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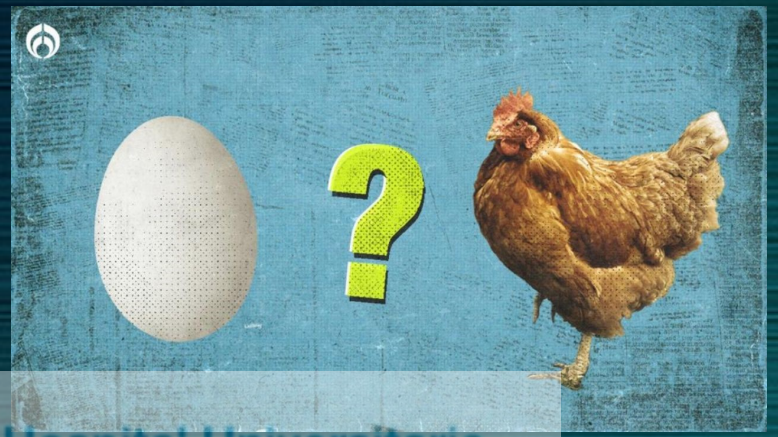

Coronary Haemodynamic in Aortic Stenosis

¿Which came first the chicken or the eggs?

Alejandro Gutiérrez Barrios
FEA Cardiología HUPM
Noviembre 2023

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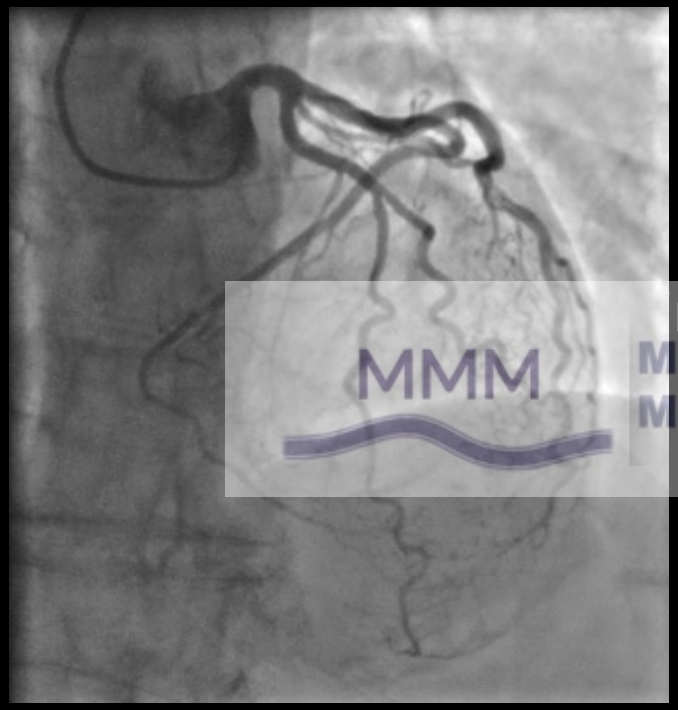
Ana María 71 yo



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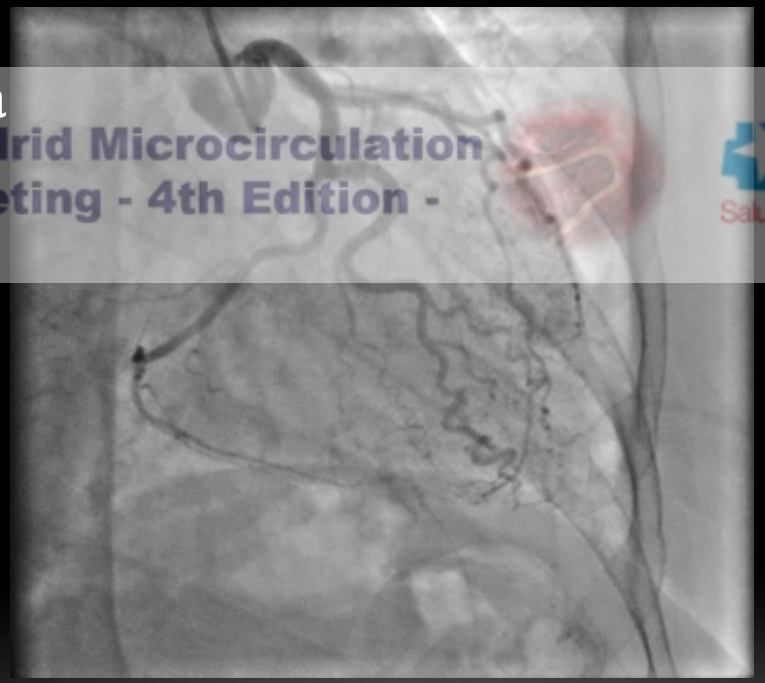

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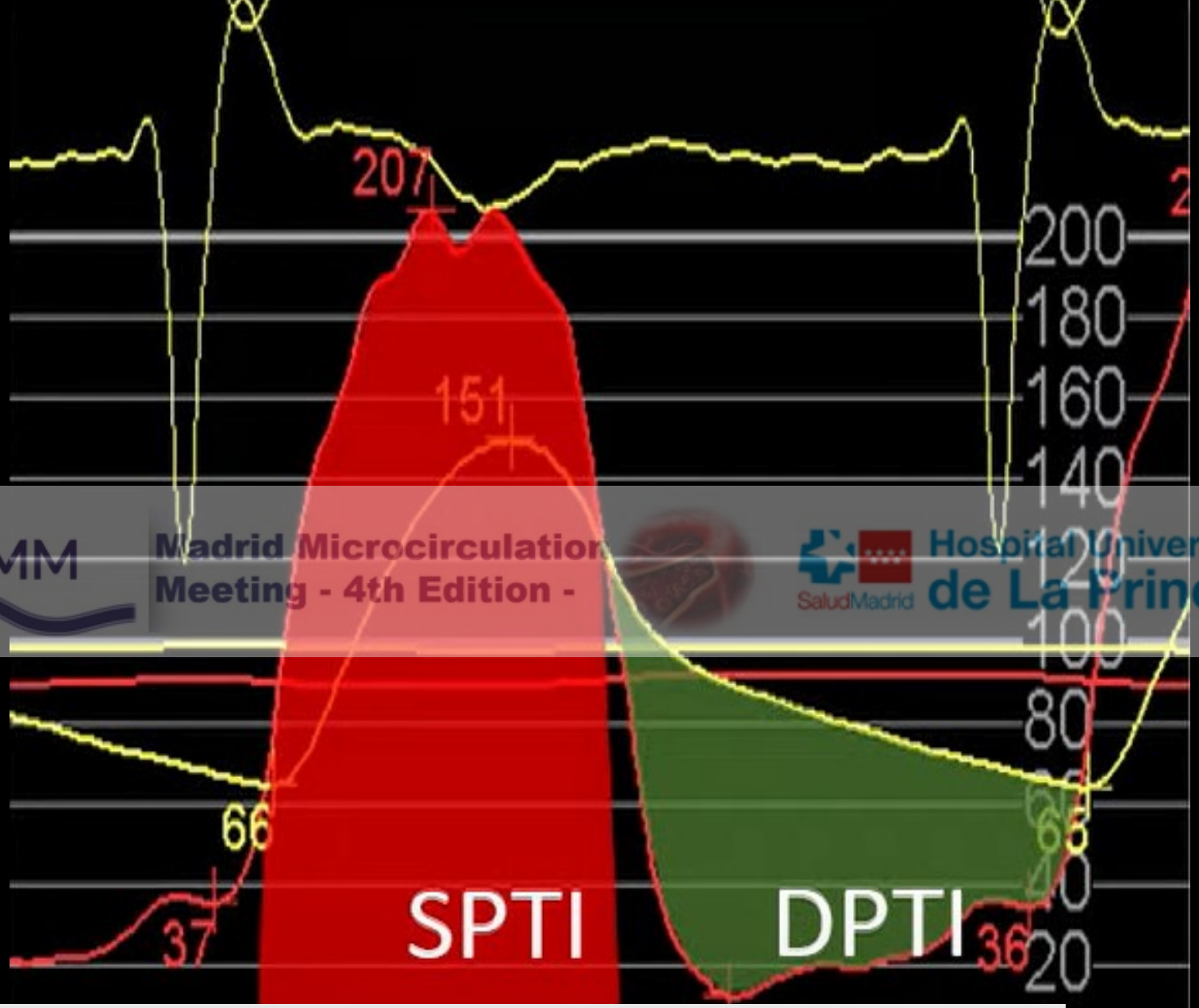
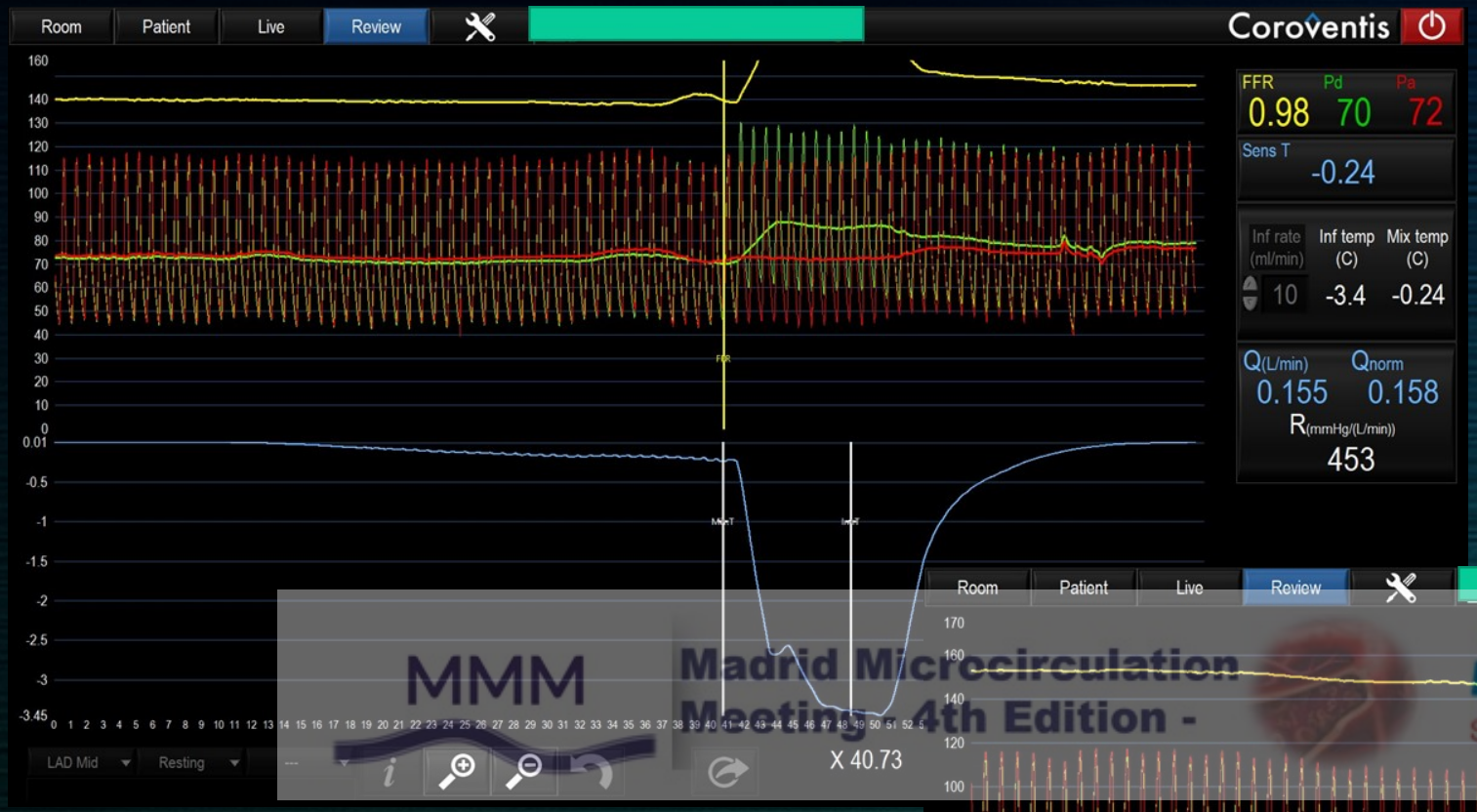
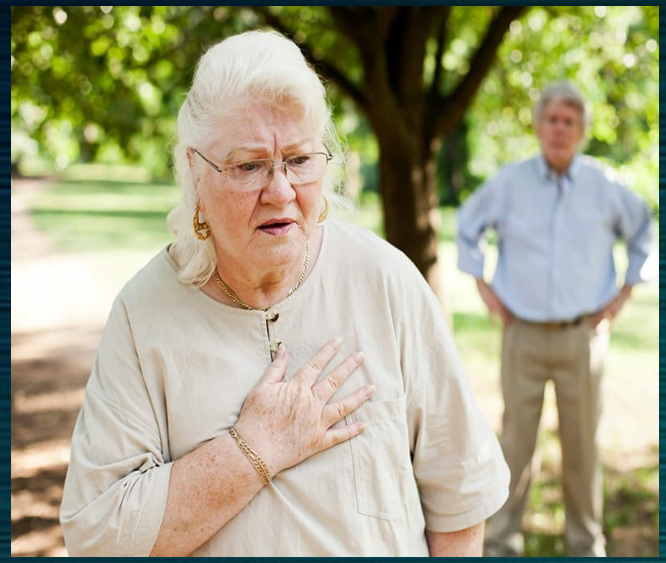
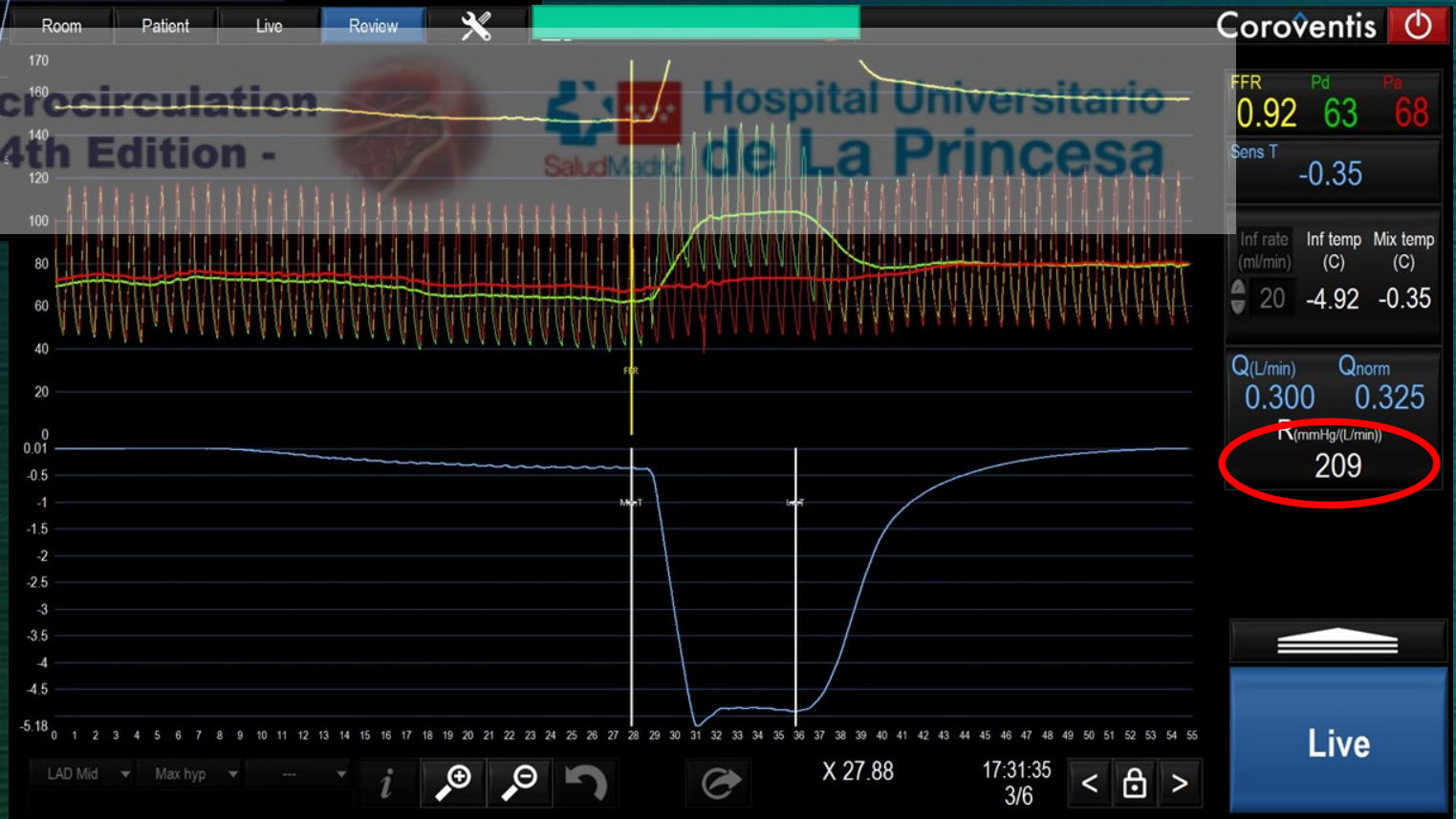


- SPTI = systolic pressure time integral (myocardial O^2 demand)
- DPTI = diastolic pressure time integral (myocardial O^2 supply)

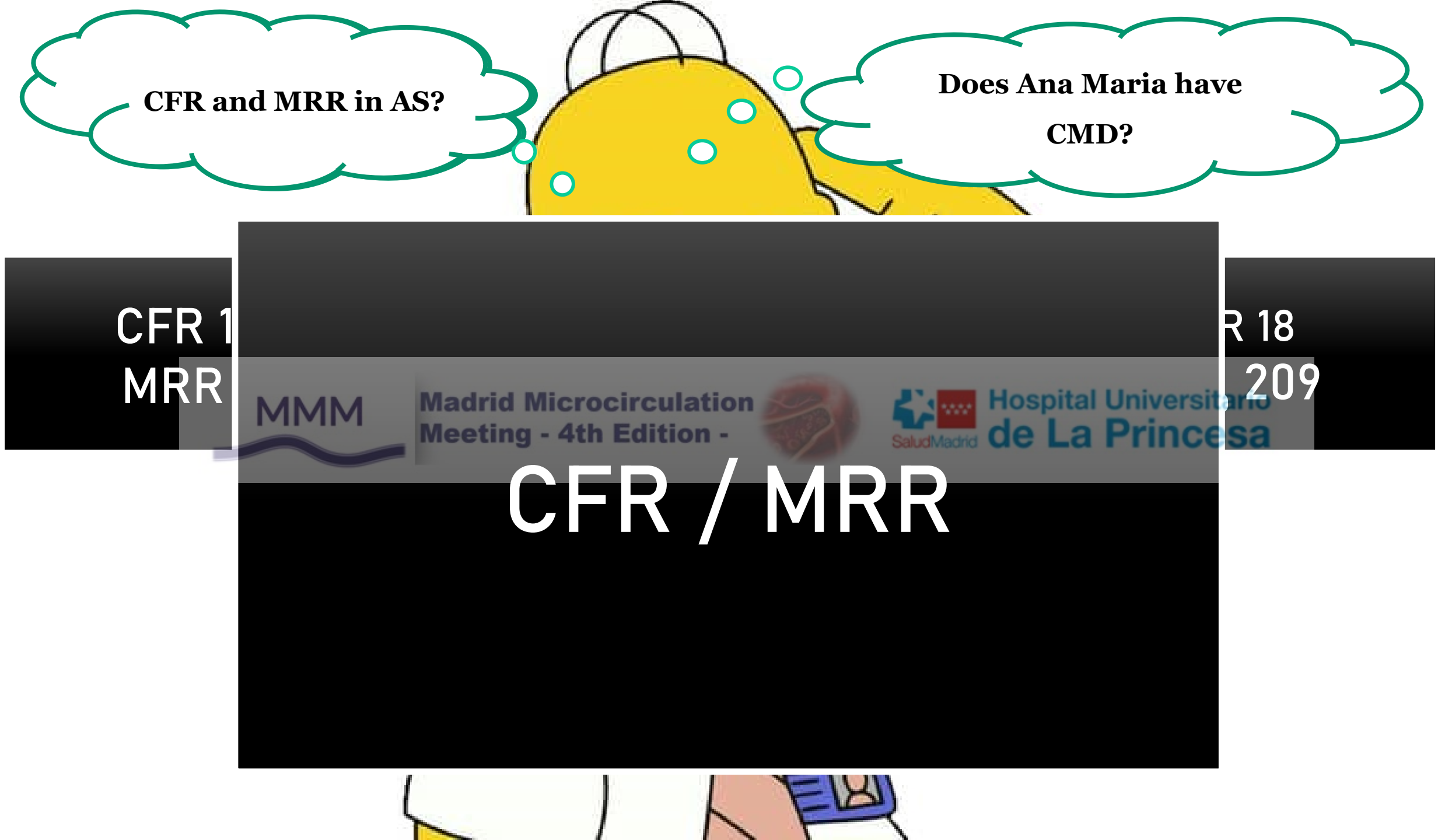
Hoffman JI, Buckberg GD. J Am Heart Assoc. 2014







CFR 1.93
MRR 2.1


CFR and MRR in AS?
Does Ana Maria have CMD?
CFR 1
MRR
R 18
209
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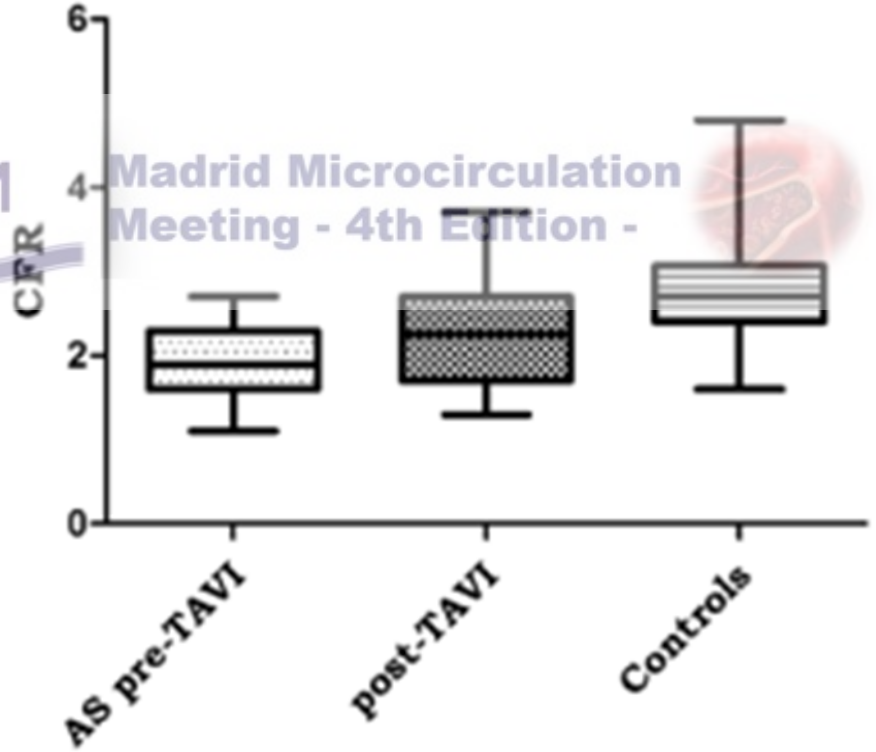
CFR / MRR

Invasive assessment of coronary flow reserve impairment in severe aortic

Impact of Aortic Valve Stenosis on Coronary Hemodynamics and the Instantaneous Effect of Transcatheter Aortic Valve Implantation

	AS (n = 35)	Controls	p
Baseline			
			.001
			.02
			NS
			NS
			NS
			.02
			.01
			NS
			NS
			NS
			<0.001
			<0.001
∇LVRPP mm Hg beats/min 10^{-4}	0.4 ± 0.5		

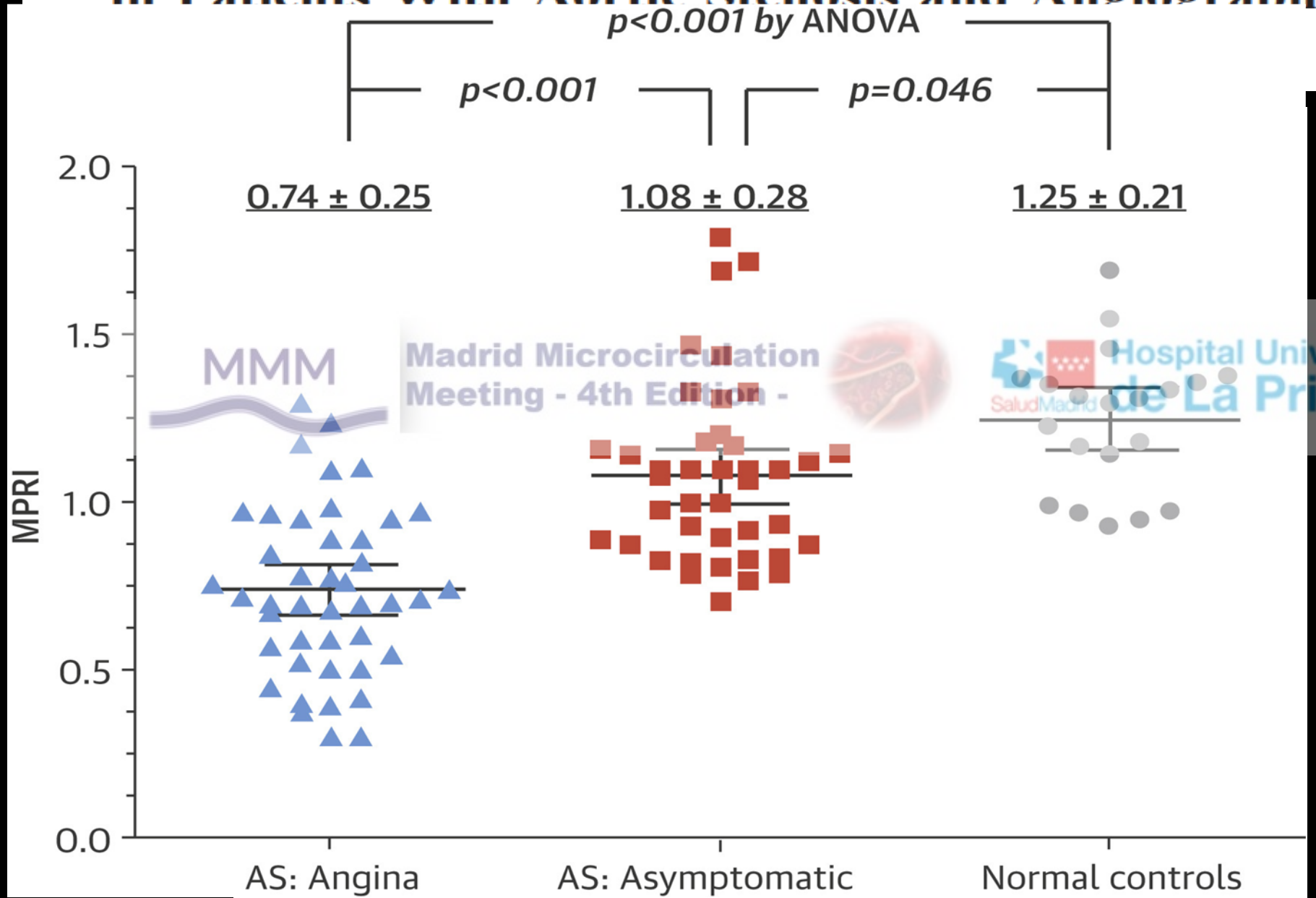


Wiegerinck et al Barrios
Circ Cardiovasc Interv. 2015;8:e002443.017) 370–374

Coronary Microvascular Dysfunction as a Mechanism of Angina in Severe AS

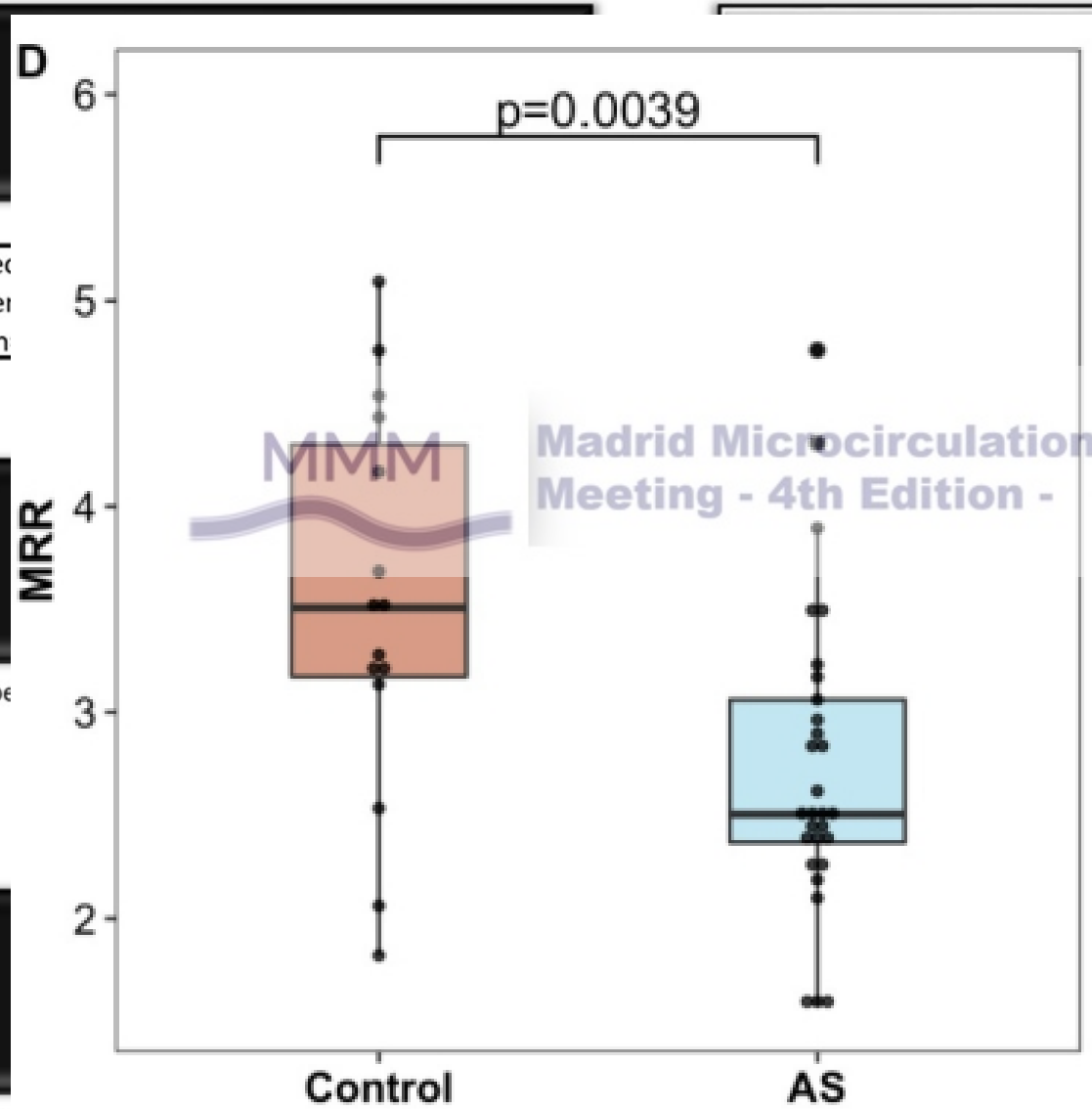
Prospective Adenosine-Stress CMR Study

Me ry Dysfunction in Patients With Aortic Stenosis and Angiographically



Kim Rajappan, Jong-Hwa Ahn, *Cir* 105:470-476
JACC VOL. 67, NO. 12, 2016

Absolute Coronary Flow and Microvascular Resistance Reserve in Patients with Severe Aortic Stenosis



functional severity of epicardial coronary lesions. Myocardial work, total myocardial mass and LAD-specific mass were quantified by echocardiography and cardiac-CT.
Results.Patients with AS presented a significantly positive LV remodeling with lower global longitudinal strain and higher global work index compared to controls ($p<0.02$). Total LV myocardial mass and LAD-specific myocardial mass were significantly higher in patients with AS. Compared to matched controls, absolute resting flow in the LAD was significantly higher in the AS cohort ($p=0.036$), resulting, in lower CFR and MRR in the AS cohort compared to controls ($p=0.005$ for both). No differences were found in hyperemic flow and resting and hyperemic resistances. Interestingly, hyperemic myocardial perfusion (calculated as the ratio between the absolute coronary flow subtended to the LAD and expressed in mL/min/g), but not resting, was significantly lower in the AS group ($p=0.036$).
Conclusions.In patients with severe AS and non-obstructive coronary artery disease, with the progression of LVH, the compensatory mechanism of increased resting flow maintains an adequate perfusion at rest, but not during hyperemia. As consequence, both CFR and MRR are significantly impaired.

Paolisso et al 2022. Heart

Gutiérrez-Barrios et al 2023.Under review

CFR and MRR are impaired in AS

But what about IMR and $R_{u\,hyp}$?

Index of microvascular resistance

Invasive Coronary Measurements in the LAD

Variable	LAD, all (n=53)	LAD, LVH (n=32)	LAD, no LVH (n=21)	*P* value
P_d, rest, mm Hg	76±14	77±14	75±13	0.58
P_a, rest, mm Hg	83±13	83±13	82±12	0.78
P_d/P_a, rest	0.93 (0.91–0.95)	0.93 (0.90–0.96)	0.93 (0.91–0.94)	0.30
P_d, hyperemia, mm Hg	67±15	68±13	66±16	0.52
P_a, hyperemia, mm Hg	76±14	76±13	75±16	0.80
FFR	0.90 (0.87–0.93)	0.91 (0.88–0.94)	0.87 (0.87–0.91)	0.04
Average resting T_{mn}, s	0.51±0.32	0.43±0.23	0.63±0.41	0.054
Average hyperemic T_{mn}, s	0.21±0.12	0.19±0.12	0.24±0.12	0.18
CFR	2.5 (1.5–3.6)	2.2 (1.5–3.2)	2.7 (1.5–3.9)	0.52
CFR corrected for FFR	2.9 (1.7–3.9)	2.5 (1.7–3.3)	3.1 (1.8–4.5)	0.37
IMR, mm Hg·s	13±8	13±8	15±7	0.37

...al - Cardiovascular Imaging, Volume 23,

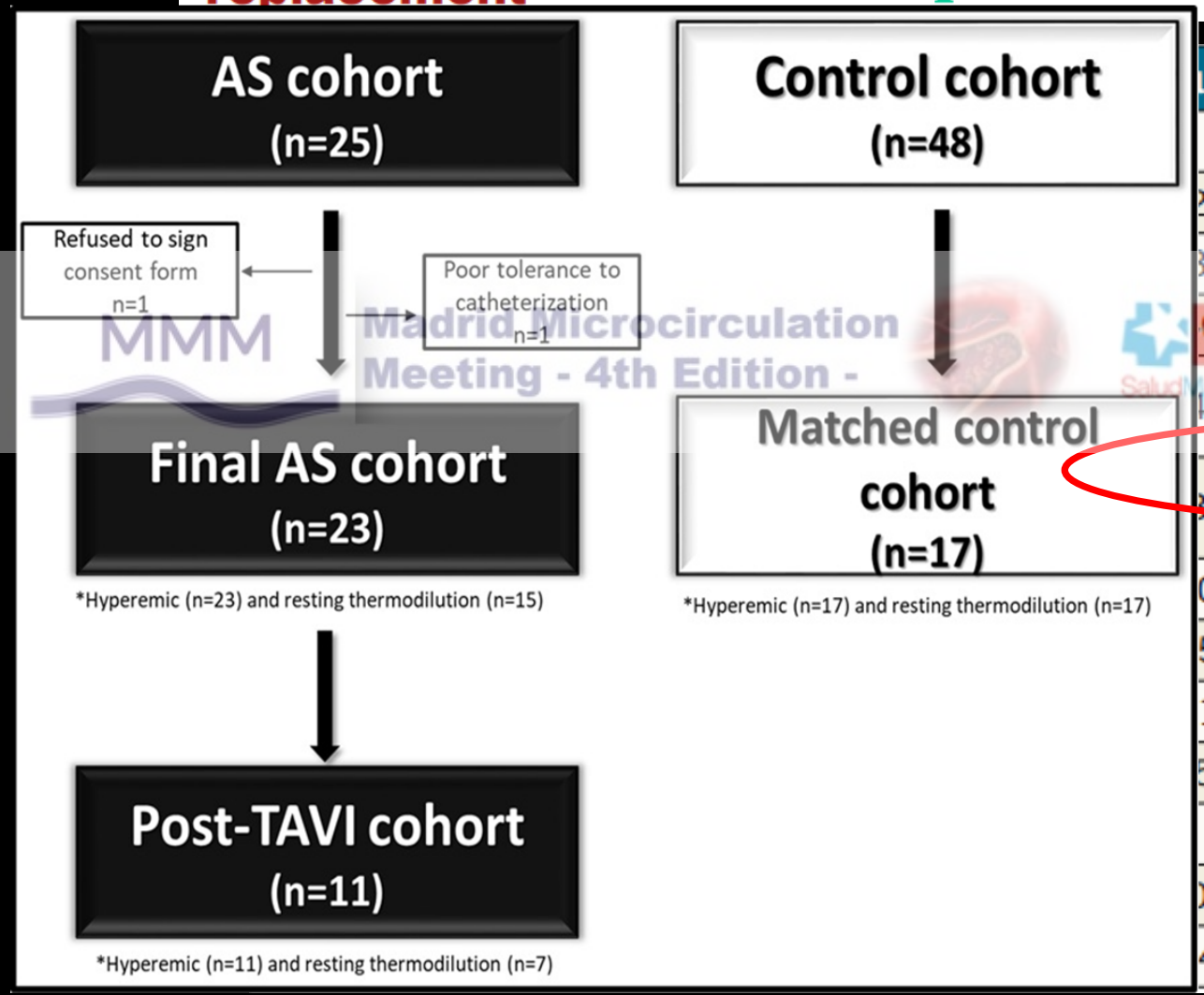
...ry J Am Heart Assoc. 2022 May 3;

Quantitative Alterations in Absolute Resting and Hyperemic Coronary Blood Flow After Severe Aortic Stenosis Replacement

Long-term changes in coronary physiology after aortic valve replacement

Mohammad Subban

EuroIntervention 2022;



up	*p*-value
	0.26
2	0.85
3	0.96
0.97)	0.40
	0.60
	0.73
0.95)	0.39
50	0.005
11	0.52
5.1)	0.005*
	1.00
01	0.26
456)	0.20

	AS-preTAVI (n=23)*	Controls (n=17)	P Value
	0.9±0.05	0.92±0.03	0.14
	0.89±0.06	0.91±0.06	0.6
IMR	20.1±16	21.1±15	0.8

Gutiérrez-Barrios 2023.Under review


Room
Patient
Live
Review
170
160
140
120
100
80
60
40
20
0
0.01
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
-4.5
-5.18
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55
(ml/min)
(C)
(C)
20
-4.92
-0.35
Q(L/min)
0.300
Qnorm
0.325
R(mmHg/(L/min))
209
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LAD Mid
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X 27.88
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3/6
Live

Quantitative Alterations in Absolute Resting and Hyperemic Coronary

Long-term changes in coronary physiology after aortic valve replacement

Muhammad Sabbah EuroIntervention 2022;

	Baseline	Follow-up	*p*-value
Heart rate, min^{-1}	79±13	81±9	0.26
P_d, rest, mmHg	76±13	77±12	0.85
P_a, rest, mmHg	82±14	82±13	0.96
P_d/P_a, rest	0.93 (0.92-0.95)	0.95 (0.92-0.97)	0.40
P_d, hyperaemia, mmHg	65±16	67±14	0.60
P_a, hyperaemia, mmHg	73±17	74±13	0.73
FFR	0.90 (0.87-0.92)	0.91(0.87-0.95)	0.39
Resting T_{mn}, sec	0.51±0.38	0.71±0.50	0.005
Hyperaemic T_{mn}, sec	0.20±0.12	0.19±0.11	0.52
CFR	2.5 (1.5-3.3)	3.1 (2.2-5.1)	0.005*
IMR, mmHg·sec	13±8	13±7	1.00
Q_{LAD}, mL/min	230±106	250±101	0.26
$R_{\mu,LAD}$, WU	347 (247-463)	287 (230-456)	0.20

	P value
	0.79
	0.61

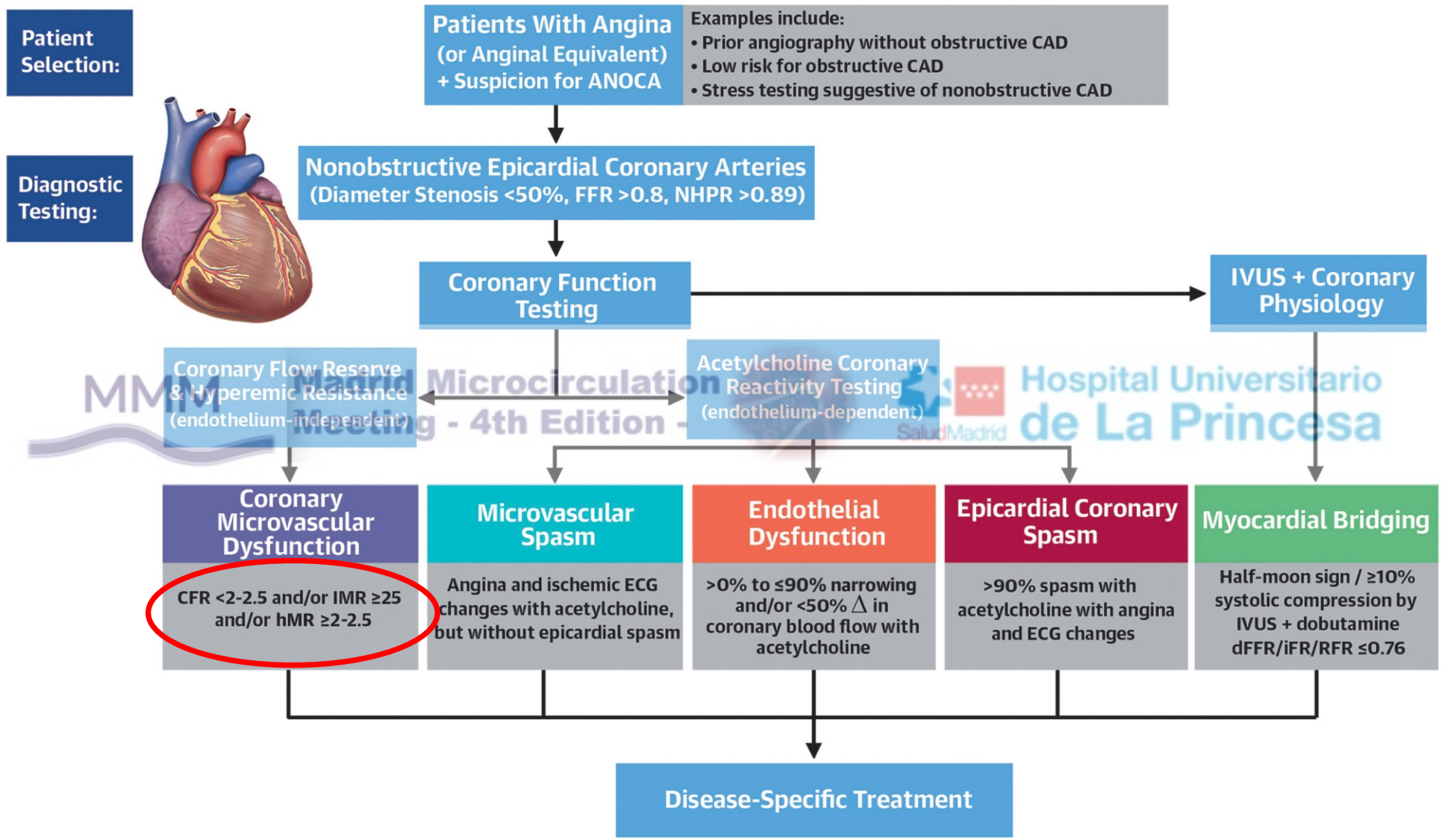
Ru hypermia (uW)

érrez-Barrios 2023. American Journal of Cardiology. (Under review)

In aortic stenosis (AS), a longstanding question revolves around mechanisms for ischemia in patients with angina but normal coronary arteries (1). The debate has focused on competing theories of microvascular dysfunction (inability of the myocardium to reduce arteriolar resistance) versus blood flow maldistribution (inability to meet a higher workload due to combined effects of a transmural perfusion flow gradient and reduced diastolic perfusion time). The elegant study by Lumley et al. (2) in this issue of the *Journal* definitively resolves mechanisms of ischemia in severe AS without comorbidities.

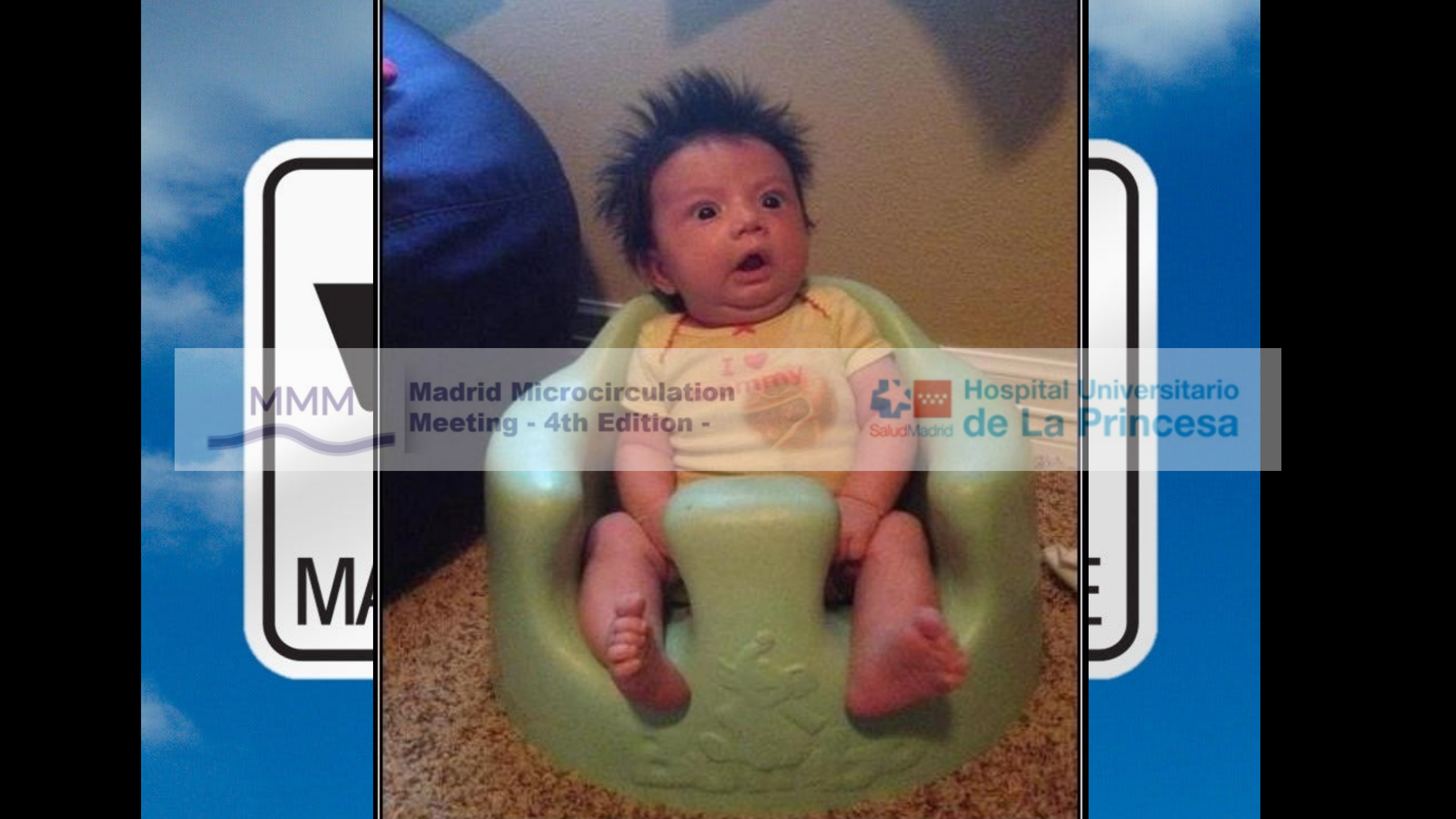
Journal of the American College of Cardiology
Volume 68, Issue 7, 16 August 2016, Pages 698-701

CENTRAL ILLUSTRATION: Invasive Diagnostic Pathway for Patients With ANOCA



Samuels BA, et al. J Am Coll Cardiol. 2023;82(12):1245–1263.

(2020) 41, 3504–3520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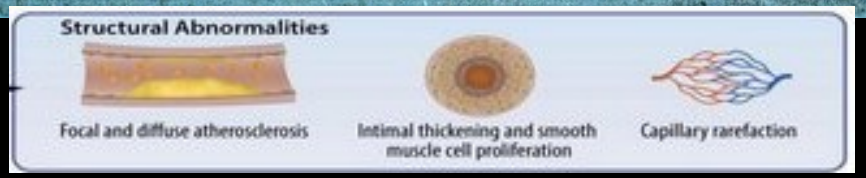
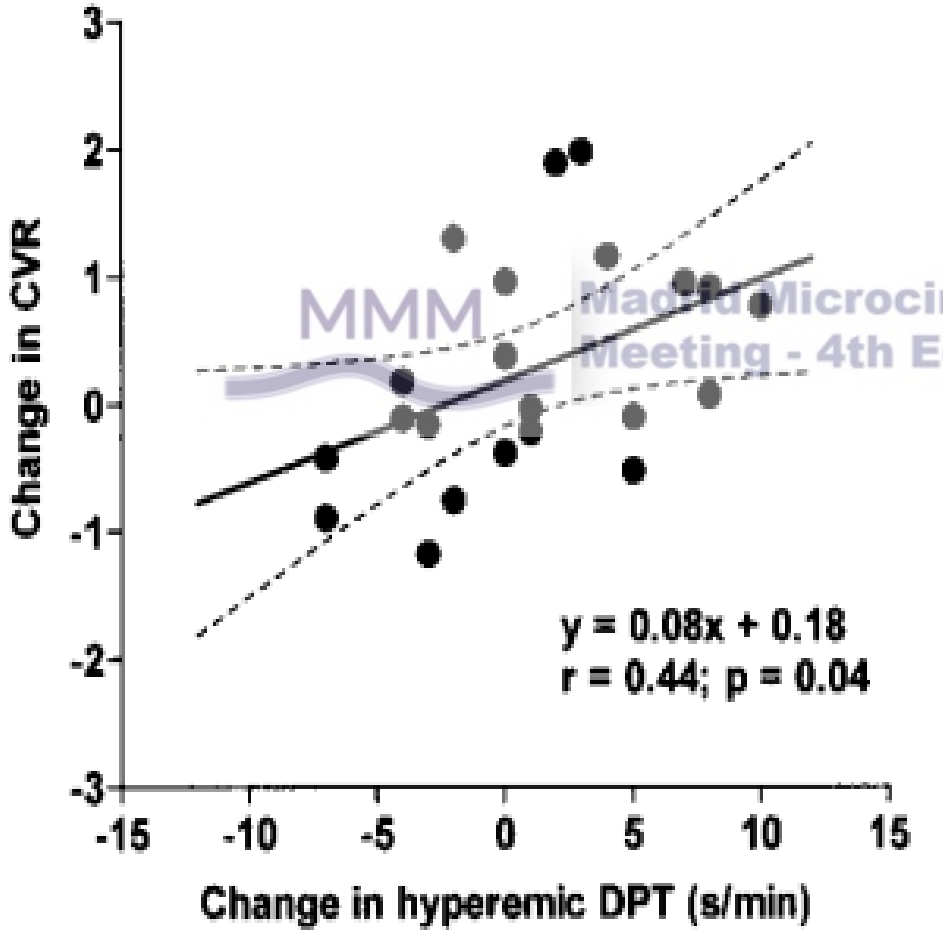
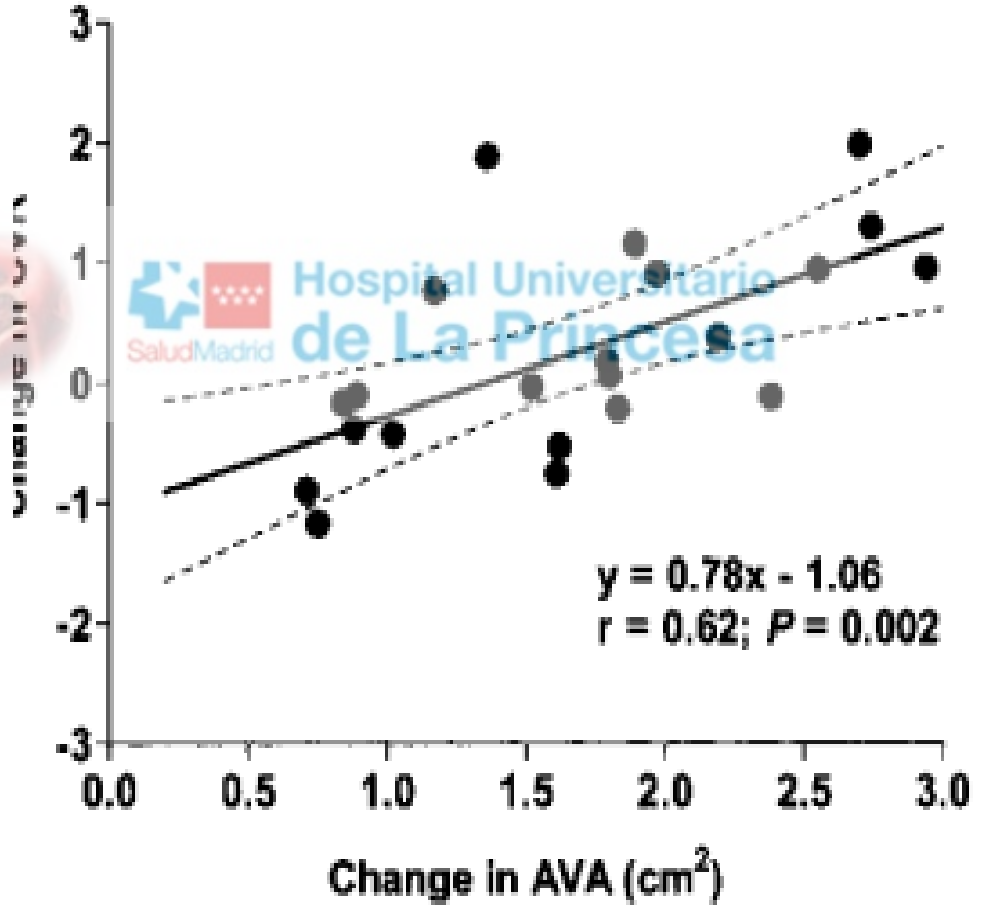
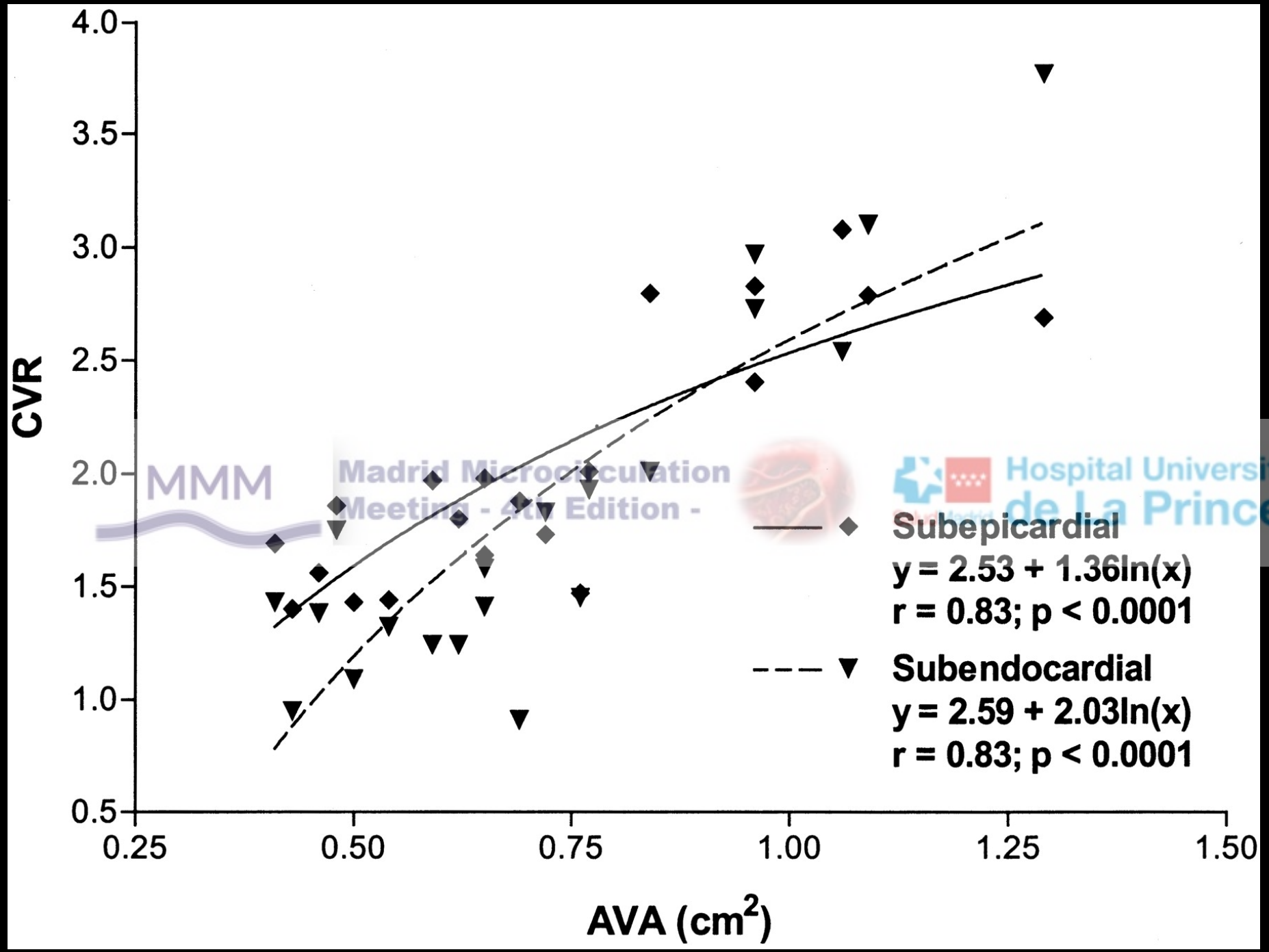
¿Which came first the chicken or the eggs?





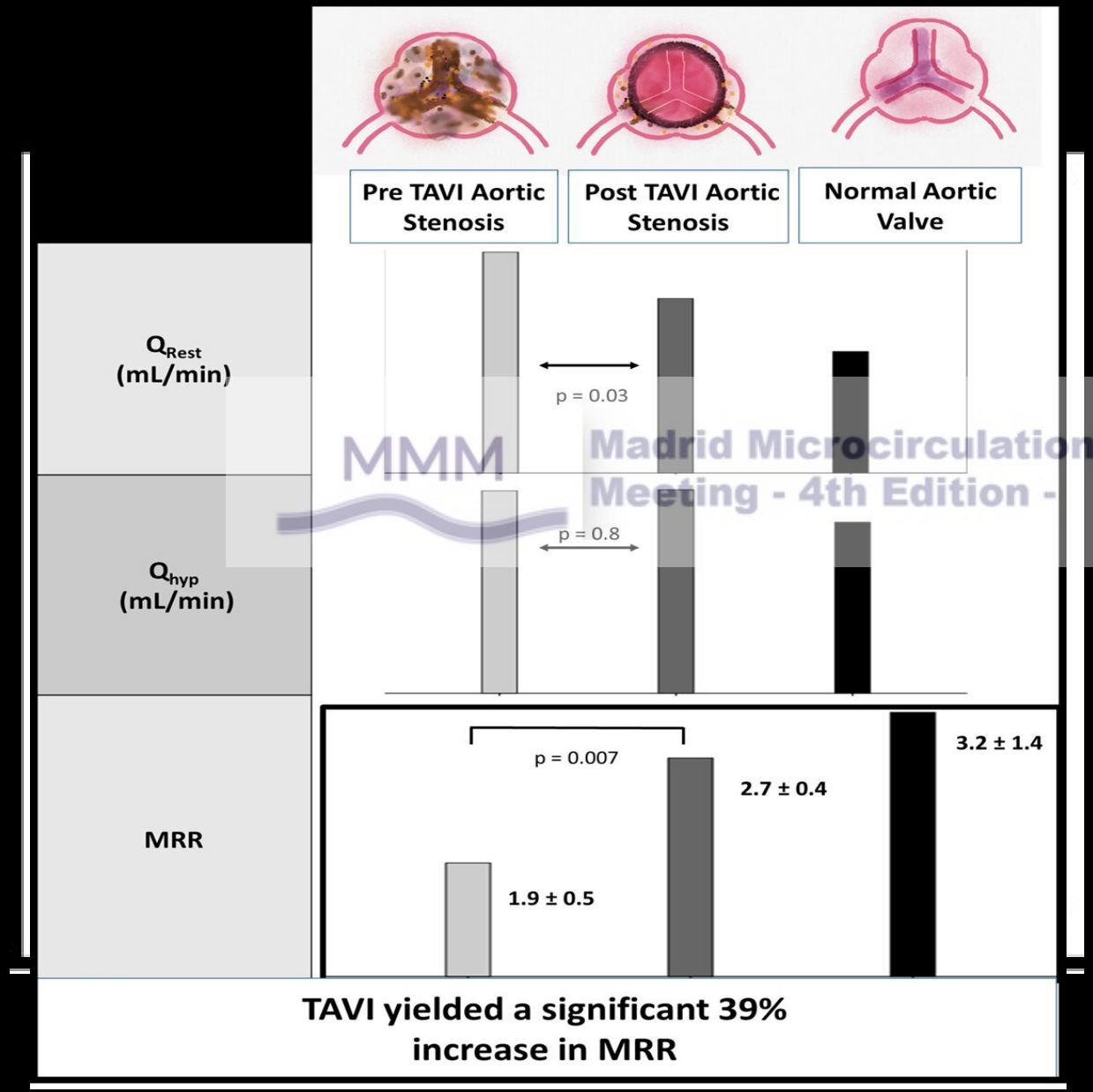


Kim Rajappan, (*Circulation*. 2003;107:3170-3175.)



Kim Rajappan. *Circulation*. 2002;105:470-476.

Quantitative Alterations in Absolute Resting and Hyperemic Coronary Blood Flow After Severe Aortic Stenosis Replacement



	AS-preTAVI (n=11)*	AS-post TAVI (n=11)*	P Value
$Q_{, Hyp}$ (mL/min)	271 ± 113	266 ± 119	0.79
$R_{u, Hyp}$ (Wu)	340 ± 149	351 ± 183	0.61
$Q_{, Rest}$ (mL/min)	157 ± 55	111 ± 46	0.03
$R_{u, Rest}$ (Wu)	641 ± 395	794 ± 545	0.2
$CFR_{, abs}$	1.7 ± 0.4	2.3 ± 0.3	0.003
MRR	1.91 ± 0.51	2.67 ± 0.41	0.007

Gutiérrez Barrios A. 2023. Not published

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CONCLUSIONS

CFR/MRR ARE IMPAIRED IN SEVERE AS

HYPERMIC RESISTANCE ARE PRESERVED ... but always?

SECONDARY TO HAEYMODYNAMIC CONDITIONS AND AT LEAST PARTIALLY REVERSIBLE AFTER VALVE REPLACEMENT

... but long term?

Problem Solved: The Egg Came First

Time to find a new brain teaser - the chicken and egg question has been solved. The egg wins

PRINCETON UNIVERSITY

Stoddard T. 2023. Science Journal


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When somebody is still asking me if
there is CMD in AS?


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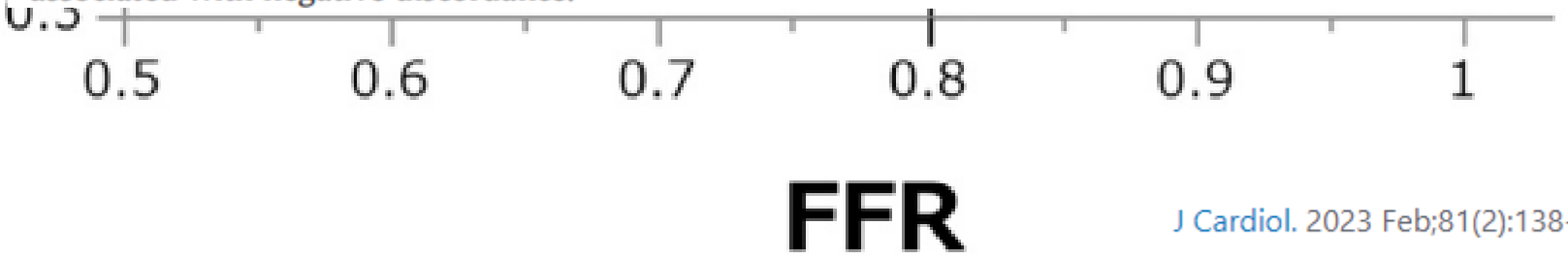
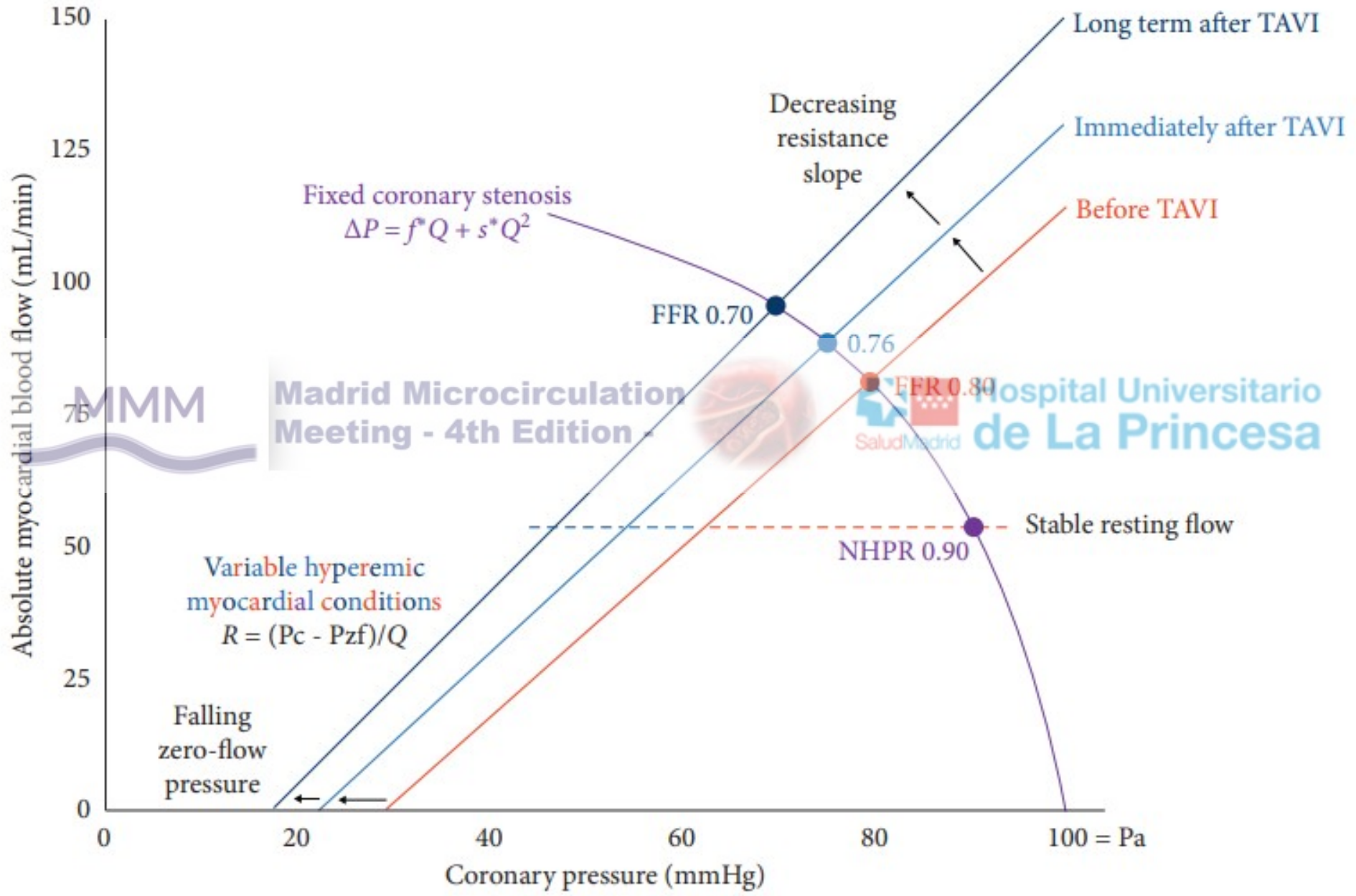
ABSTRACT

Background: Discordance between fractional flow reserve (FFR) and instantaneous wave-free ratio (iFR) occurs in approximately 20 % of cases. However, no studies have reported the discordance in patients with severe aortic stenosis (AS). We aimed to evaluate the diagnostic discordance between FFR and iFR in patients with severe AS.
Methods: We examined 140 consecutive patients with severe AS (164 intermediate coronary artery stenosis vessels). FFR and iFR were calculated in four quadrants based on threshold FFR and iFR values of ≤0.8 and ≤0.89, respectively (Group 1: iFR >0.89, FFR >0.80; Group 2: iFR ≤0.89, FFR >0.80; Group 3: iFR >0.89, FFR ≤0.80; and Group 4: iFR ≤0.89, FFR ≤0.80). Concordant groups were Groups 1 and 4, and discordant groups were Groups 2 and 3. Positive and negative discordant groups were Groups 3 and 2, respectively.
Results: The median (Q1, Q3) FFR and iFR were 0.84 (0.76, 0.88) and 0.85 (0.76, 0.91), respectively. Discordance was observed in 48 vessels (29.3 %). In the discordant group, negative discordance (Group 2: iFR ≤0.89 and FFR >0.80) was predominant (45 cases, 93.6 %). Multivariate analysis showed that the left anterior descending artery [odds ratio (OR), 3.88; 95 % confidence interval (CI): 1.54–9.79, $p = 0.004$] and peak velocity ≥5.0 m/s (OR, 3.21; 95%CI: 1.36–7.57, $p = 0.008$) were independently associated with negative discordance (FFR >0.8 and iFR ≤0.89).
Conclusions: In patients with severe AS, discordance between FFR and iFR was predominantly negative and observed in 29.3 % of vessels. The left anterior descending artery and peak velocity ≥5.0 m/s were independently associated with negative discordance.



J Cardiol. 2023 Feb;81(2):138-143.

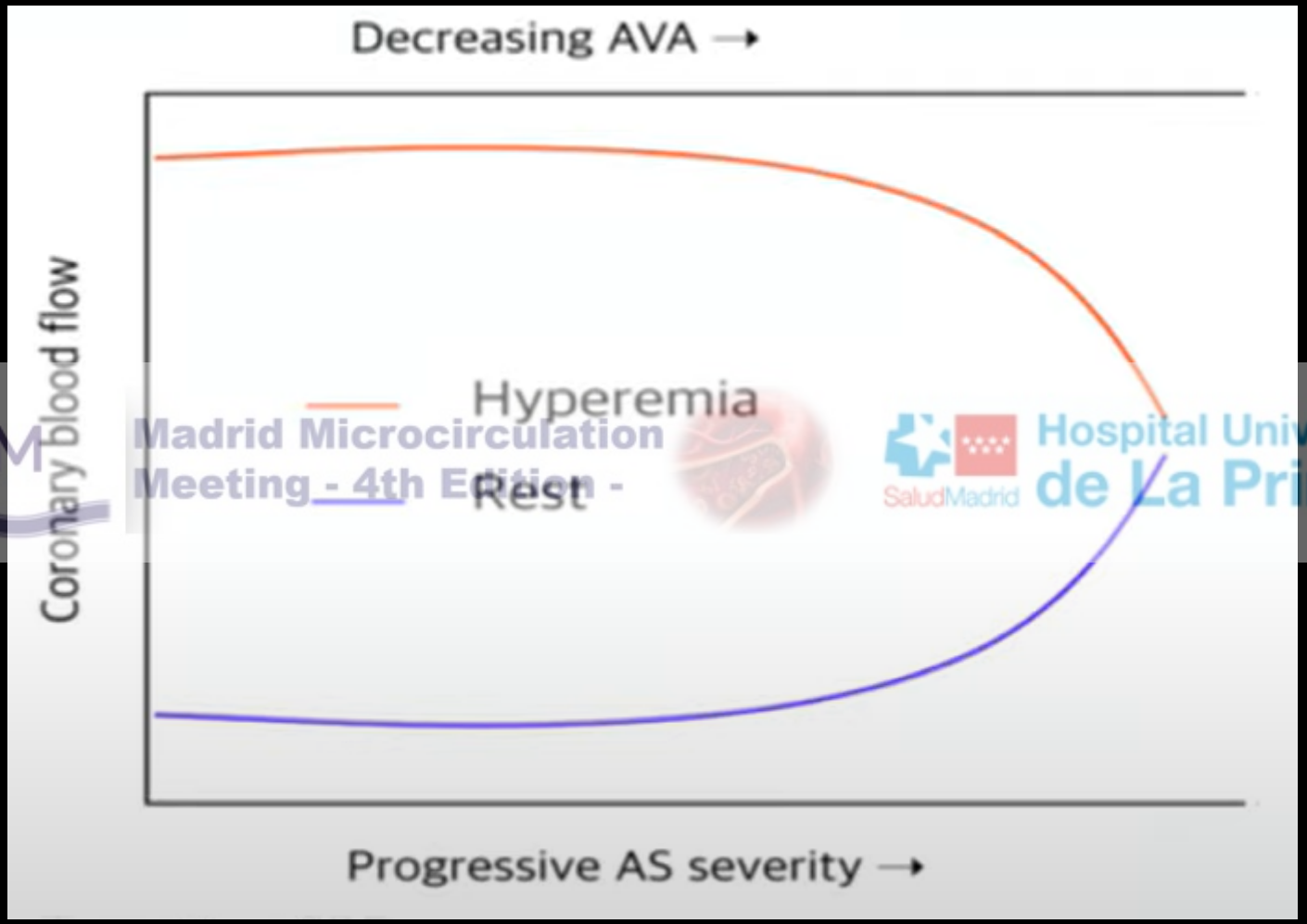


Impact of Aortic Valve Stenosis on Coronary Hemodynamics: Effect of TAVI

Esther M.A. [illegible] Pandi, PhD;

Hyperemia	
HR	0.004
Pd	0.437
Pa	0.123
PdPa	0.122

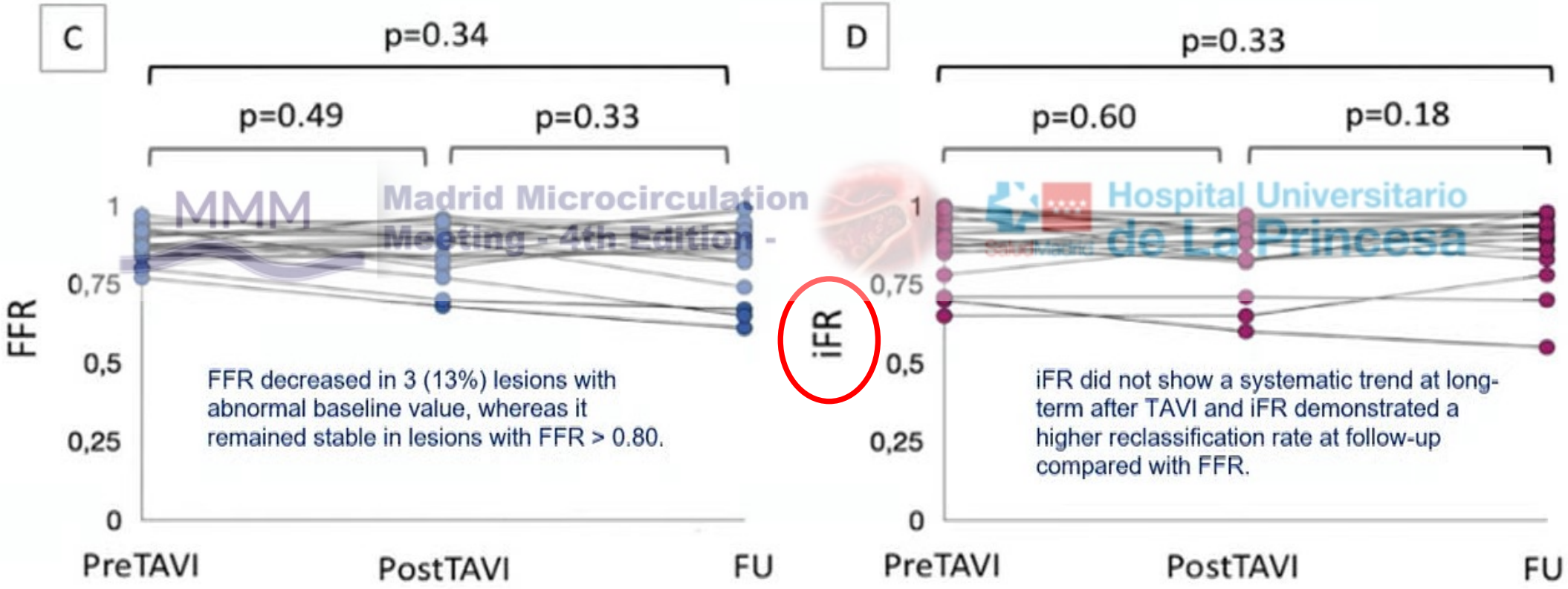
(*Circ Cardiovasc Interv*. 2015;8:e002443.



Garcia D et al. J Appl Physiol 106: 113–121, 2009.

Immediate & long-term variations in FFR & iFR after TAVR

The normalization of the aortic valve gradient may have only a minor impact on coronary physiology assessment after TAVR. Caution seems advisable in the interpretation of borderline FFR or iFR results in the presence of severe AS



The usual thresholds of FFR & iFR are still valid

Scarsini R et al. Int J Cardiol;2020:317,37-41.

Functional Assessment of Coronary Artery Disease in Patients Undergoing Transcatheter Aortic Valve Implantation

Influence of Pressure Overload on the Evaluation of Lesions Severity

Gabriele Pesarini, MD; Roberto Scarsini, MD; Carlo Zivelonghi, MD; Anna Piccoli, MD;

Background—Aortic valve stenosis may influence fractional flow reserve (FFR) of concomitant coronary artery disease by causing hypertrophy and reducing the vasodilatory reserve of the coronary circulation. We sought to investigate whether FFR values might change after valve replacement.

Methods and Results—The functional relevance of 133 coronary lesions was assessed by FFR in 54 patients with severe aortic valve stenosis before and after transcatheter aortic valve implantation (TAVI) during the same procedure. A linear mixed model was used to verify the interaction of TAVI effect with the FFR values. No significant overall change in FFR values was found before and after the aortic valve stenosis removal (0.89±0.10 versus 0.89±0.13; *P*=0.73). A different trend in FFR groups (positive if ≤0.8; negative if >0.8) was found after TAVI (*P* for interaction <0.001). Positive FFR values worsened after TAVI (0.71±0.11 versus 0.66±0.14). Conversely, negative FFR values improved after TAVI (0.92±0.06 versus 0.93±0.07). Similarly, FFR values in coronary arteries with lesions presenting percent diameter stenosis >50 worsened after TAVI (0.84±0.12 versus 0.82±0.16; *P*=0.02), whereas FFR values in arteries with mild lesions (percent diameter stenosis <50) tended toward improvement after TAVI (0.90±0.07 versus 0.91±0.09; *P*=0.69). Functional FFR variations after TAVI changed the indication to treat the coronary stenosis in 8 of 133 (6%) lesions.

Conclusions—Coronary hemodynamics are influenced by aortic valve stenosis removal. Nevertheless, FFR variations after TAVI are minor and crossed the diagnostic cutoff of 0.8 in a small number of patients after valve replacement. Borderline coronary lesions might become functionally significant after valve replacement, although FFR-guided interventions were infrequent even in patients with angiographically significant lesions. **(*Circ Cardiovasc Interv*. 2016;9:e004088.**

***Circ Cardiovasc Interv*. 2016;9:e004088.**