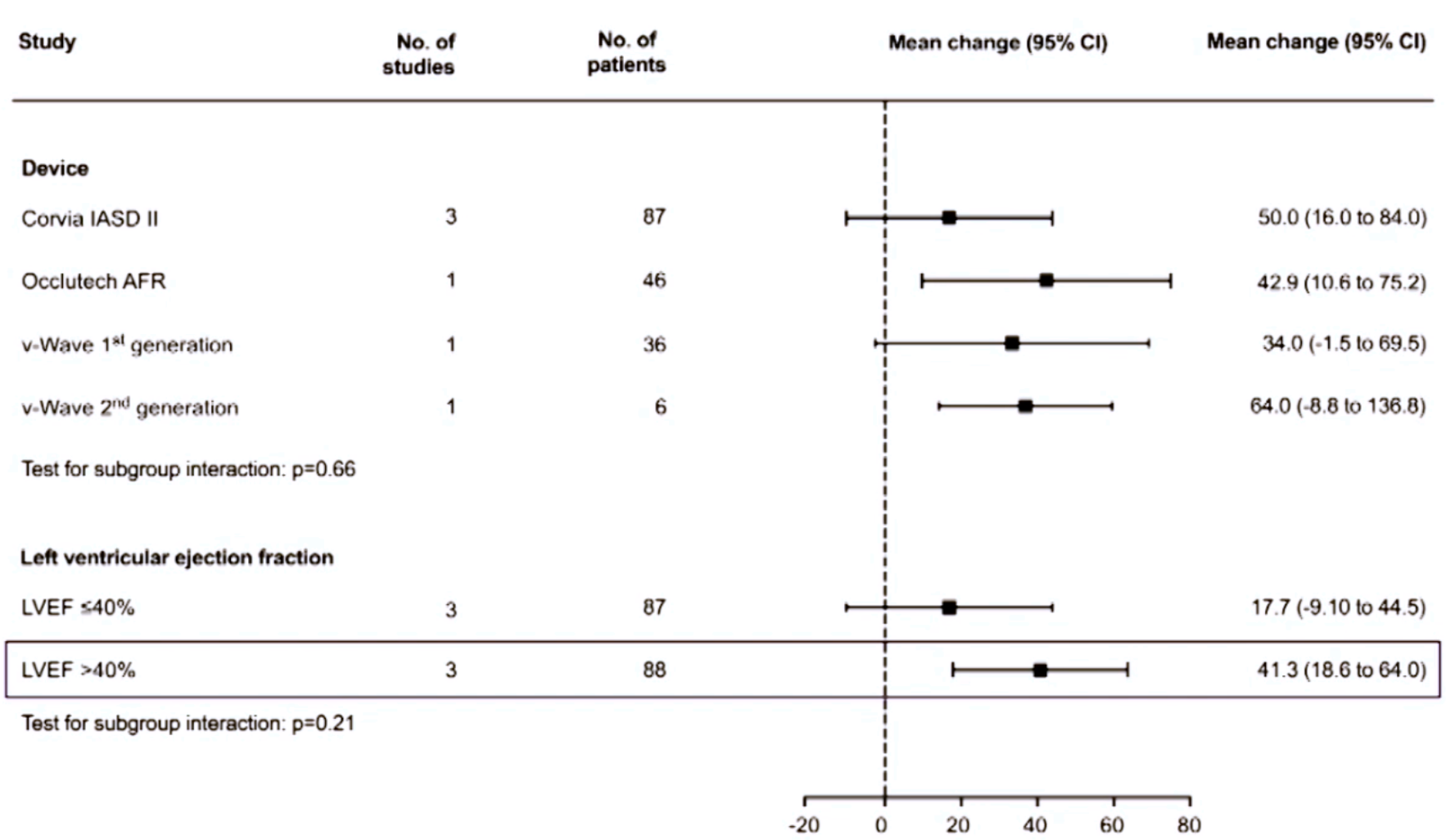
Change in 6-MWD



Lauder L, Da Costa BR, et al. Unpublished

Change in 6-MWD



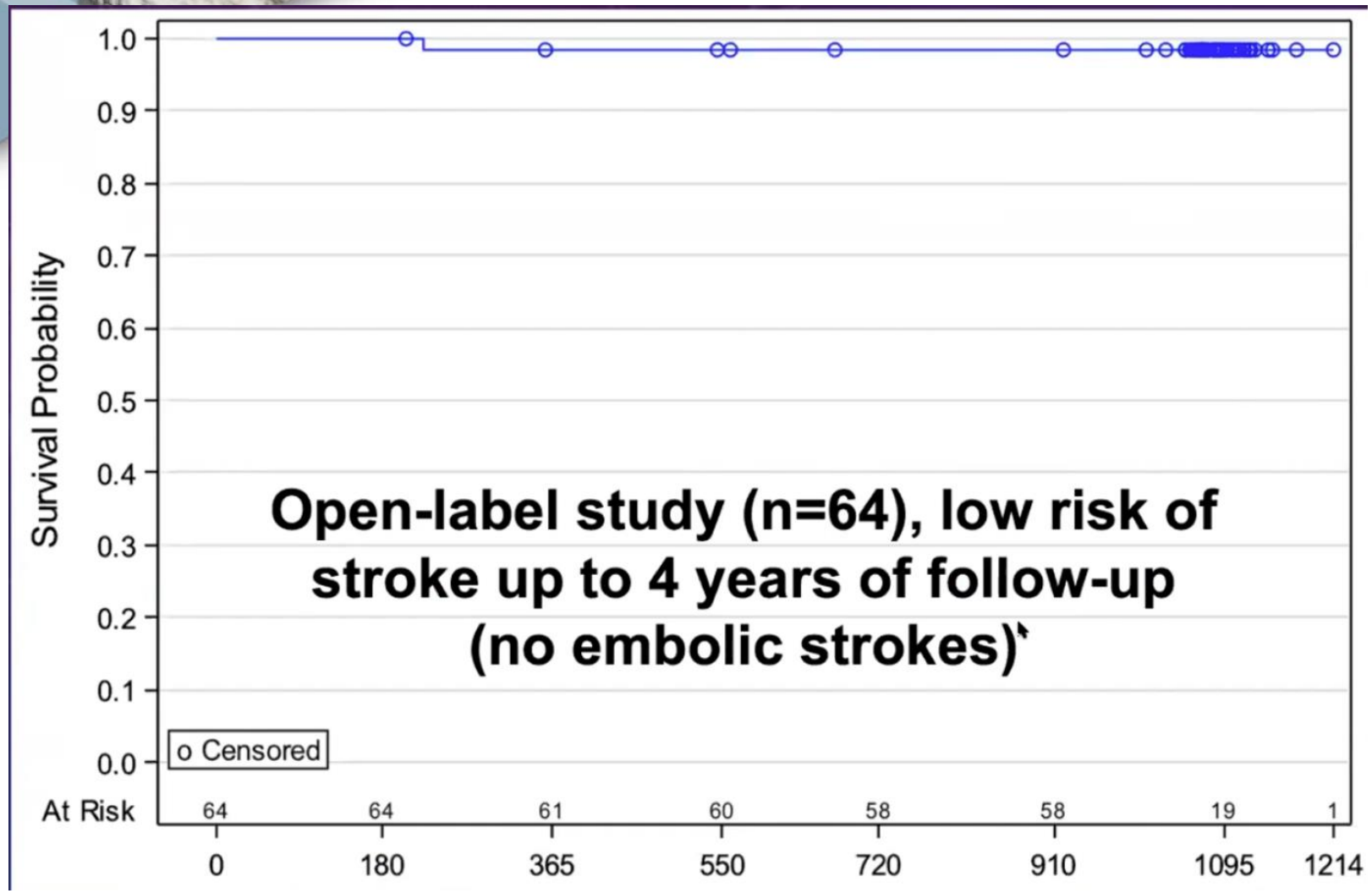
Lauder L, Da Costa BR, et al. Unpublished

Secondary endpoint

Outcome	No. of patients	Mean change at 12 months (95% CI)
Cardiac status		
NT-proBNP, pg/mL	102	-56.5 (-199.7 to 86.7)
NYHA class	182	-0.6 (-1.0 to -0.3)
Standardized QoL	146	**17.7 (10.8 to 24.6)**

Lauder L, Da Costa BR, et al. Unpublished

Risk of stroke ?



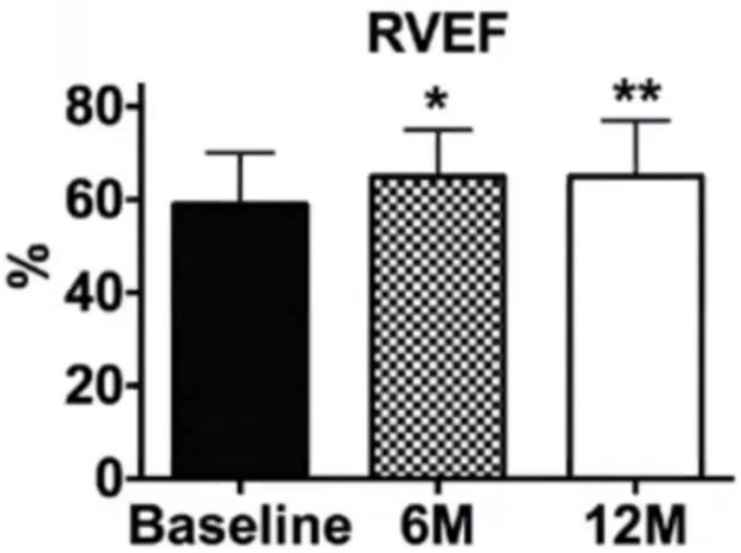
Anticoagulation:

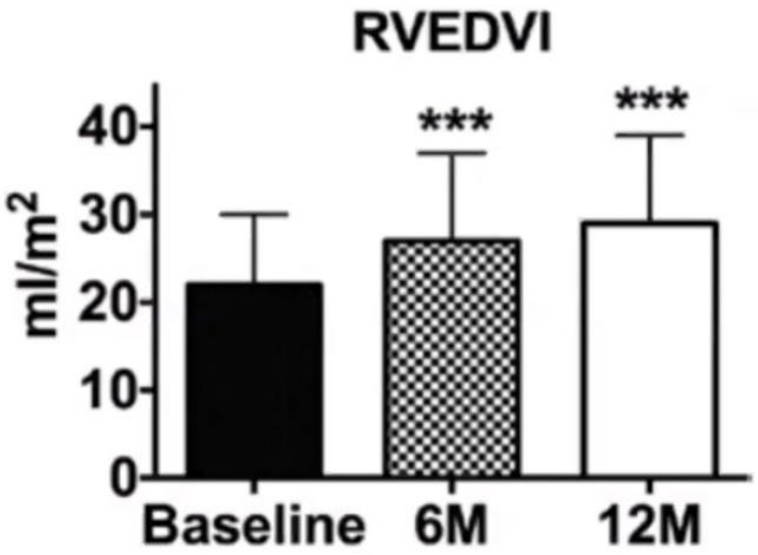
- All get ASA 81 mg po qd indefinitely
- If on anticoagulation (e.g., DOAC, warfarin, clopidogrel) continue for at least 6 months
- If not on anticoag, Rx with clopidogrel x 6 mo.

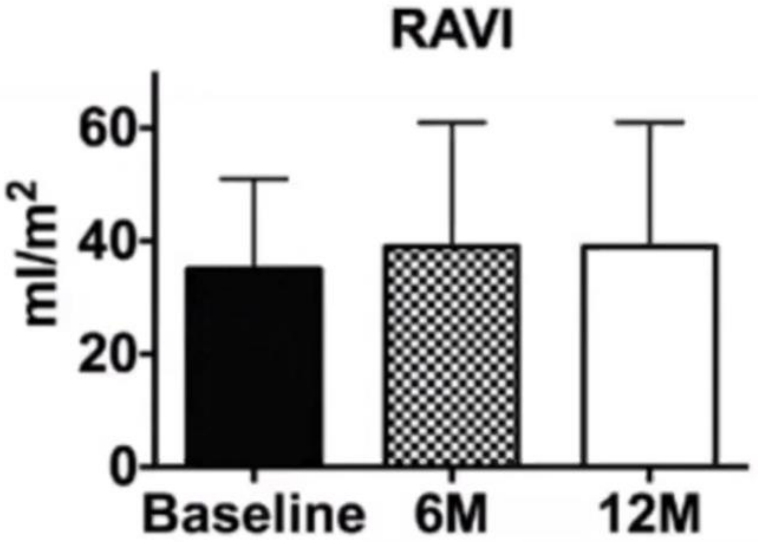
Hasenfub G et al. Lancet 2016

Risk of RV failure ?

No change in RV parameters between 6 and 12 months

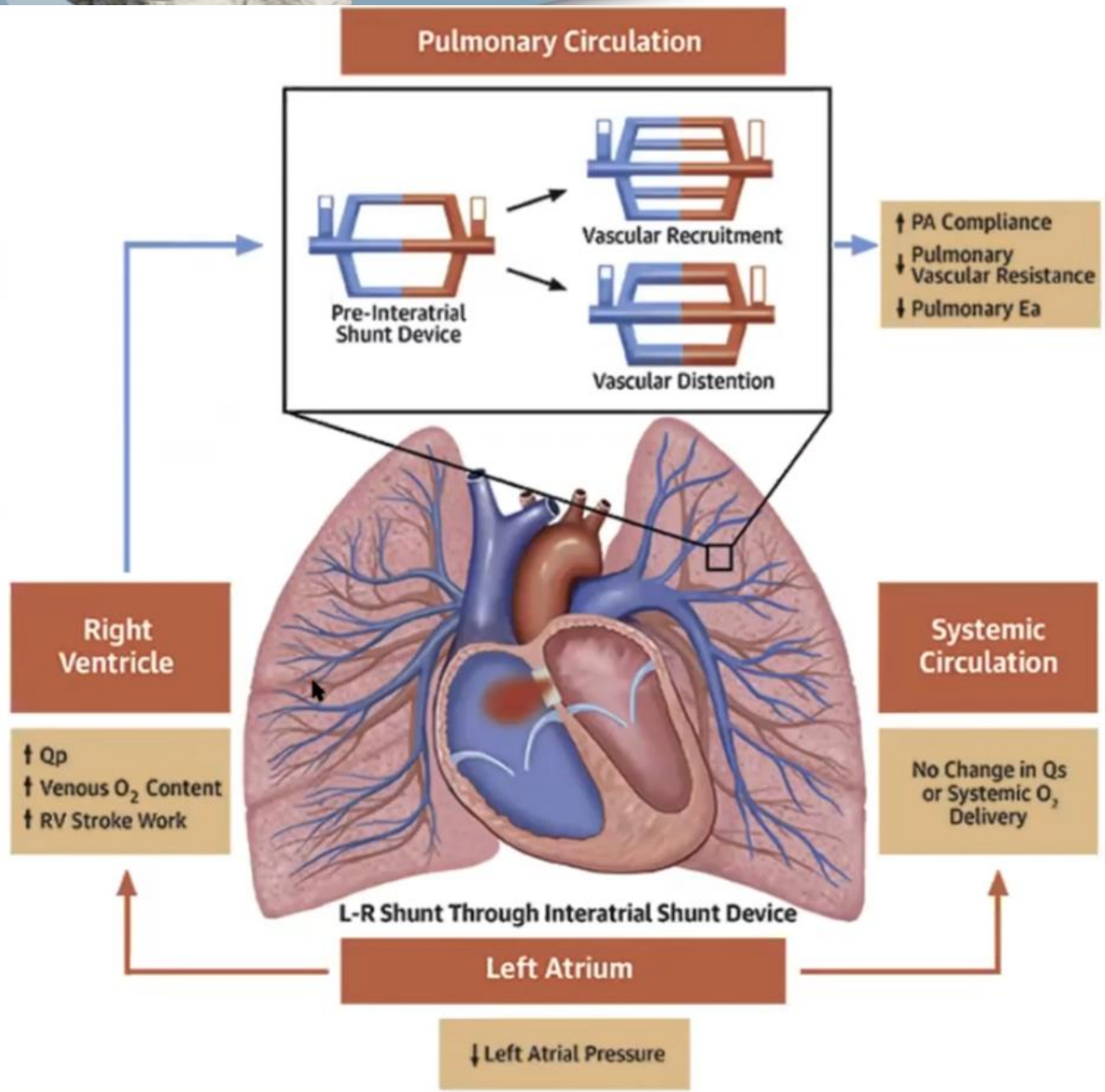






Feldman et al. Circulation. 2018;137:364–375

Risk of RV failure ?



Atrial Shunt device

- ↓ *PCWP*
- ↓ *Augmentation of PA systolic pres*
- ↑ *O2 delivery to pulmonary vasculature*
- ↑ *Flow to pulmonary vasculature*
- ↑ *Pulmonary vascular recruitment*

Obokata et al. JACC 2019

How big ?

Basic Science and Experimental Studies

Effects of an Interatrial Shunt on Rest and Exercise Hemodynamics: Results of a Computer Simulation in Heart Failure

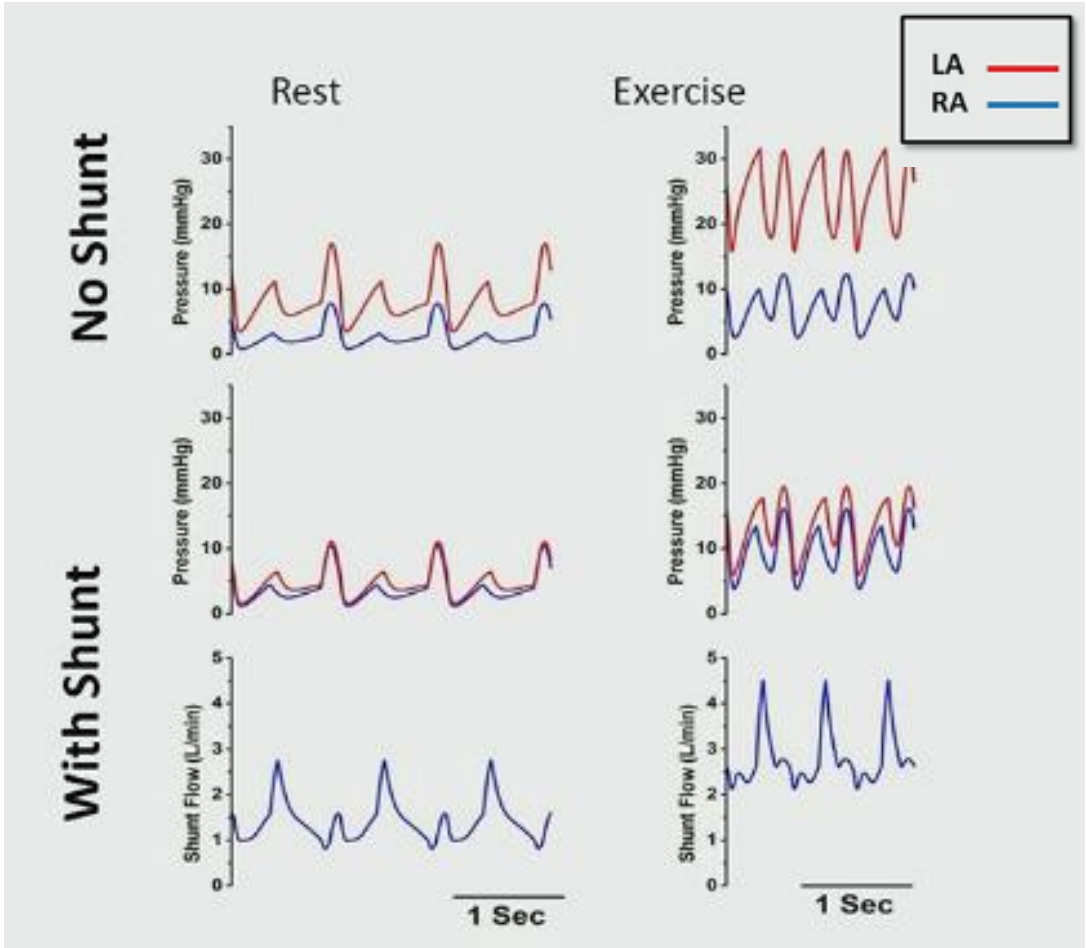
DAVID KAYE, MD, PhD,[1] SANJIV J. SHAH, MD,[2] BARRY A. BORLAUG, MD,[3] FINN GUSTAFSSON, MD,[4] JAN KOMTEBEDDE, DVM,[5] SPENCER KUBO, MD,[6] CHRIS MAGNIN,[5] MATHEW S. MAURER, MD,[7] TED FELDMAN, MD,[8] AND DANIEL BURKHOFF, MD, PhD[7]

ABSTRACT

Background: A treatment based on an interatrial shunt device has been proposed for counteracting elevated pulmonary capillary wedge pressure (PCWP) in patients with heart failure and mildly reduced or preserved ejection fraction (HFpEF). We tested the theoretical hemodynamic effects of this approach with the use of a previously validated cardiovascular simulation.

Methods and Results: Rest and exercise hemodynamics data from 2 previous independent studies of patients with HFpEF were simulated. The theoretical effects of a shunt between the right and left atria (diameter up to 12 mm) were determined. The interatrial shunt lowered PCWP by ~3 mm Hg under simulated resting conditions (from 10 to 7 mm Hg) and by ~11 mm Hg under simulated peak exercise conditions (from 28 to 17 mm Hg). Left ventricular cardiac output decreased ~0.5 L/min at rest and ~1.3 L/min at peak exercise, with corresponding increases in right ventricular cardiac output. However, because of the reductions in PCWP, right atrial and pulmonary artery pressures did not increase. A majority of these effects were achieved with a shunt diameter of 8–9 mm. The direction of flow though the shunt was left to right in all of the conditions tested.

Conclusions: The interatrial shunt reduced left-sided cardiac output with a marked reduction in PCWP. This approach may reduce the propensity for heart failure exacerbations and allow patients to exercise longer, thus attaining higher heart rates and cardiac outputs with the shunt compared with no shunt. These results support clinical investigation of this approach and point out key factors necessary to evaluate its safety and hemodynamic effectiveness. (*J Cardiac Fail 2014;20:212–221*)



How big ?

Ideal hemodynamics after AFR®

Pulmonary Hypertension

RA pressure < 15 mmHg

LA pressure < 15 mmHg

Systemic saturation > 85%

Qp:Qs ratio > 0.75

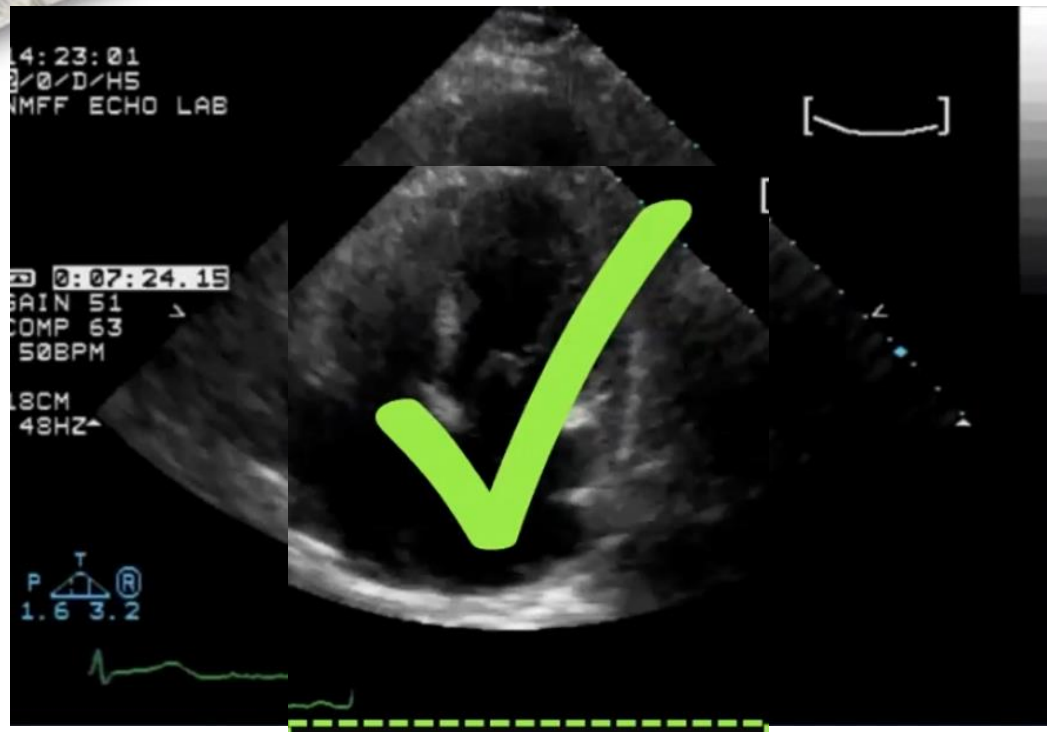
HFpEF

AFR size (mm)	Pre-procedure LAP (mmHg)	Pre-procedure Qp:Qs (%)	Post-procedure LAP (mmHg)	Post-procedure Qp:Qs (%)	Δ in LAP (mmHg)
	20		18	109	2
4	25	95	23	110	2
	30		28	111	2
	20		17	128	3
6	25	95	21	131	4
	30		25	133	5
	20		14	150	6
8	25	95	18	156	7
	30		22	161	8
	20		13	175	7
10	25	95	16	183	9
	30		20	190	10

Initial experience and Computer simulation suggests AFR 6-10 mm can reduce RAP, with increase CO without dropping Qp/Qs below 0.75 & saturation above 85%

Safe ASD size is crucial – 8 mm = Qp/Qs 1.3:1

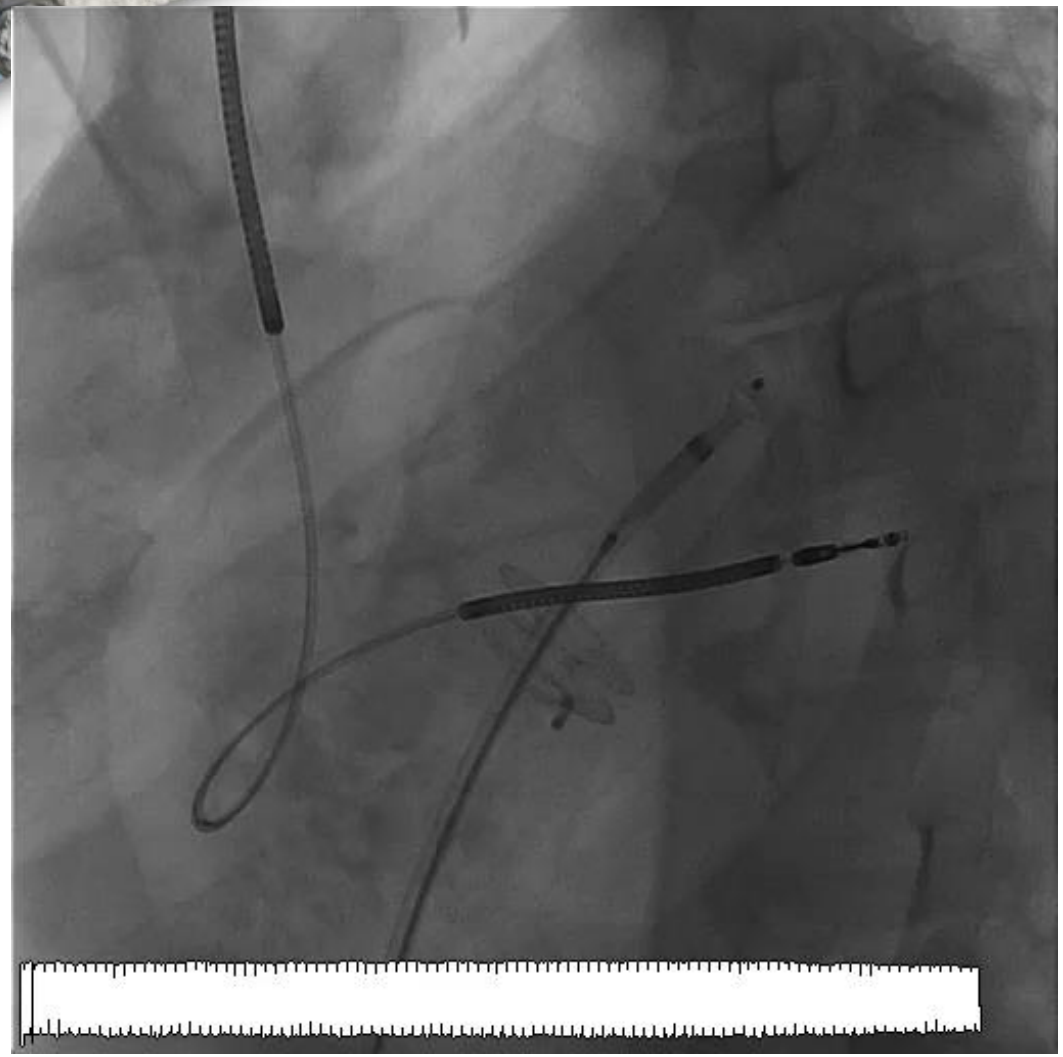
Selection of patients

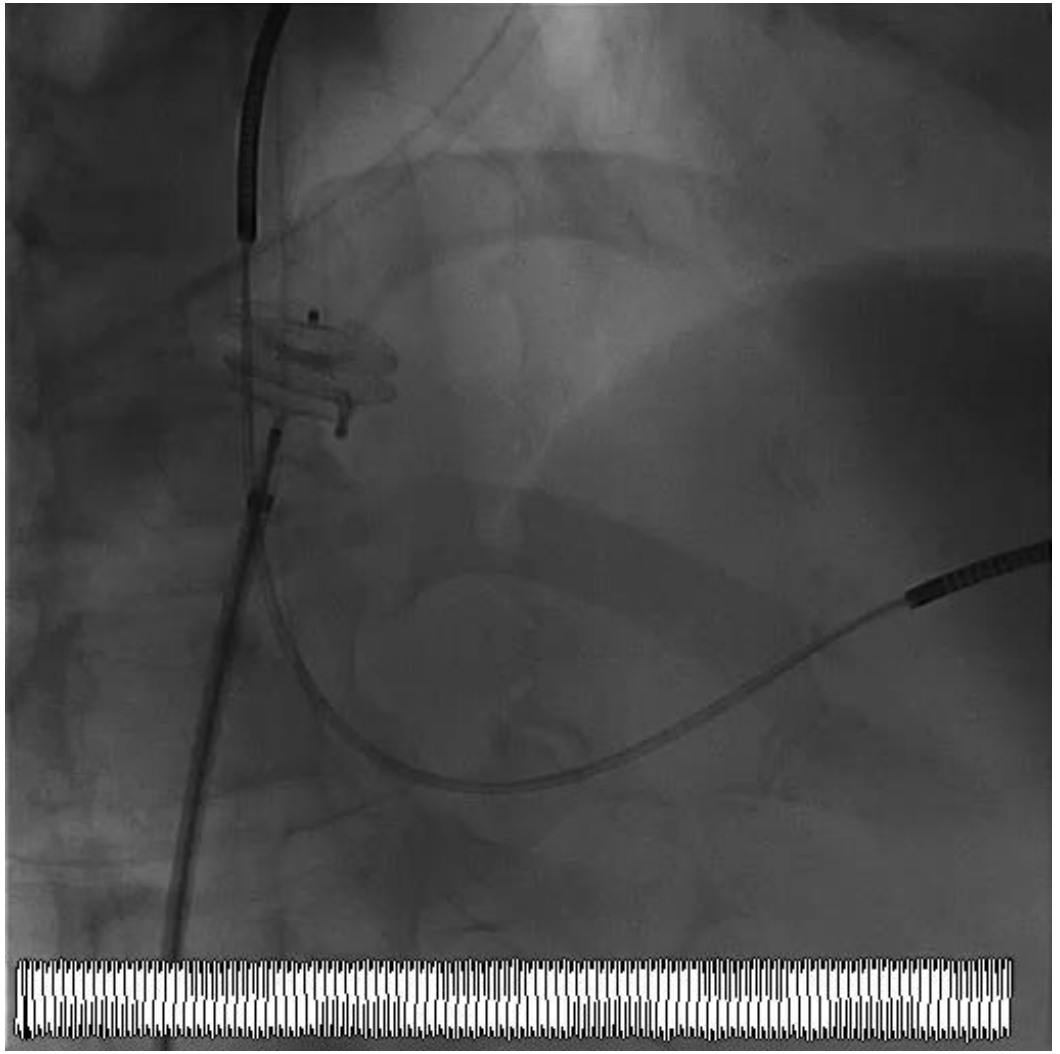


RAP: 8 mmHg
PCWP: 29 mmHg
CI: 3.4 L/min/m²
PVR: 1.8 WU

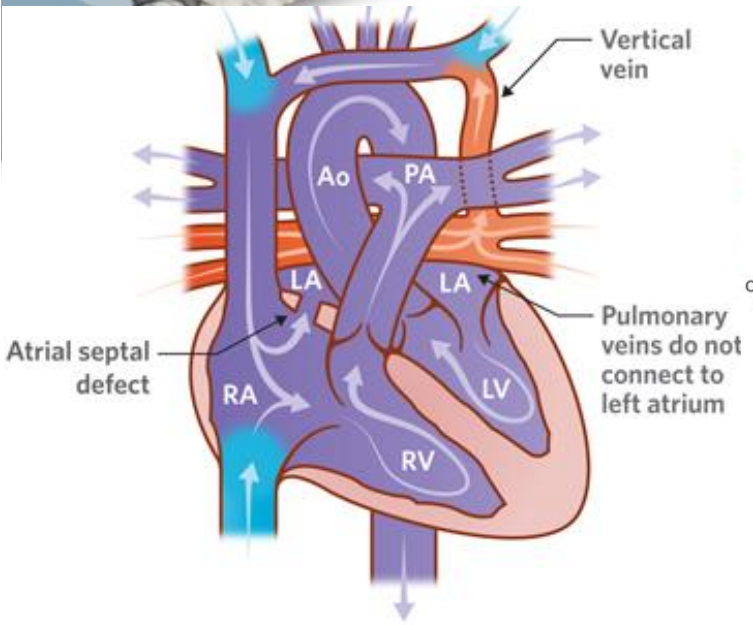
RAP: 24 mmHg
PCWP: 28 mmHg
CI: 2.1 L/min/m²
PVR: 3.8 WU

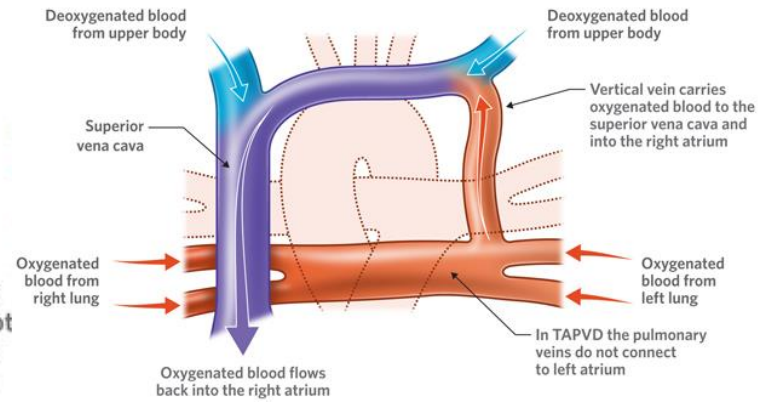
Easily to close

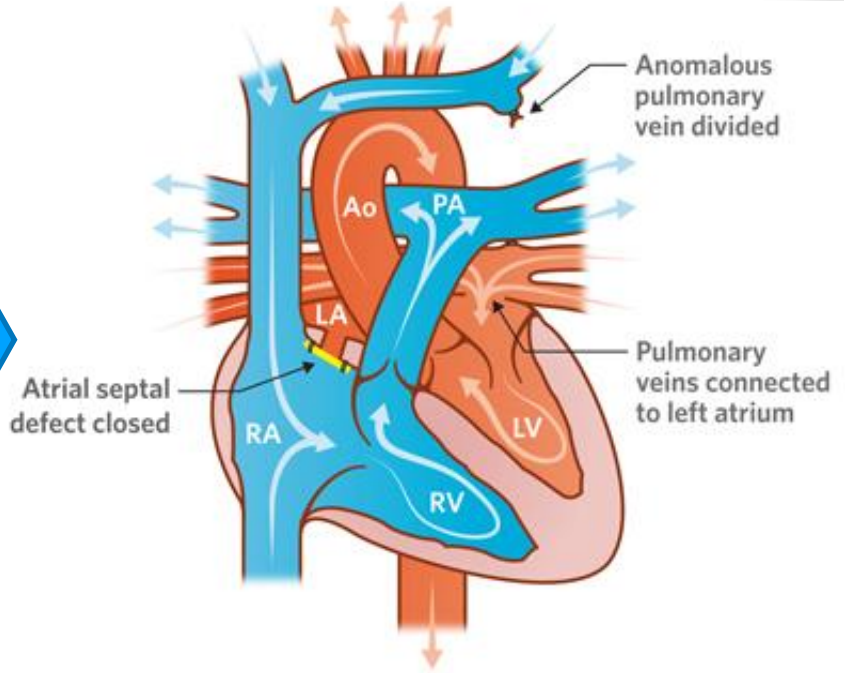




Case CHD. Restrictive LV - AFR®







62 y.o. man. Supracardiac total anomalous pulmonary venous connection + ASD

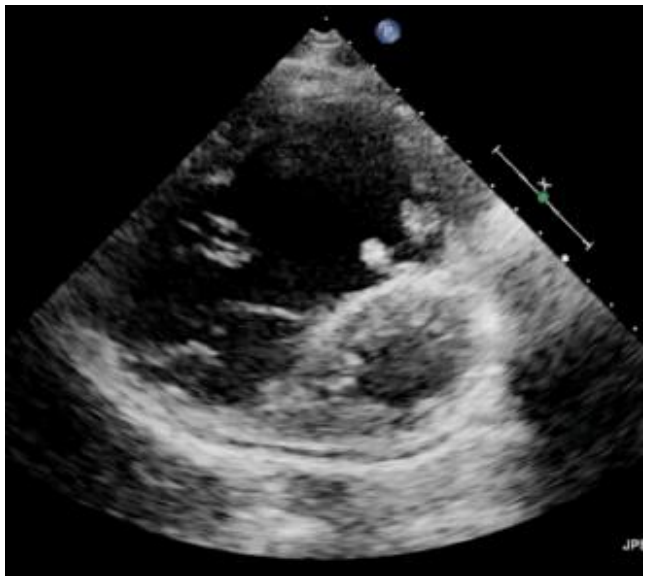
1st surgery (median sternotomy): connection pulmonary venous confluence with LA + closure of ASD with a patch (33 y.o.)

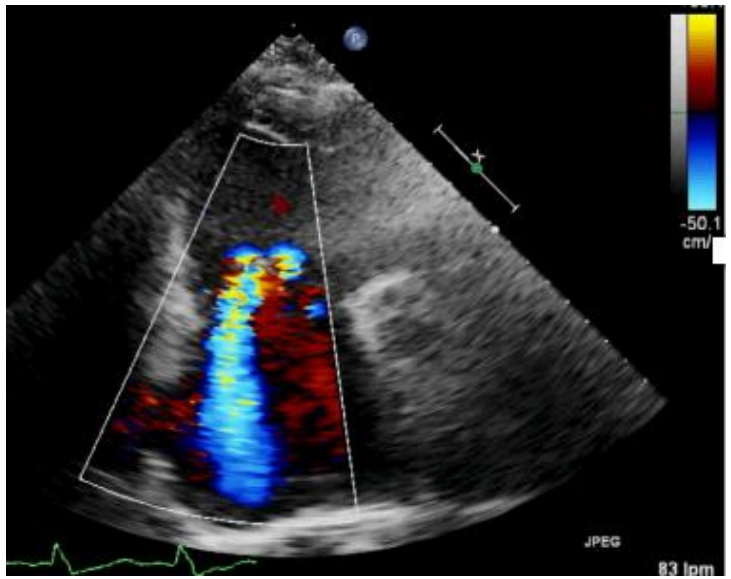
2nd surgery (left thoracotomy): surgical vertical vein ligation (52 y.o.)

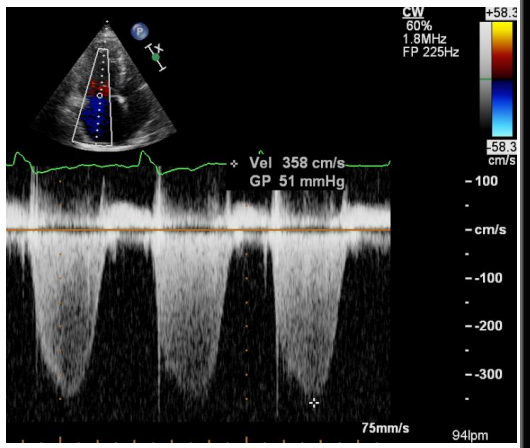
Case CHD. Restrictive LV - AFR®

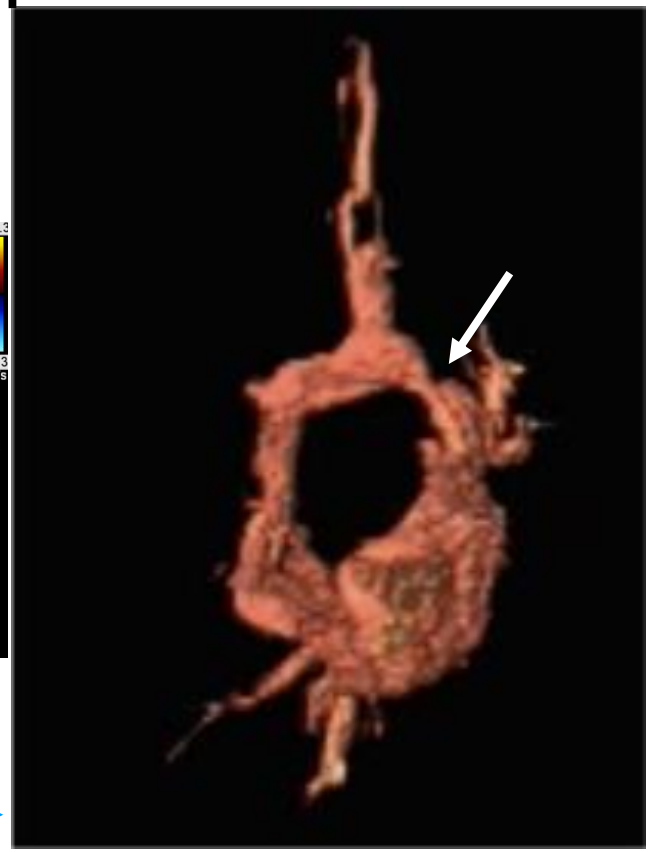
Currently: patient complaints of dyspnea and angina with minimal exertion.
FC III NYHA

Echo: Enlargement and dysfunction of the right ventricle + severe tricuspid regurgitation + severe pulmonary artery hypertension





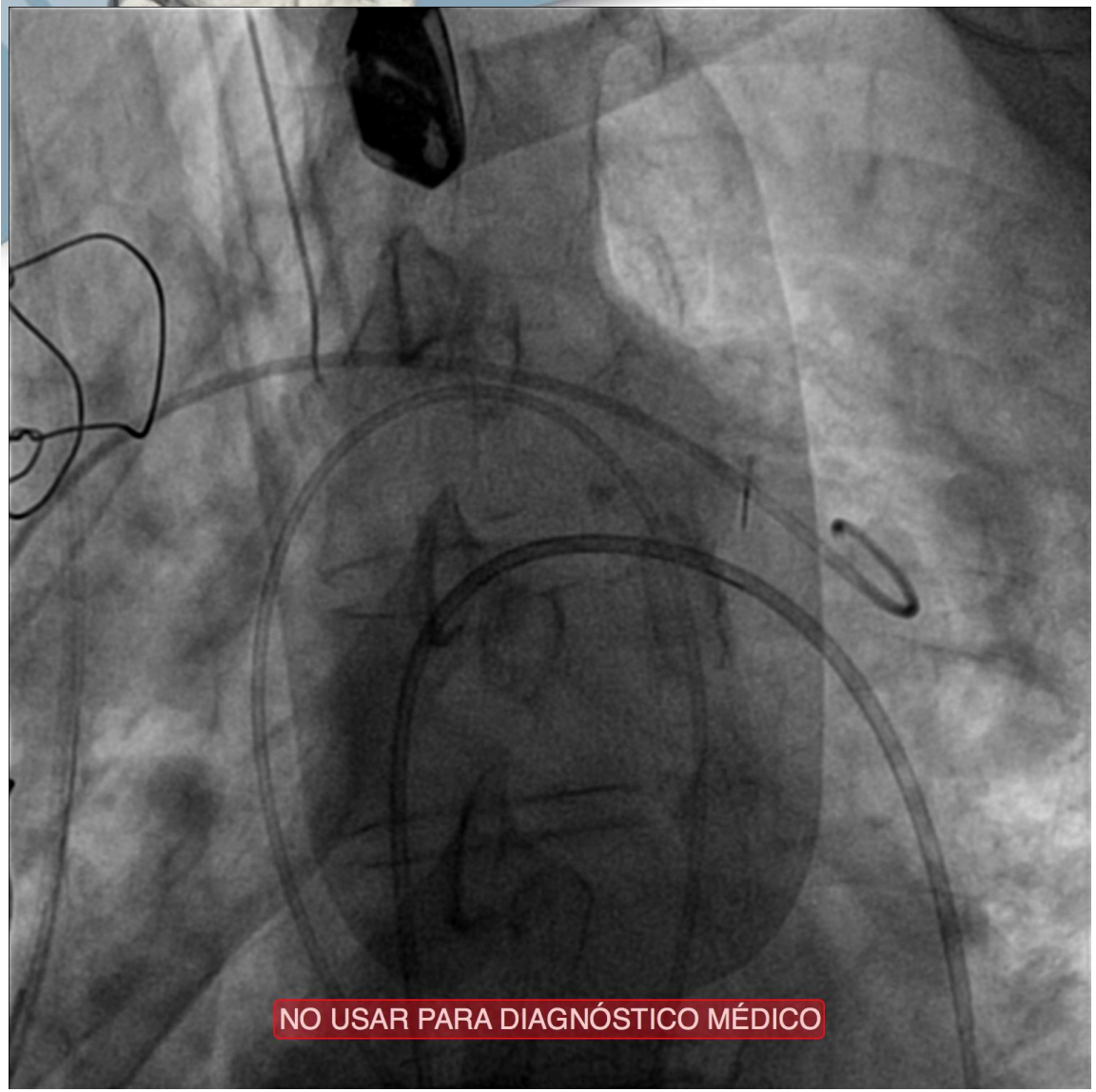




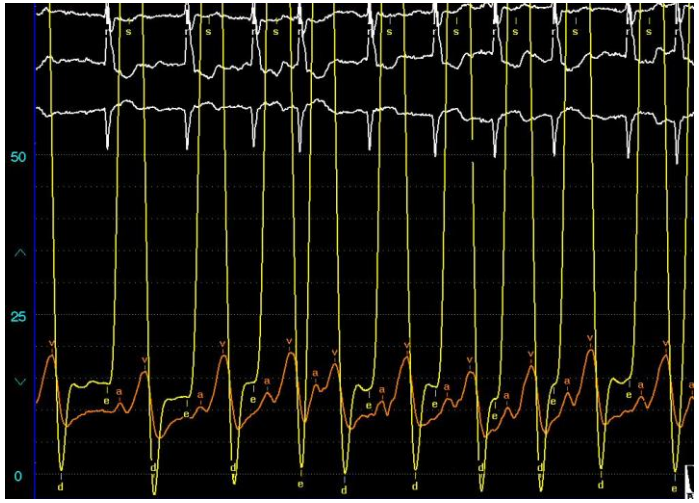
MRI: patency of the vertical vein, in spite of previously surgical ligation

Case CHD. Restrictive LV - AFR®

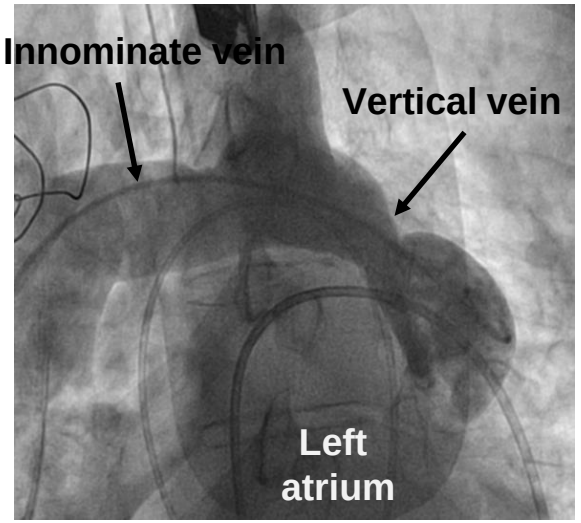
Cardiac catheterization



LA 12/18 (12) LV 110/0-12



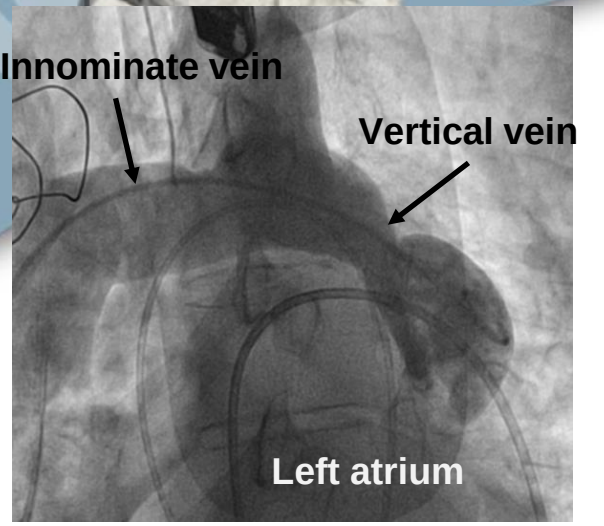
PA 56/20 (32) LV 110/0-12



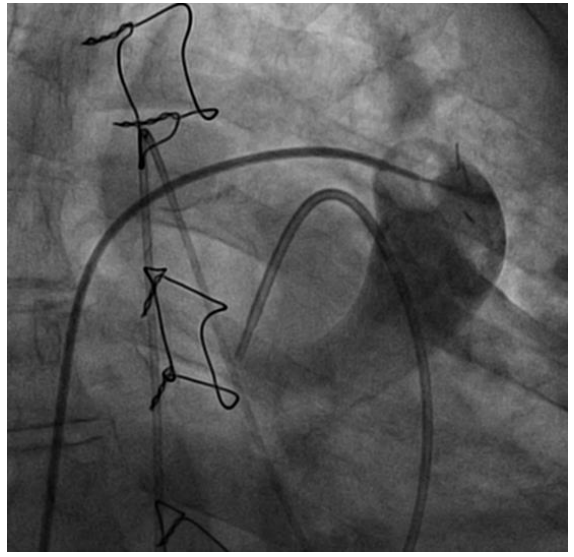
Saturations: IVC: 57%, RA: 77%, PA: 73%, LA: 90%, LV: 90% .... Qp/Qs: 2.5:1

Case CHD. Restrictive LV - AFR®

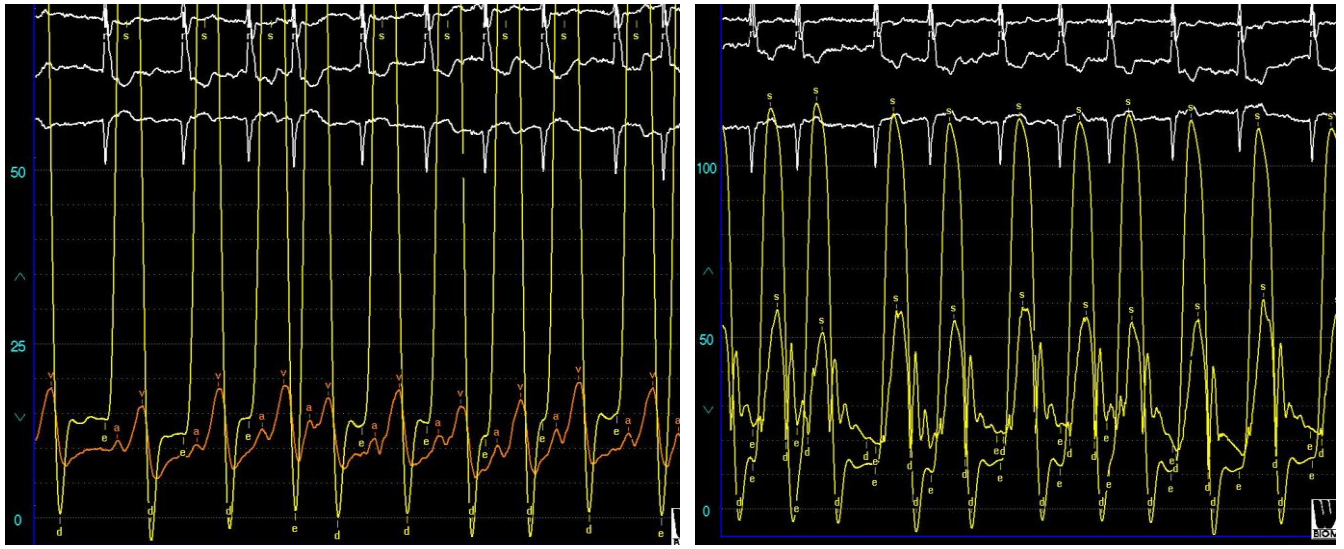
Basal:



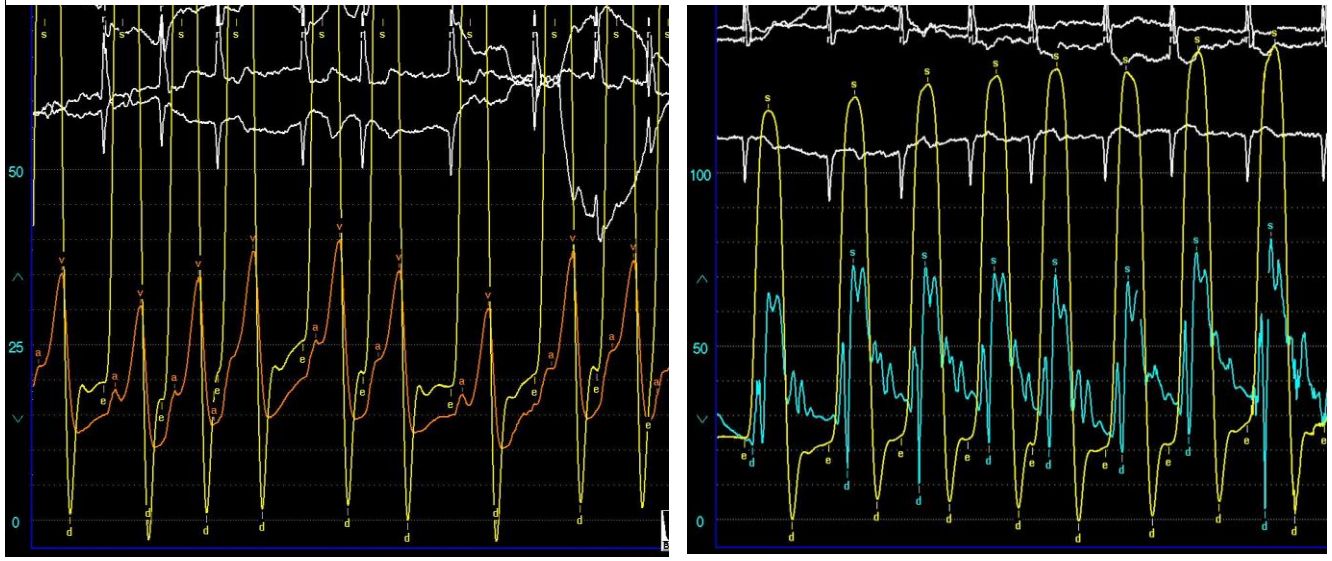
Transient occlusion innominate vein:



LA 12/18 (12) LV 110/0-12 PA 56/20 (32) LV 110/0-12

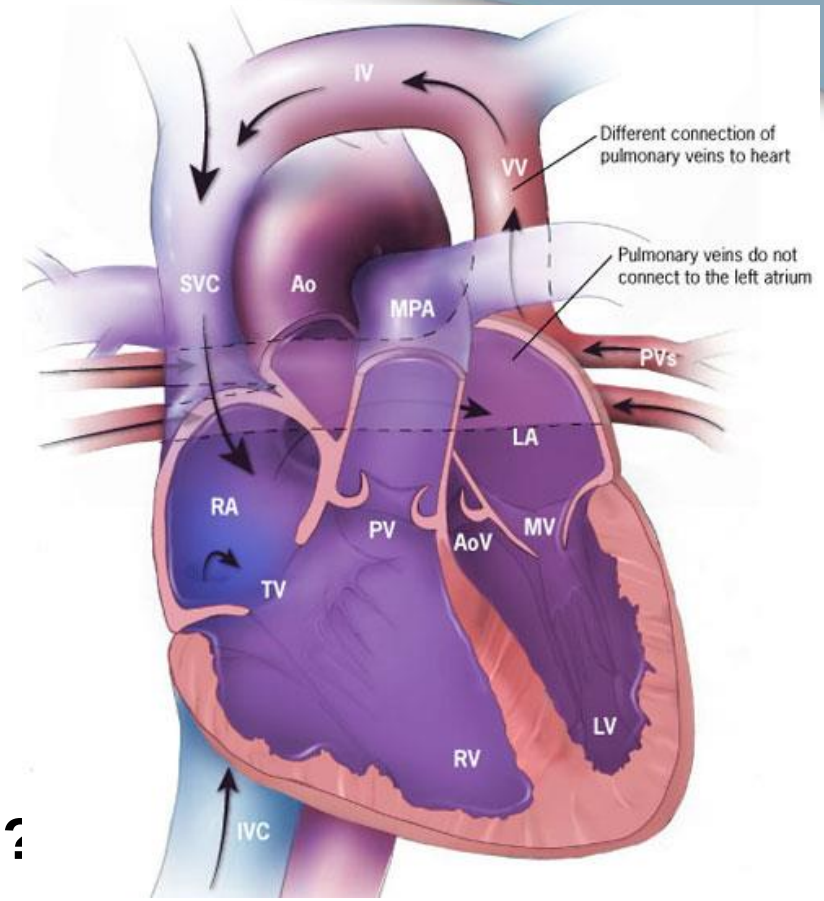


LA 22/36 (22) LV 120/0-22 PA 75/20 (22) LV 134/0-22



We close temporarily the vertical vein with a balloon: An increase in the left atrium pressure from 12 to 22 mmHg with the patient complaining of chest pain and breathlessness

Best aproach?



1. Medical treatment ?

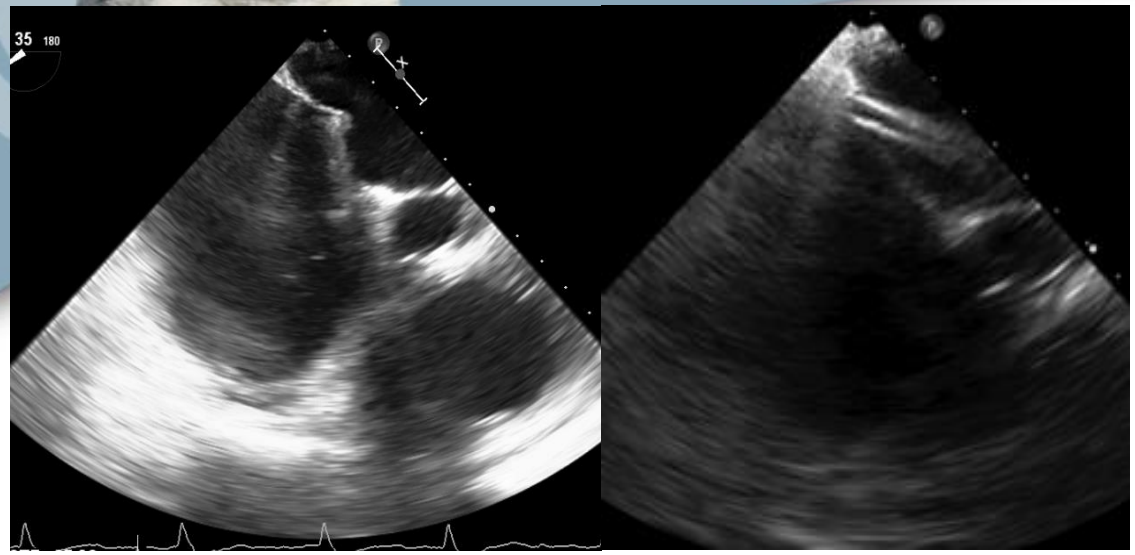
2. Percutaneous closure of vertical vein ?

3. New surgery of ligadure of vertical vein ?

4. Percutaneous fenestrated closure of vertical vein ?

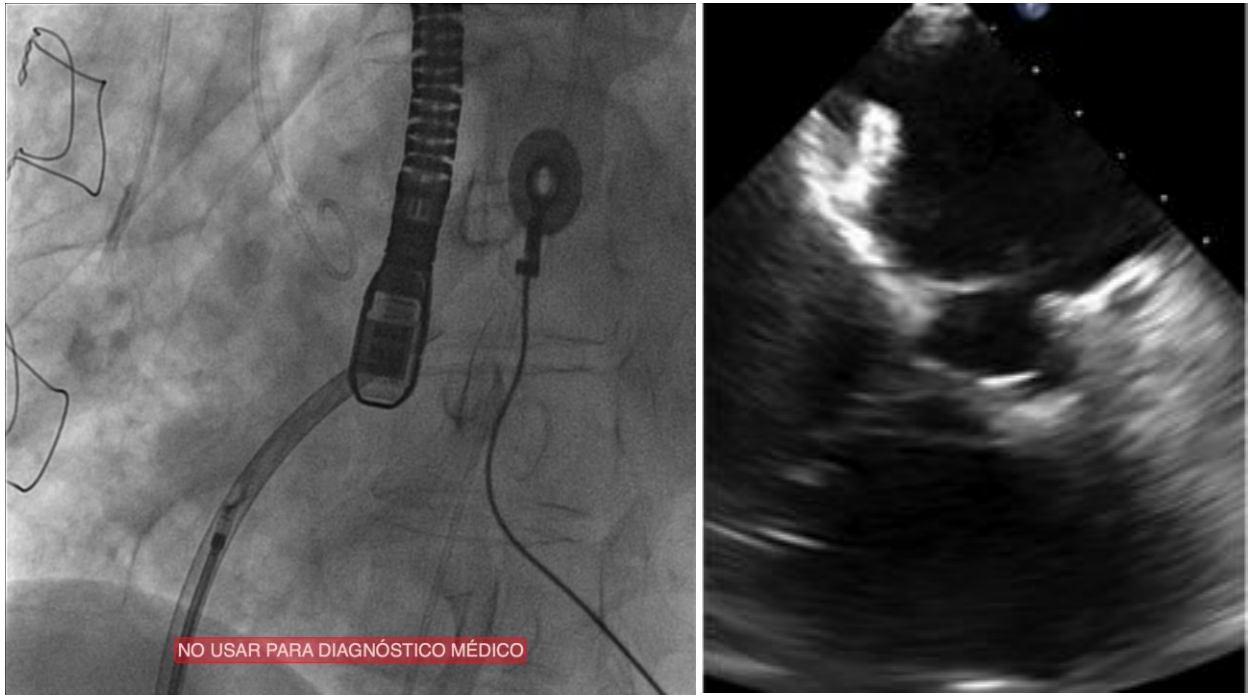
5. **Percutaneous controlled left atrial decompression & closure of vertical vein ?**

Transseptal puncture of the surgical patch

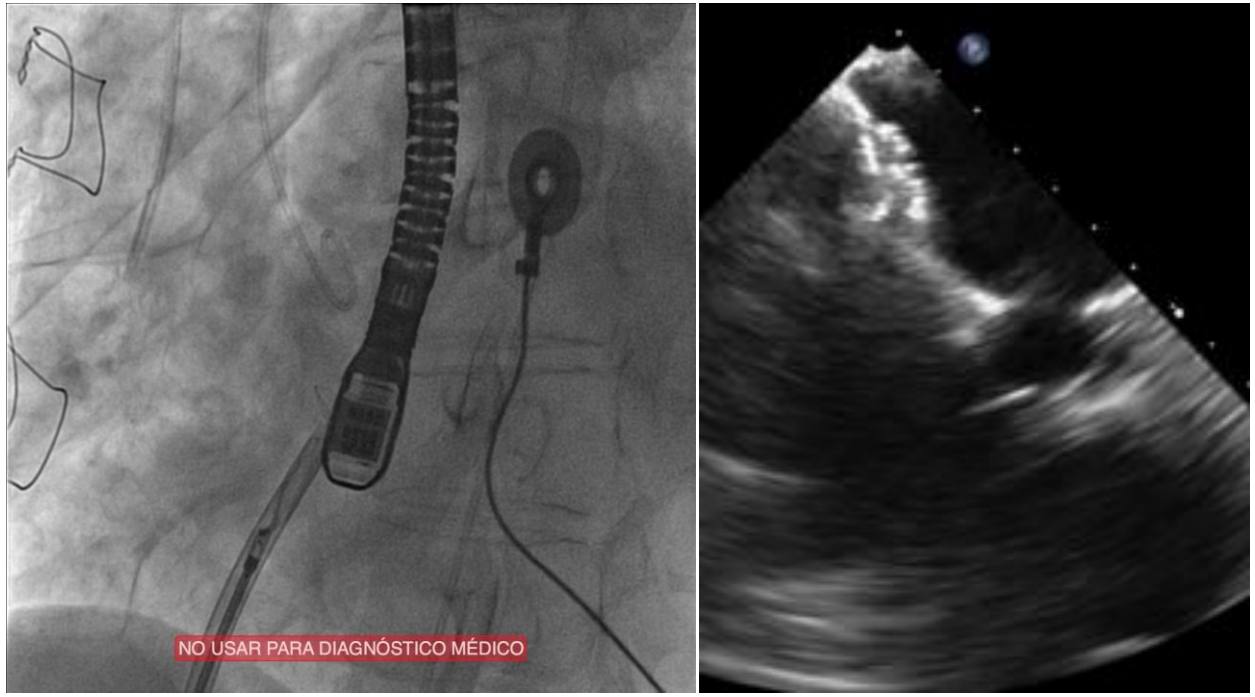


Atrial Flow Regulator 8 mm device (*Occlutech*)

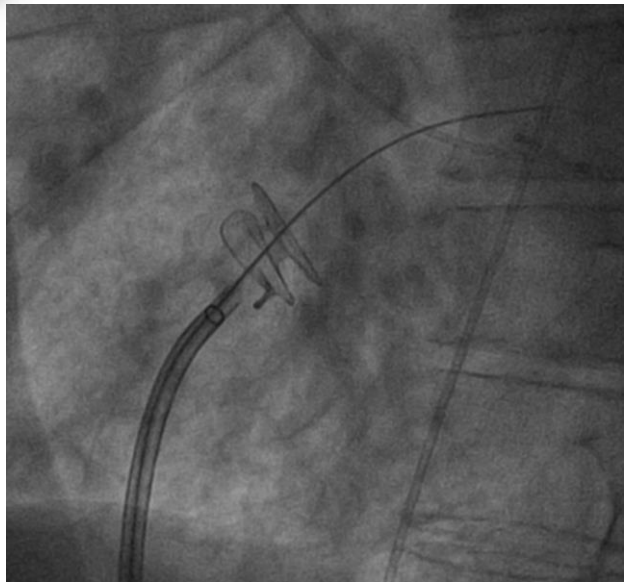
Lelft disc deployment

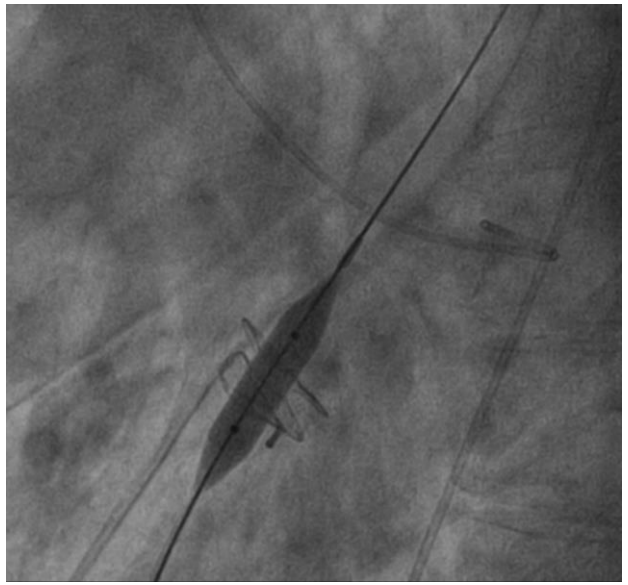


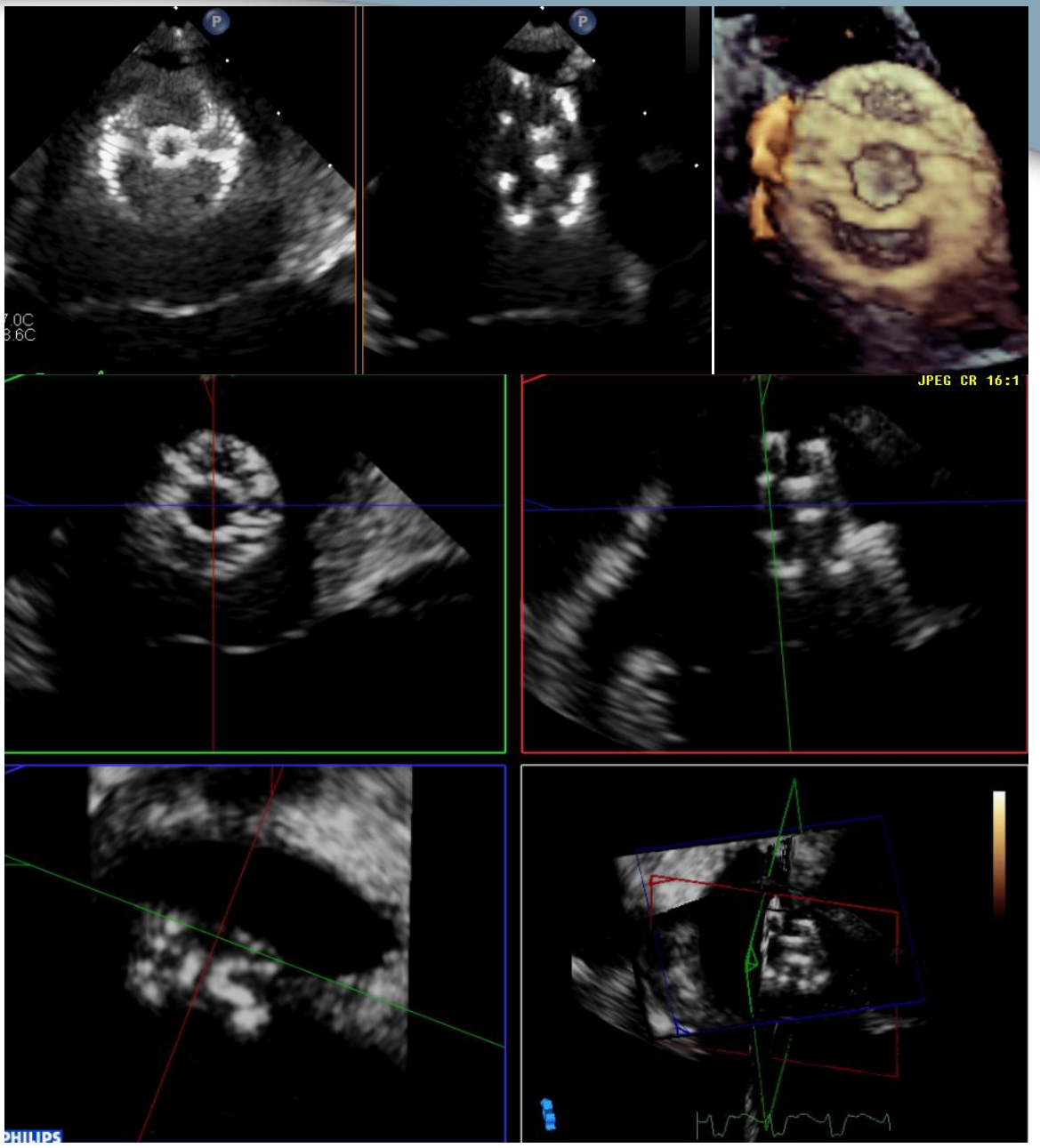
Right disc deployment



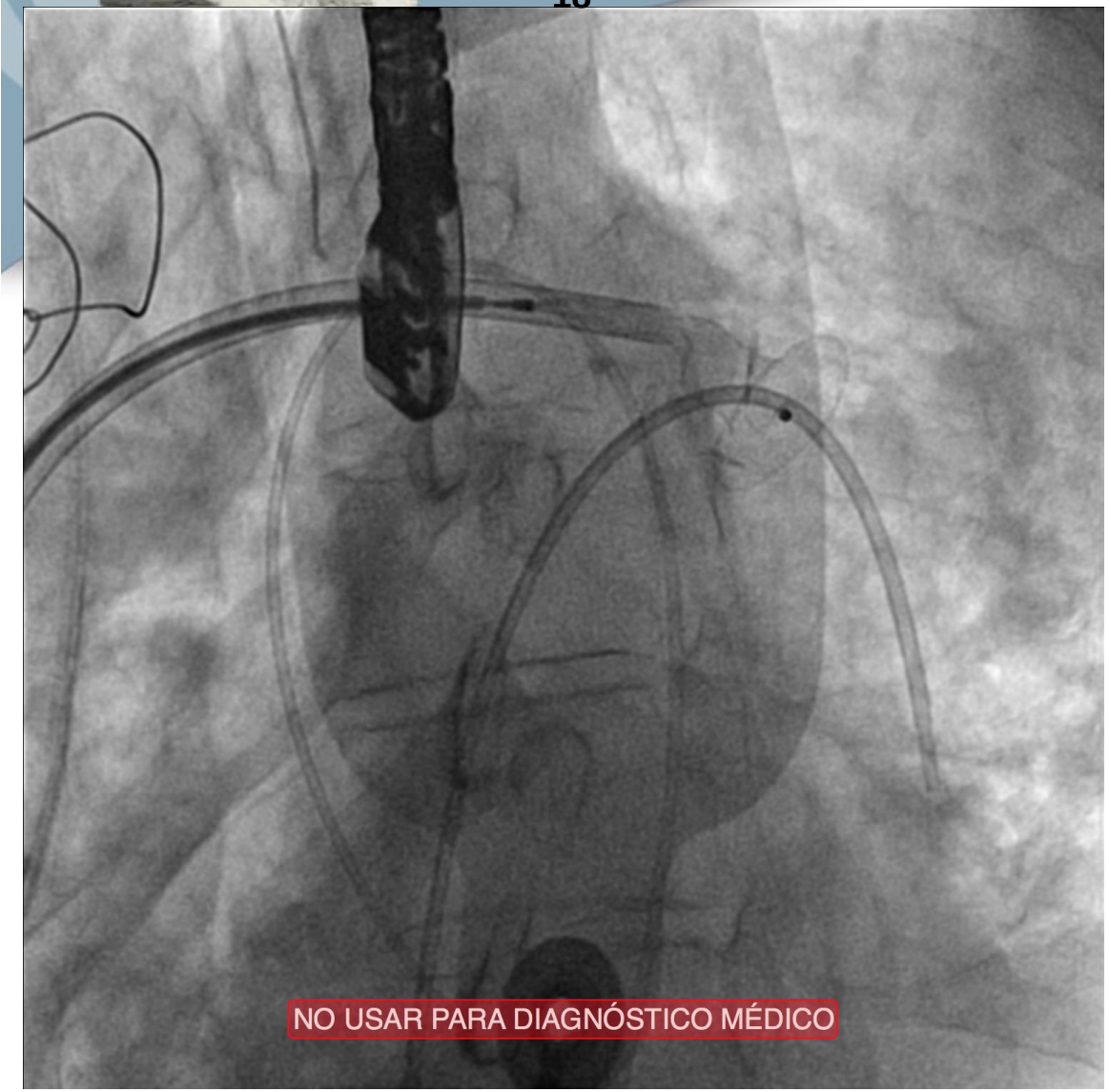
Post-dilatation Balloon NC 8 mm

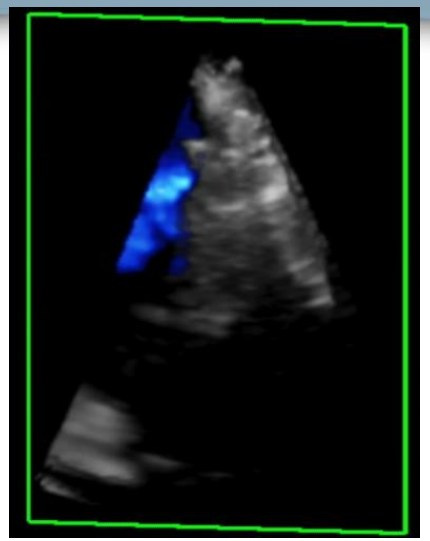




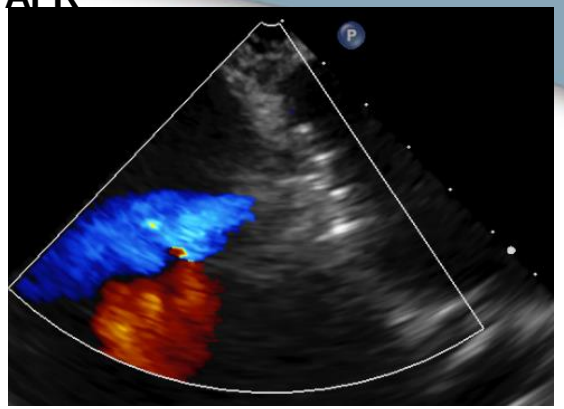


Vertical Vein closure with Amplatzer Muscular VSD nº 18

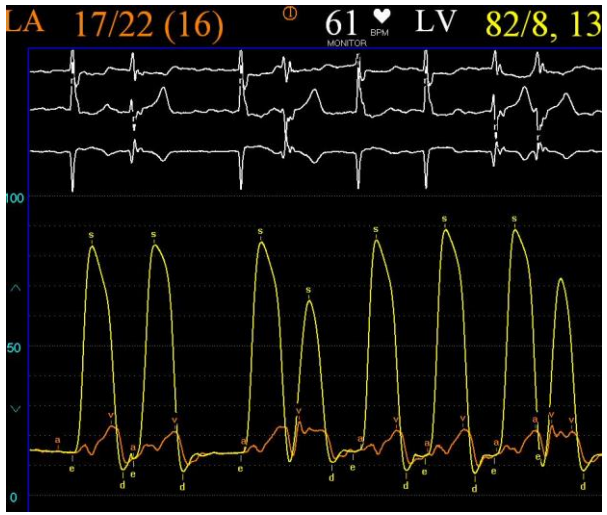




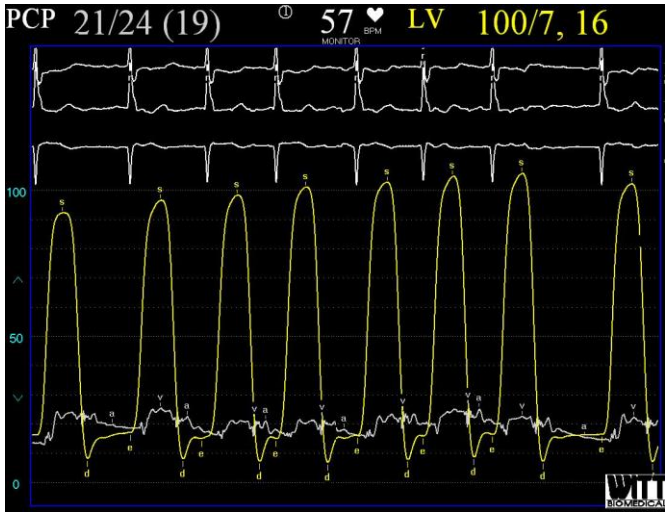
Left-to-right flow through AFR



Pre



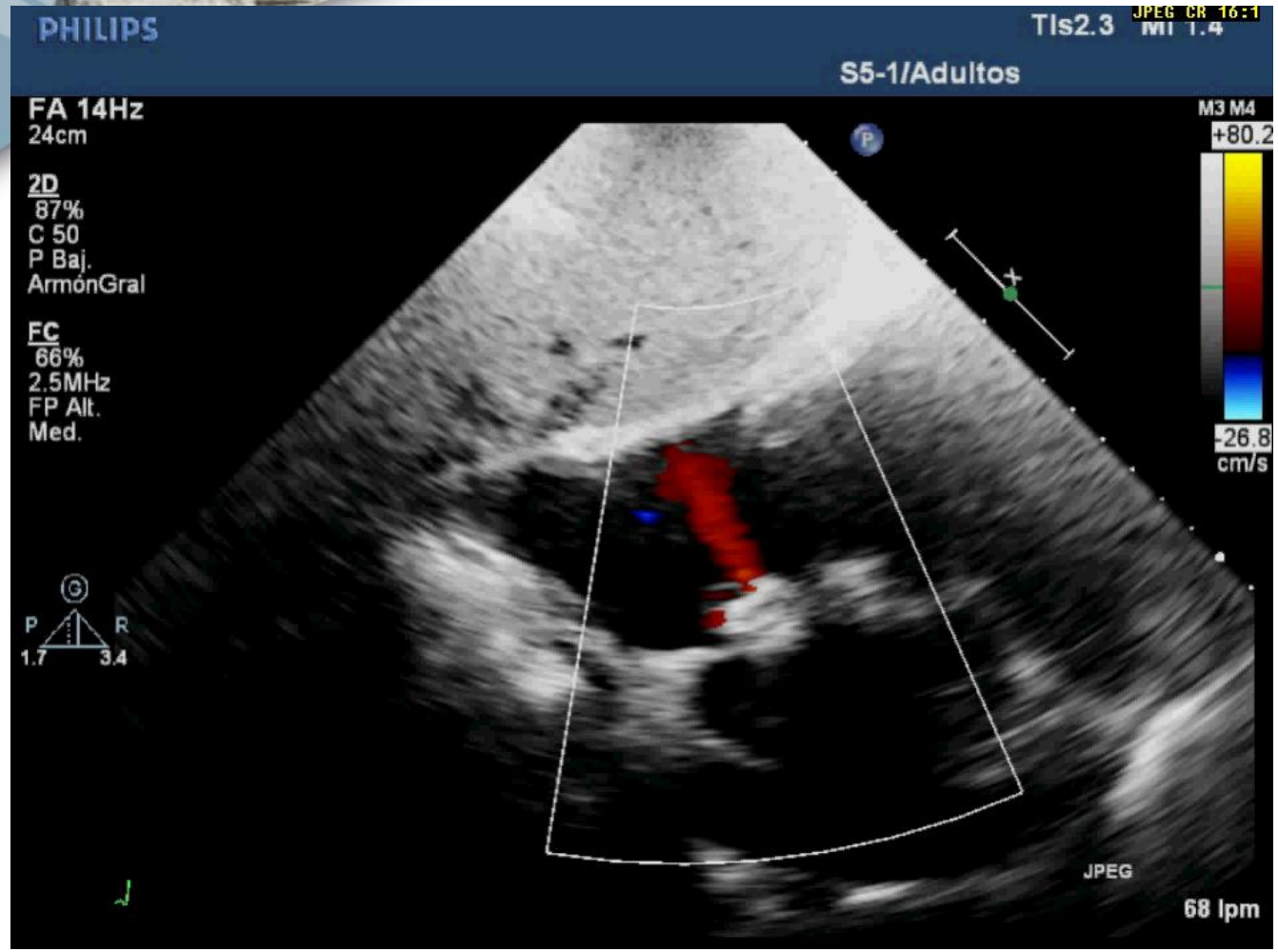
Post

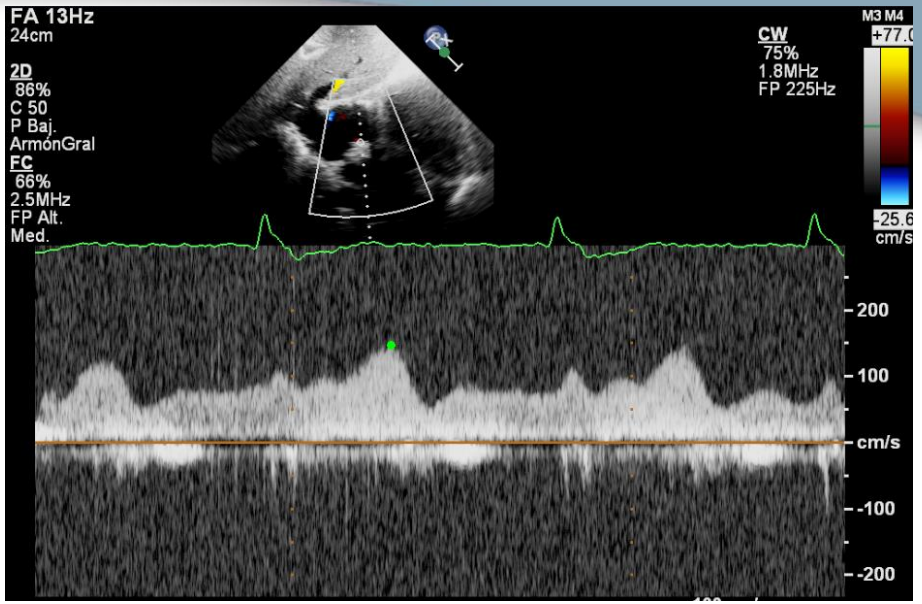


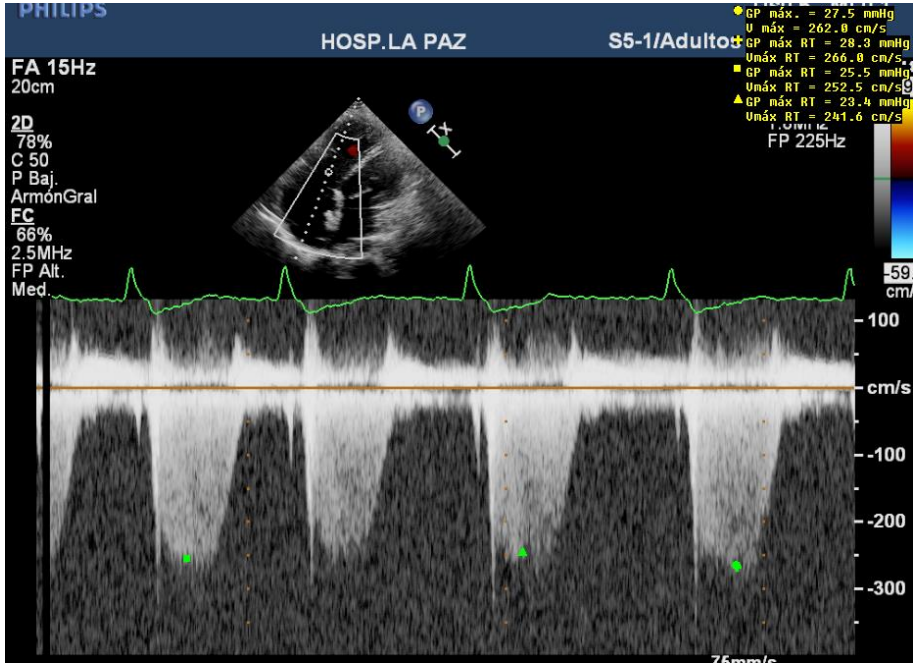
No left atrium Pressure elevation after vertical vein Occlussion

There is a LA de- compression through AFR device

Echo (48 h)


PHILIPS
TIs2.3
S5-1/Adultos
FA 14Hz
24cm
2D
87%
C 50
P Baj.
ArmónGral
FC
66%
2.5MHz
FP Alt.
Med.
M3 M4
+80.2
-26.8
cm/s
P
R
1.7
3.4
JPEG
68 lpm


FA 13Hz
24cm
2D
86%
C 50
P Baj.
ArmónGral
FC
66%
2.5MHz
FP Alt.
Med.
CW
75%
1.8MHz
FP 225Hz
M3 M4
-25.6
cm/s
200
100
cm/s
-100
-200


PHILIPS
HOSP.LA PAZ
S5-1/Adultos
FA 15Hz
20cm
2D
78%
C 50
P Baj.
ArmónGral
FC
66%
2.5MHz
FP Alt.
Med.
FP 225Hz
100
cm/s
-100
-200
-300

Scientific letter

Transcatheter closure of a vertical vein in a patient with total anomalous pulmonary venous drainage decompressing the left atrium with an *AFR* device

Cierre percutáneo de vena vertical en paciente con drenaje venoso pulmonar anómalo total previa descompresión de la aurícula izquierda con dispositivo AFR

Virginia Pascual-Tejerina,[a] Ángel Sánchez-Recalde,[b,*] Federico Gutiérrez-Larraya,[c] José Ruiz-Cantador,[d] Luis Rodríguez-Padial,[a] and José L. Zamorano[b]

Rev Esp Cardiol (Engl Ed) 2021 May 20;S1885-5857(21)00138-9. doi: 10.1016/j.rec.2021.04.009. Online ahead of print

New devices….

■ Characteristics

1. The stent is in the sheath.

2. The LA part is released from the sheath.

3. The stent is released from the sheath, with an min size of 4mm.

4.The waist diameter can be adjusted up to 10 mm.

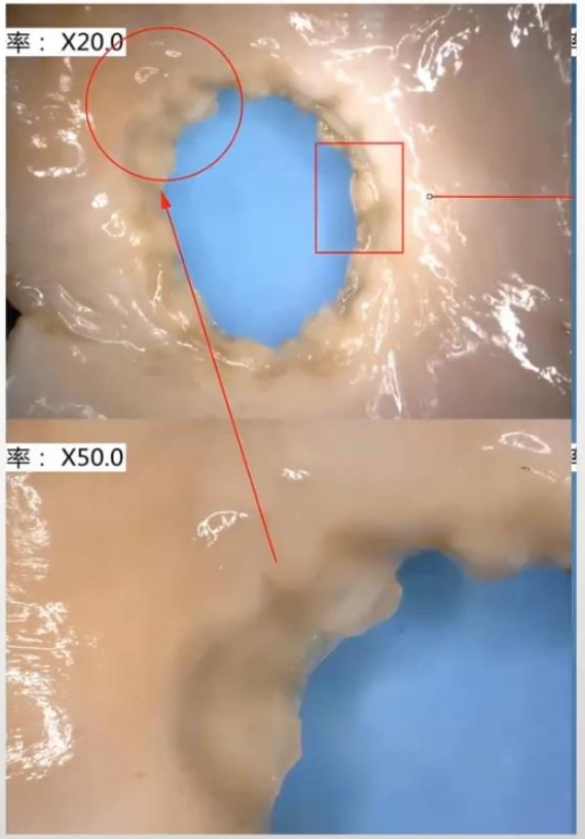
Connection to the RF Ablation Generator.

New devices….

- Ablate as the Stent Expand:

Process

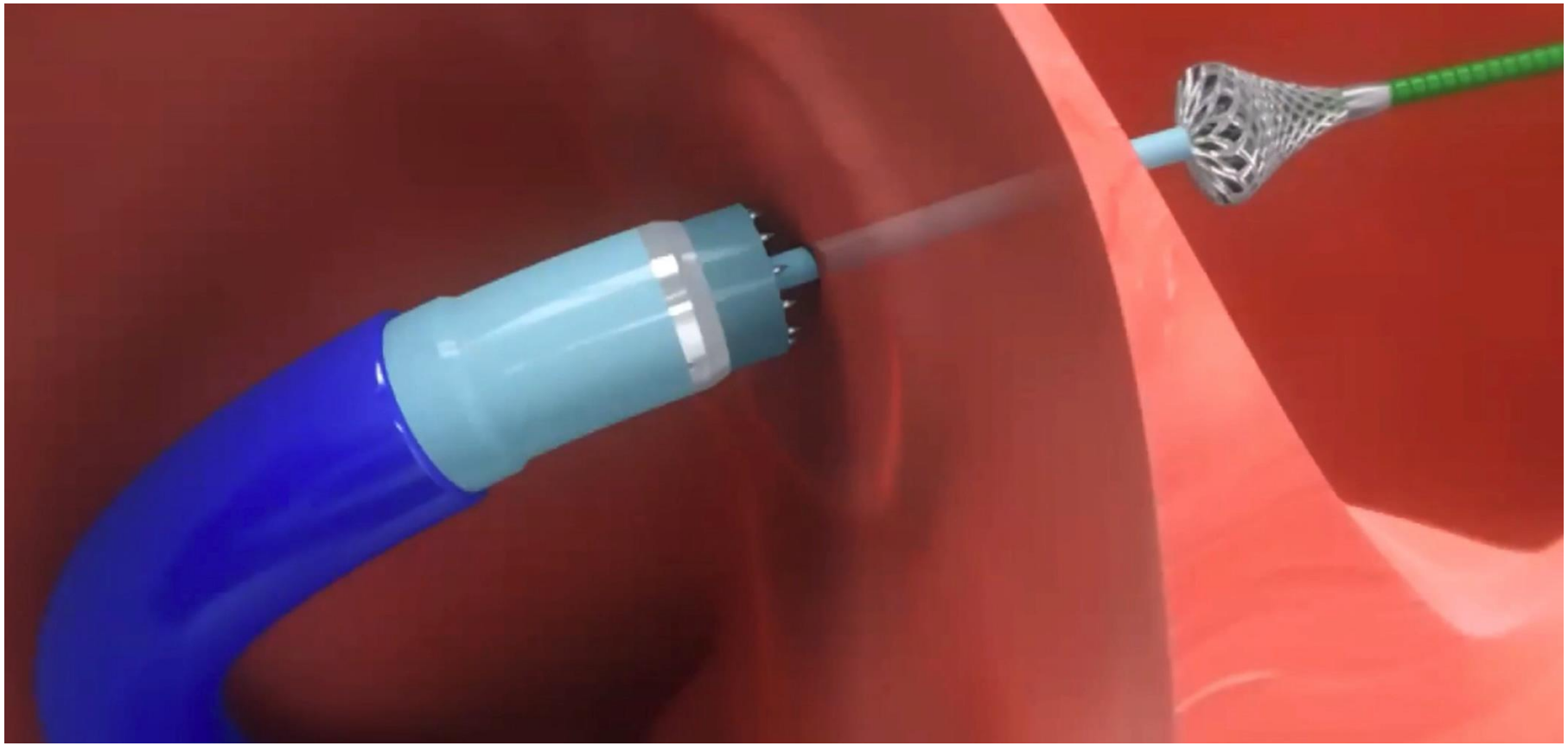
Final result



Microscopic Result

New devices….

DOVES: Durability Of Vardi Endocardial Septostomy



4-10 mm

Conclusions

- ✓ **Dynamic elevations in LAP -- worsening HF symptoms, morbidity and mortality**
- ✓ **Lowering LAP may improve symptoms and clinical outcomes pharmacological therapies may not fully adress dynamic increases in LAP during HF exacerbations**
- ✓ **Inteartrial shunts (on-demand & self-regulating) lower LAP in both HFrEF & HFpEF**
  - **Very high implant success, excellent device safety and wide patency**
  - **Improved quality of life, functional class, exerciese ability, regardless LFEF**
- ✓ **These observations will be further evaluated in the ongoing trials (RELIEVE-HF, REDUCE LAP-HF 2, etc)**