Clinical Evaluation of a Patient with a Dysfunctional Prosthetic Aortic Valve Before Pregnancy
A True Clinical Challenge

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Pregnancy with Heart Disease Service

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The Patient

- 39 years old woman G0P0
- 2012: Syncope due to previously unknown severe aortic stenosis
- 2012: Biological AVR (Magna Ease 19 mm)
- 02/15: Referred from another hospital for re-do AVR due to ↑ gradients across the prosthetic valve in order to allow a future pregnancy
- Pre-operative evaluation requested by cardiac surgeons

The Patient

- Currently asymptomatic
- No co-morbidities
- First post operative echo(2012): AV Δ 34/21 mmHg
- Last echo(exercise stress echo in 2014): Normal LV size, no LVH, LVEF=65%
- Resting Δ 68/35 mmHg, walked 6 and a half minutes Δ ↑ to 115/86 mmHg, SPAP: 56 mmHg
- No symptoms

Objectives

- Define aortic stenosis severity
- Echocardiographic evaluation of Aortic Stenosis
- Pitfalls on severity evaluation
- Assessment of prosthetic Valves
- Surgical indications
- Aortic stenosis in pregnancy

Aortic *Stenosis: Classification*

	Sclerosis	Mild	Moderate	Severe
Jet Velocity(m/sec)	<2.5	2.6-2.9	3.0-4.0	>4.0
Mean Gradient (mmHg)		<20	20-40	>40
Valve Area (cm^2)		>1.5	1.0-1.5	<1.0
Valve Area Index(cm^2/m^2)		>0.85	0.6-0.85	<0.6

ESC and ACC-Guidelines

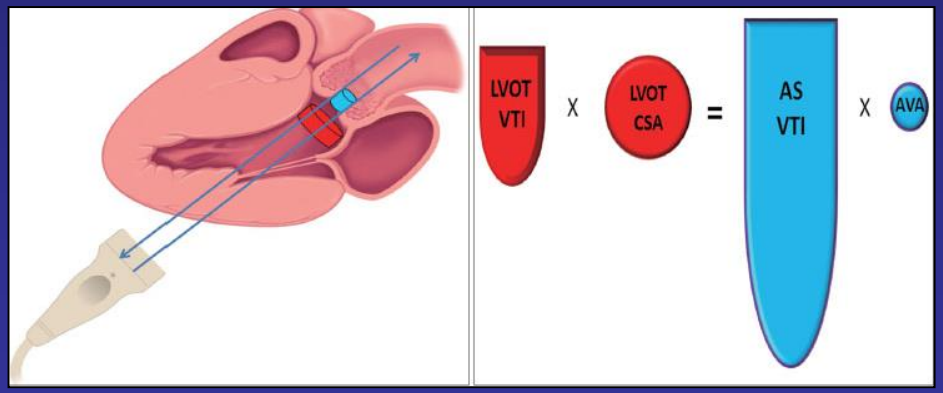
Echocardiographic Evaluation of Aortic Stenosis
The Continuity Equation

- Continuity equation states that the stroke volume ejected through the LVOT all passes through the stenotic AV

$$AVA = CSA_{LVOT} \times VTI_{LVOT} / VTI_{AV}$$

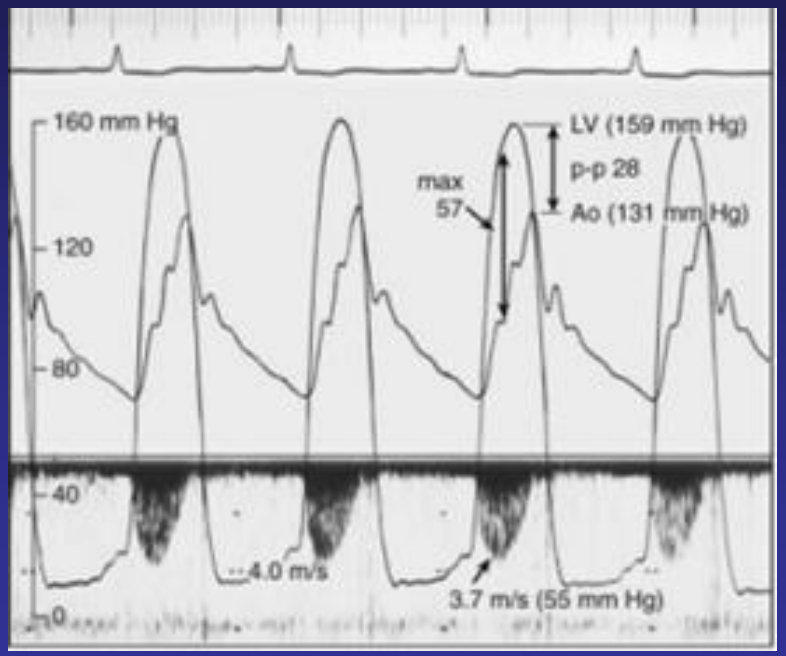
Calculation of continuity equation valve area requires 3 measurements

- AS velocity by CW
- LVOT diameter
- LVOT velocity by PW



Comparing Pressure Gradients Calculated from Doppler Velocities to Pressures Measured at Cardiac Catheterization

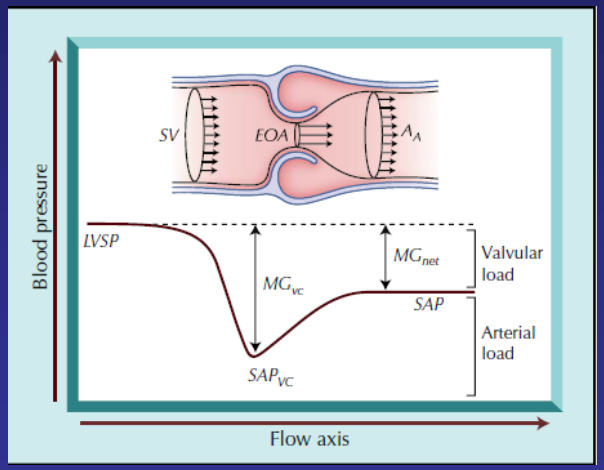
- **Peak to peak Δ**
- **Peak instantaneous Δ**



Pitfalls on the Assessment of Severity

Sources of error for pressure gradient calculations

- Pressure Recovery is greatest in patients with narrow aortas (<3 cm diameter)



Evaluation of the Prosthetic Aortic Valve

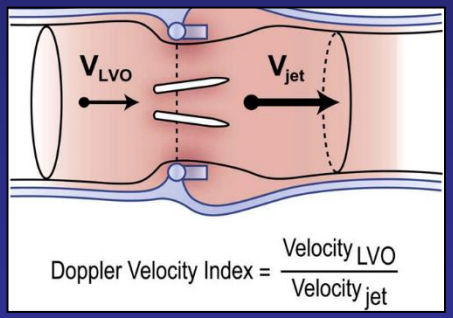
Imaging Considerations

- Identify the sewing ring and surrounding area
- Leaflets of normal tissue valves should be thin with an unrestricted motion

Evaluation of the Prosthetic Aortic Valve

Doppler Considerations

- Doppler velocity
- Wave shape
- Velocity ratio



Doppler & Prosthetic AV

- High gradients may be seen with normal functioning valves with:
  - Small size
  - Increased stroke volume
  - Patient prosthetic mismatch(PPM)
  - Valve obstruction
- Thus, the ability to distinguish malfunctioning from normal PVs in high flow states on the basis of gradients alone may be difficult

Prosthetic Valve Evaluation

Magna Ease 19 mm

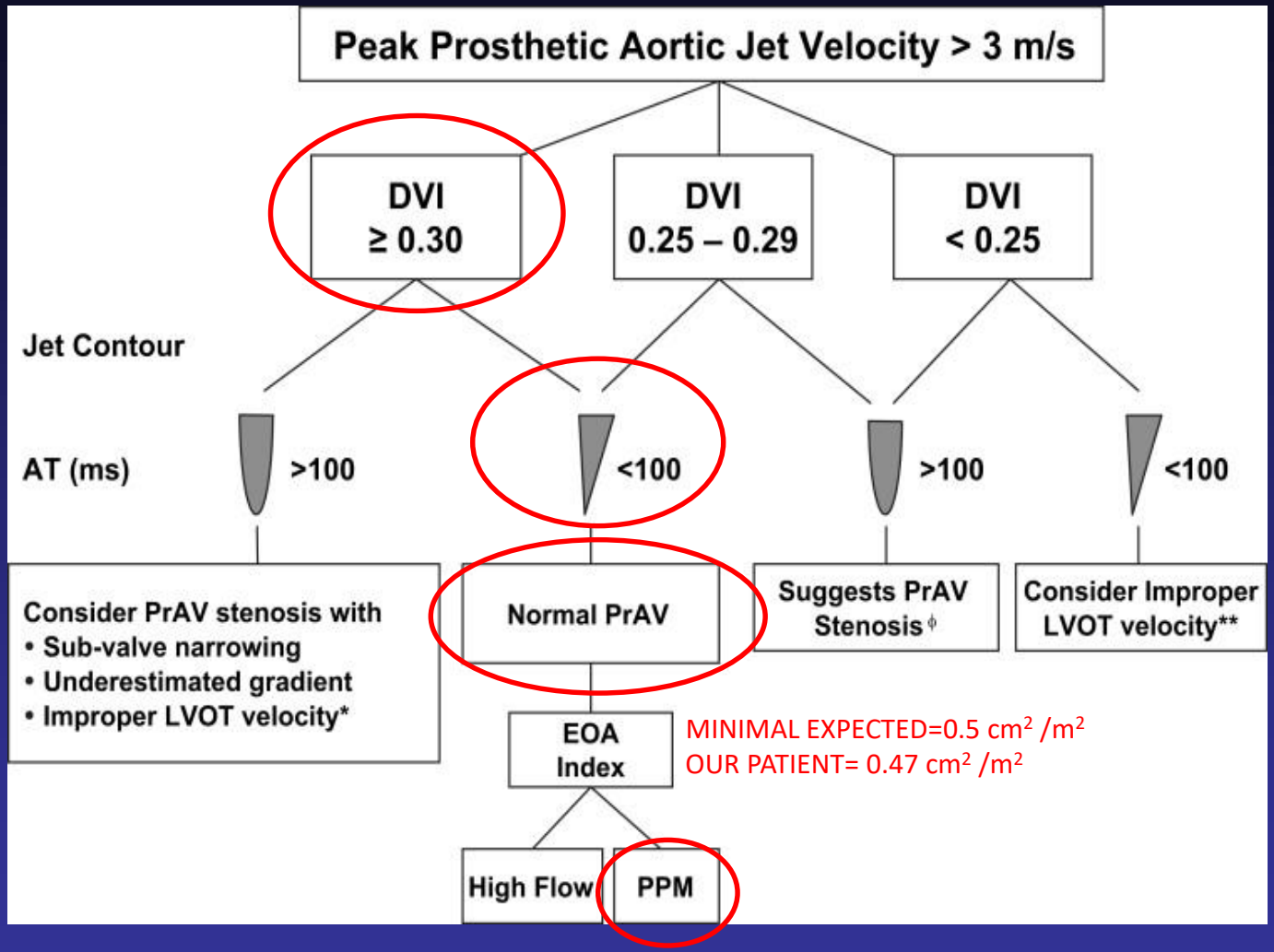
- Expected gradients
  - Peak: 32 ± 3.4 mmHg
  - Mean: 24.8 ± 8.6 mmHg
  - Expected EOA: 1.2±0.3 cm^2


Magna Ease valve

Our Patient Re-Evaluation

- Normal LV size, No LVH, LVEF=65%
- Peak Δ=53/31mmHg, EOA=0.69 cm^2,
- LVOT Diameter= 1.7 cm,
- Asc Ao Diameter= 2.4 cm
- Pressure Recovery was calculated
- PR=14mmHg
- Net gradient (53-14) = 39 mmHg
- AVA corrected for PR=0.82 cm^2
- Acceleration time: 90 ms
- DVI ratio=0.3

Our Patient Re-Evaluation



Additional Investigations

Exercise Stress Echo

- 6’30” Bruce protocol, Maximal Δ=81/55 mmHg, Maximal SPAP 55 mmHg. No symptoms

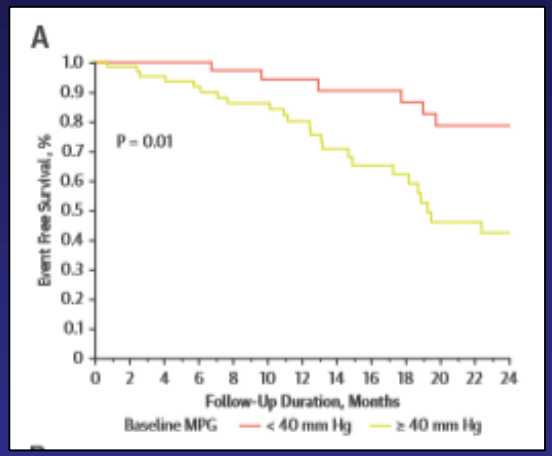
TEE

- Mildly thickened leaflets with normal motion
- Anatomic AVA: 0.9 cm^2
- Cardio-pulmonary exercise test: normal

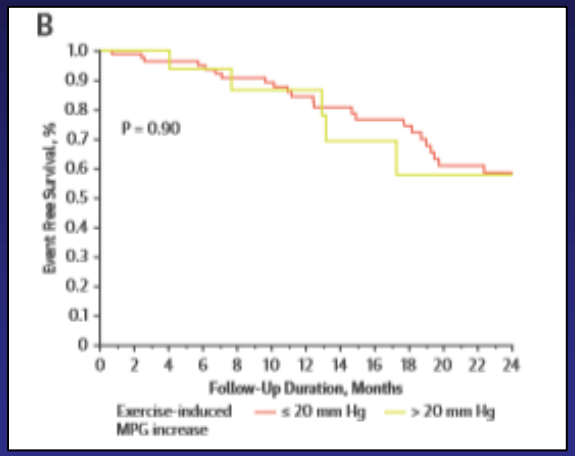
ORIGINAL RESEARCH

Prognostic Value of Exercise-Stress Echocardiography in Asymptomatic Patients With Aortic Valve Stenosis

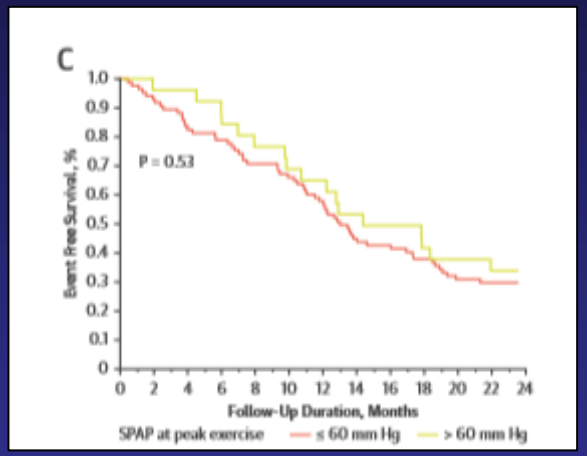
Rest Mean Δ



Exercise Mean Δ Increase



SPAP at Peak Exercise



n=148

On multivariable analysis only Mean Δ at rest predicted long term outcomes

Goublaire, J Am Coll Img 2018

Surgical Indications

C) Asymptomatic patients with severe aortic stenosis (refers only to patients eligible for surgical valve replacement)		
SAVR is indicated in asymptomatic patients with severe aortic stenosis and systolic LV dysfunction (LVEF <50%) not due to another cause.	I	C
SAVR is indicated in asymptomatic patients with severe aortic stenosis and an abnormal exercise test showing symptoms on exercise clearly related to aortic stenosis.	I	C
SAVR should be considered in asymptomatic patients with severe aortic stenosis and an abnormal exercise test showing a decrease in blood pressure below baseline.	IIa	C
SAVR should be considered in asymptomatic patients with normal ejection fraction and none of the above-mentioned exercise test abnormalities if the surgical risk is low and one of the following findings is present: • Very severe aortic stenosis defined by a V_{max} >5.5 m/s • Severe valve calcification and a rate of V_{max} progression ≥0.3 m/s/year • Markedly elevated BNP levels (>threefold age- and sex-corrected normal range) confirmed by repeated measurements without other explanations • Severe pulmonary hypertension (systolic pulmonary artery pressure at rest >60 mmHg confirmed by invasive measurement) without other explanation.	IIa	C

ESC Valvular Guidelines 2017

Surgical Indications

Recommendations for Prosthetic Valve Stenosis		
COR	**LOE**	**Recommendations**
I	C	Repeat valve replacement is indicated for severe symptomatic prosthetic valve stenosis (239-241).

AHA/ACC Updated Valvular Guidelines, 2017

And what About Pregnancy with Aortic Stenosis

Guidelines

Class IIa

1. **Exercise testing is reasonable in asymptomatic patients with severe AS (aortic velocity ≥4.0 m per second or mean pressure gradient ≥40 mm Hg, stage C) before pregnancy.** ***(Level of Evidence: C)***

Class I

4. **Pregnant patients with severe valve stenosis (stages C and D) should be monitored in a tertiary care center with a dedicated Heart Valve Team of cardiologists, surgeons, anesthesiologists, and obstetricians with expertise in the management of high-risk cardiac patients during pregnancy.** ***(Level of Evidence: C)***

* Pregnancy should be discouraged in women with severe symptomatic aortic stenosis

ACC/AHA Valvular Guidelines 2014
** ESC Valvular Guidelines 2017*

Risk of Pregnancy in Moderate and Severe Aortic Stenosis

From the Multinational ROPAC Registry

- 96 women with moderate or severe AS
- Severe AS(n=34): Peak Δ ≥ 64 mmHg
- Moderate AS (n=62): Peak Δ ≥ 36 mmHg
  - 7 patients had an Aortic Bioprosthesis
  - (Peak Δ 47±6.5 mmHg , mean Δ 28±5.5 mmHg)

Risk of Pregnancy in Moderate and Severe Aortic Stenosis

From the Multinational ROPAC Registry

TABLE 1 Maternal Baseline Characteristics

	All AS Patients	Moderate AS	Severe AS	p Value	Asymptomatic Patients	Symptomatic Patients	p Value
Number of patients	96	62	34		60	36	
Age in yrs	30.3 (26.0-32.8)	29.8 (26.3-32.9)	30.6 (25.9-32.7)	0.96	30.5 (26.2-33.4)	29.9 (25.8-32.8)	0.67
Nulliparous	47 (49)	36 (58.1)	11 (32.4)	**0.028**	36 (60)	11 (30.6)	**0.01**
Prior cardiac intervention	48 (50)	34 (54.8)	14 (41.2)	0.11	30 (50.0)	18 (50)	0.83
NYHA functional class							
I	60 (62.5)	45 (72.6)	15 (44.1)	**0.02**	60 (100)	–	–
II	32 (33.3)	15 (24.2)	17 (50.0)		–	32 (88.9)	
III	4 (4.2)	2 (3.2)	2 (5.9)		–	4 (11.1)	
IV	0 (0)	0 (0)	0 (0)		–	0 (0)	
AS location							
Valvular	59 (61.5)	45 (72.6)	18 (52.9)	**0.02**	35 (58.3)	24 (66.7)	0.49
Subvalvular	22 (22.9)	11 (17.7)	11 (32.4)		16 (26.7)	6 (16.7)	
Supravalvular	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)	
Not specified	15 (15.6)	10 (16.1)	5 (14.7)		9 (15.0)	6 (16.7)	
Bicuspid aortic valve	46 (53.5)	34 (60.7)	12 (40.0)	0.18	35 (64.8)	11 (34.4)	**0.02**
Peak aortic gradient, mm Hg	62.1 ± 26.3	47.5 ± 6.9	88.7 ± 28.0	**<0.0001**	56.8 ± 20.1	71.1 ± 32.7	**0.006**
Mean aortic gradient, mm Hg	39.1 ± 17.9	27.8 ± 5.3	55.1 ± 17.4	**<0.0001**	35.4 ± 16.0	44.3 ± 19.5	**0.006**
Left ventricular function	65.6 ± 8.7	67.4 ± 6.2	62.4 ± 11.5	0.27	66.6 ± 7.1	64.0 ± 10.7	0.60

Orwat et al, JACC 2016

Risk of Pregnancy in Moderate and Severe Aortic Stenosis

From the Multinational ROPAC Registry

- No maternal mortality
- 2 miscarriages
- 1 fetal death (woman severe AS and previous heart failure)

Orwat et al, JACC 2016

Risk of Pregnancy in Moderate and Severe Aortic Stenosis

From the Multinational ROPAC Registry

Maternal Outcomes

	All AS Patients	Moderate AS	Severe AS	p Value	Asymptomatic Patients	Symptomatic Patients	p Value
Maternal mortality	0	–	–	–	–	–	–
Maternal hospital admission	34 (35.8)	17 (27.4)	17 (51.5)	**0.027**	21 (35.0)	13 (37.1)	0.42
Maternal cardiac hospital admission	20 (20.8)	8 (12.9)	12 (35.3)	**0.02**	9 (15.0)	11 (30.6)	0.12
Cardiac complications							
Heart failure	11 (11.5)	5 (8.1)	6 (17.6)	0.29	5 (8.3)	6 (16.7)	0.36
Arrhythmias (SVT)	1 (1.0)	1 (1.6)	0 (0)	0.76	1 (1.7)	0 (0)	0.80
Arrhythmias (VT/VF)	1 (1.0)	0 (0)	1 (2.9)	0.76	0 (0)	1 (2.8)	0.79
Endocarditis	1 (1.0)	1 (1.6)	0 (0)	0.76	1 (1.7)	0 (0)	0.80
Valve thrombosis	0 (0)	0 (0)	0 (0)	–	0 (0)	0 (0)	–
Cerebrovascular complication	0 (0)	0 (0)	0 (0)	–	0 (0)	0 (0)	–
Pulmonary embolism	0 (0)	0 (0)	0 (0)	–	0 (0)	0 (0)	–
Deep venous thrombosis	0 (0)	0 (0)	0 (0)	–	0 (0)	0 (0)	–
Obstetric complications							
Pregnancy-induced hypertension	3 (3.2)	2 (3.2)	1 (3.0)	0.57	2 (3.3)	1 (2.9)	0.63
(Pre-)eclampsia	3 (3.2)	3 (4.8)	0 (0)	0.50	3 (5.0)	0 (0)	0.46
Cesarean section	54 (57.4)	30 (48.3)	24 (75.0)	**0.008**	30 (50.0)	24 (70.6)	**0.029**
Hemorrhagic events	4 (4.2)	4 (6.5)	0 (0)	0.33	4 (66.7)	0 (0)	0.29

Orwat et al, JACC 2016

Risk of Pregnancy in Moderate and Severe Aortic Stenosis

From the Multinational ROPAC Registry

Fetal Outcomes

	All AS Patients	Moderate AS	Severe AS	p Value	Asymptomatic Patients	Symptomatic Patients	p Value
Fetal outcome							
Apgar score <7	8 (9.0)	3 (5.2)	5 (16.1)	0.21	4 (7.0)	4 (12.5)	0.37
Pregnancy duration (weeks)	37.2 ± 5.2	38.0 ± 4.4	35.5 ± 6.4	**0.002**	37.0 ± 6.2	37.5 ± 2.8	0.08
Pre-term birth <37 weeks	18 (20.9)	8 (16.0)	10 (35.7)	**0.017**	10 (18.2)	8 (25.8)	0.49
Mean birth weight, g	3,010 ± 691	3,198 ± 549	2,648 ± 797	**0.003**	3,091 ± 642	2,878 ± 758	0.24
Low birth weight (<2,500 g)	16 (16.2)	4 (6.0)	12 (35.0)	**0.006**	6 (10.0)	10 (27.8)	**0.037**
Small for gestational age	8 (9.3)	2 (3.4)	6 (21.4)	**0.022**	3 (5.5)	5 (16.1)	0.21
Miscarriages	2 (2.1)	2 (3.2)	0 (0)	0.76	2 (3.3)	0 (0)	0.71
Fetal death	0 (0)	0 (0)	0 (0)	–	0 (0)	0 (0)	–
Neonatal death	1 (1.1)	0 (0)	1 (3.3)	0.05	0 (0)	1 (3.0)	0.38

Orwat et al, JACC 2016

Risk of Pregnancy in Moderate and Severe Aortic Stenosis

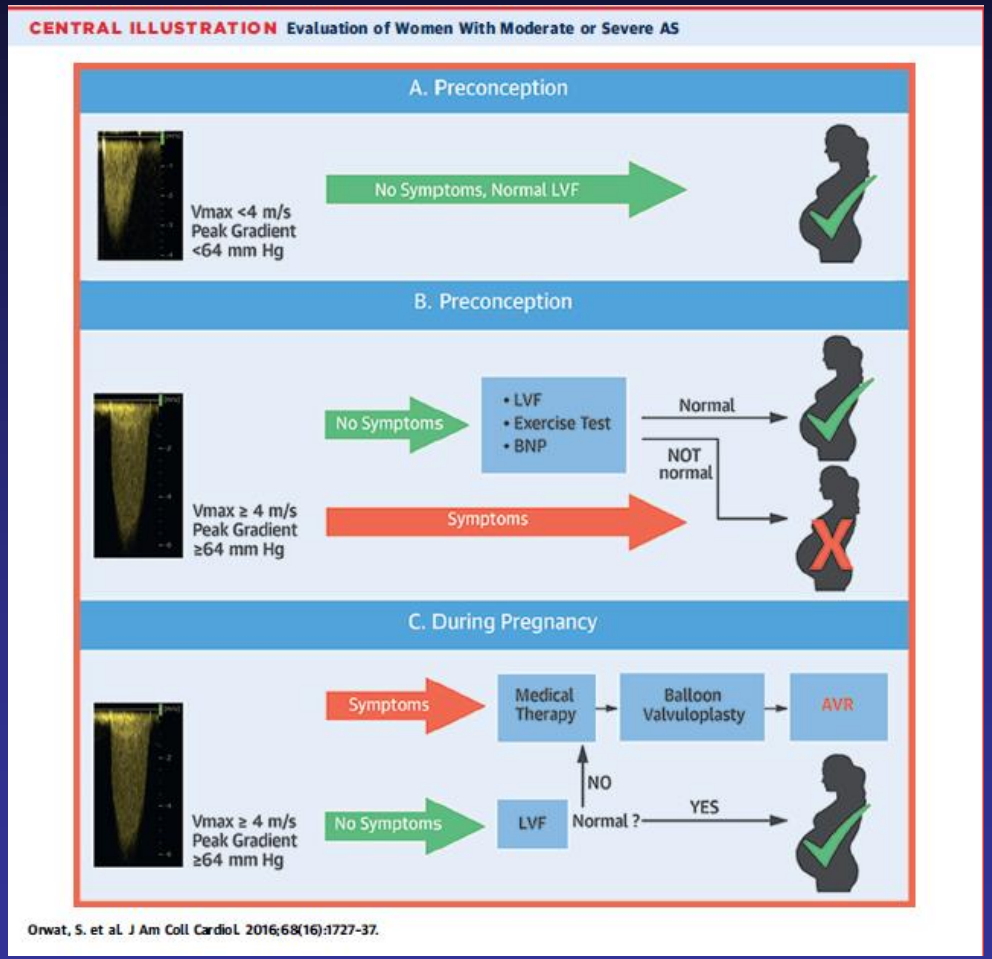
From the Multinational ROPAC Registry

- On Mutivariable Analysis
  - Only peak Δ predicted maternal outcomes
  - Peak Δ and AS severity predicted fetal outcomes

Orwat et al, JACC 2016

Risk of Pregnancy in Moderate and Severe Aortic Stenosis

From the Multinational ROPAC Registry



Orwat, S. et al. J Am Coll Cardiol. 2016;68(16):1727-37.

Back to Our Patient

- Surgery was cancelled
- Asymptomatic (2016-2017)
- No further changes on gradients or functional capacity
- BNP: Normal
- Request for IVF with egg donation accepted

Back to Our Patient

- 08/17: Pregnant
- Asymptomatic during all pregnancy
- Baseline BNP and at 32 weeks were normal
- LVEF↑ to 75%, AV gradients ↑ to 103/55 mmHg (week 32)
- Delivered on week 36+4 : Elective Cesarean
- Apgar 9/10, 2560 g
- Aortic Δ before discharge: 57/32 mmHg
- Discharged home on POD 7

Thank You!!!