

Coronary Obstruction: Treatment and Prevention

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Disclosure Statement of Financial Interest

Within the past 12 months, I or my spouse/partner have had a financial interest/arrangement or affiliation with the organization(s) listed below.

Affiliation/Financial Relationship

- Grant/Research Support
- Grant/Scientific Advisory Board
- Executive Physician Council

Company

- Edwards Lifesciences
- Medtronic
- Boston Scientific Corp

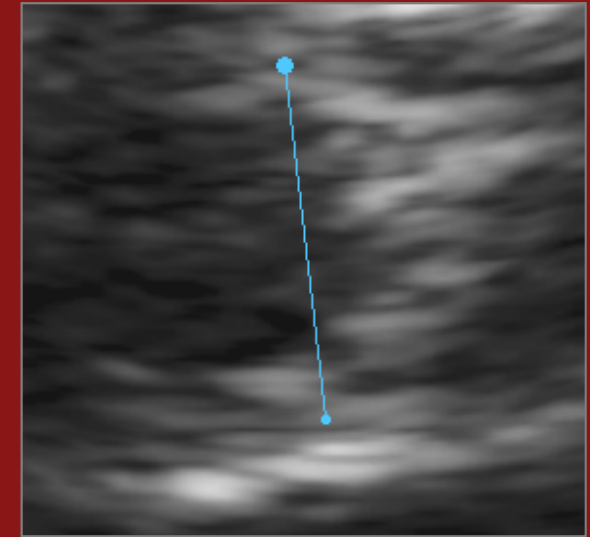


History

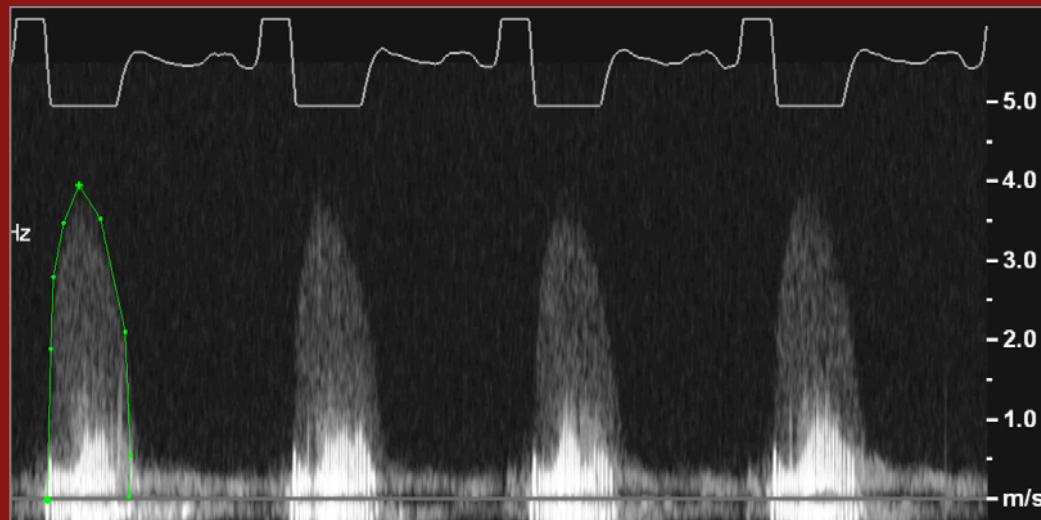
- 70 year old female with history of HTN, HLD, DM2, CVD, PVD, COPD, CKD stage 3 and severe, symptomatic AS
- History of myocardial infarctions; s/p PCI/stent to RCA
- Multiple ER visits and hospitalizations with congestive heart failure
- Recent hospitalization in March 2014 with CHF; symptomatic improvement on medical therapy
- Currently remains symptomatic of dyspnea on exertion
- PFTs (March 2013): FEV1 = 1.0 L (61%)
- Meets 2 of 4 frailty metrics (BMI 27.28): serum albumin WNL (3.6 g/dL), independent in 5/6 ADLs, reduced grip strength (13 kg), and prolonged 15-foot walk time (8 seconds)
- STS 8.3%/euroSCORE 4.16%:
 - Age 70, female, Caucasian, 65.5 kg, 155 cm (BSA 1.68), DM2 (oral), Cr 1.7, HTN, moderate lung disease, PVD, CVD, s/p PCI, s/p MI (remote), NYHA Class II, 2v CAD, EF 41%, AS, MS, mild AI, mild MR, trace TR, first op, elective
- Proposed: Prohibitive Risk (Co-morbidities) Commercial TAVR, 23 mm THV, TransAortic approach

Echo

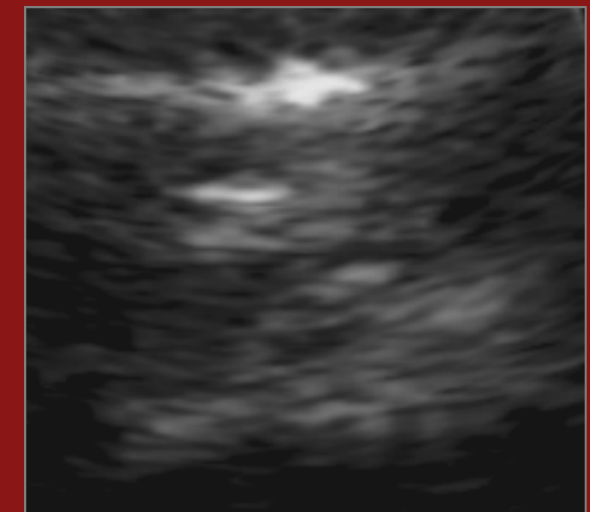
- TTE 3/25/14
 - AVA 0.78 cm²
 - AVAI 0.46 cm²/m²
 - V2 max 3.94 m/sec
 - Mean gradient 40 mmHg
 - Resting EF 41%
 - Annulus 20 mm
 - Mild MS, mild AI, mild-moderate MR, trace TR



Annulus 20 mm



CW

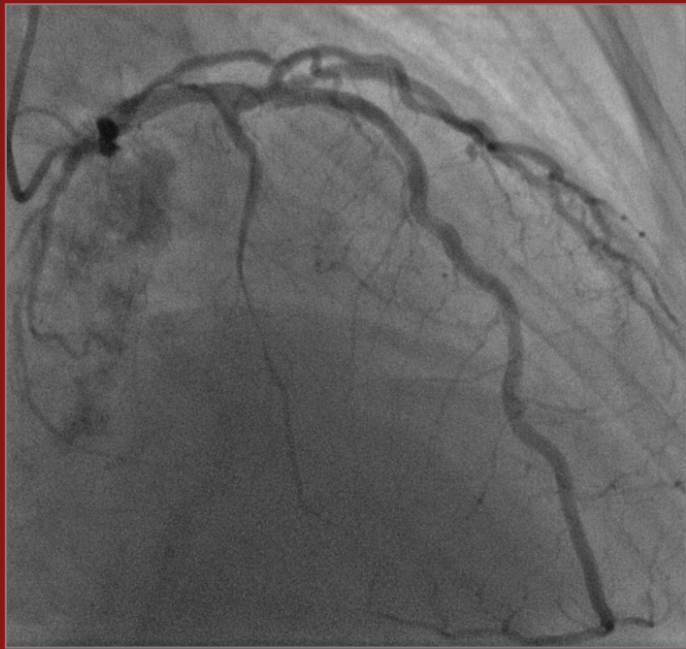


SAX

Cath Data 3/26/14

RHC: RA 5, RV 33/5, PA 30/15, PCW 8

*See Centricity for additional coronary images



LAD

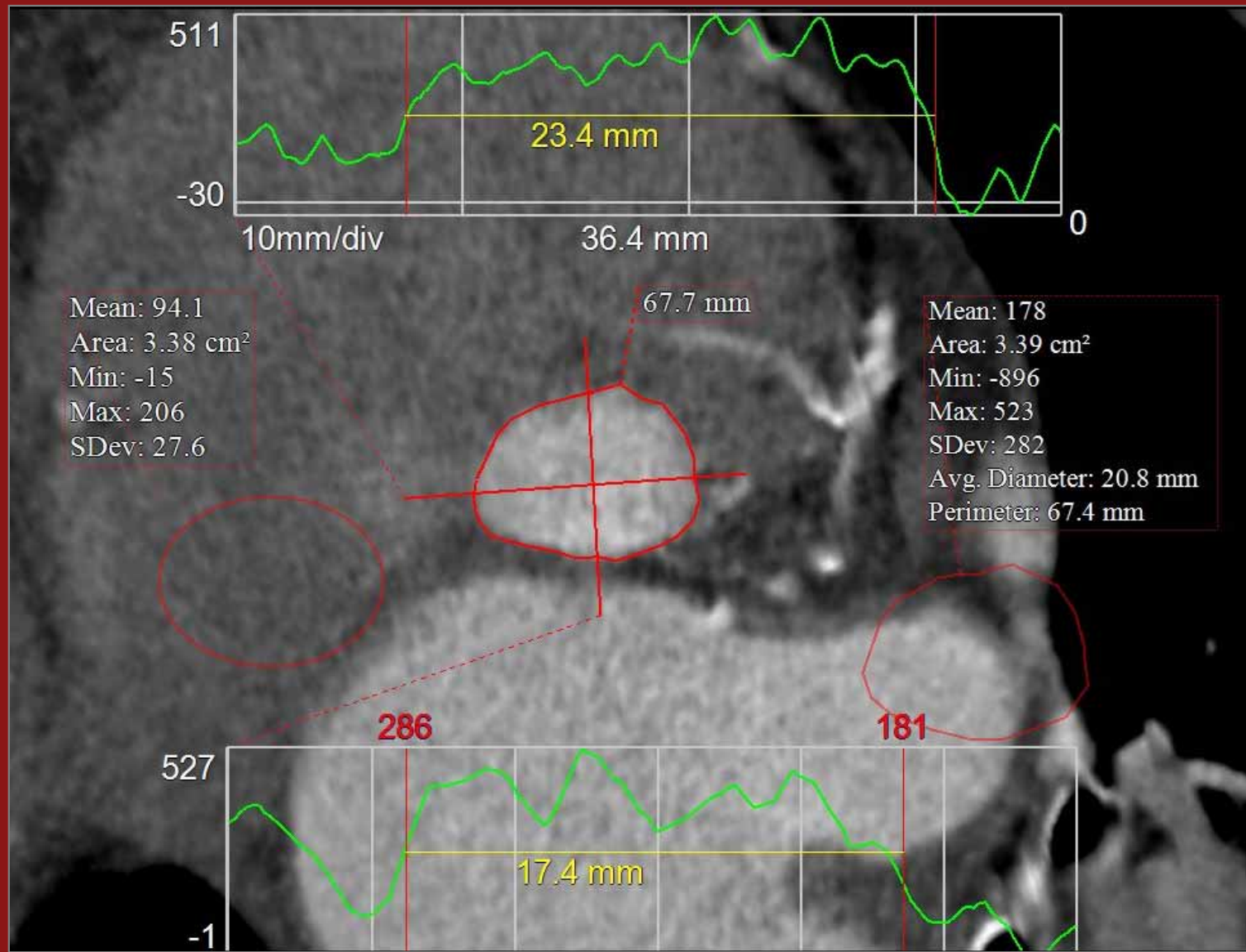


LCx



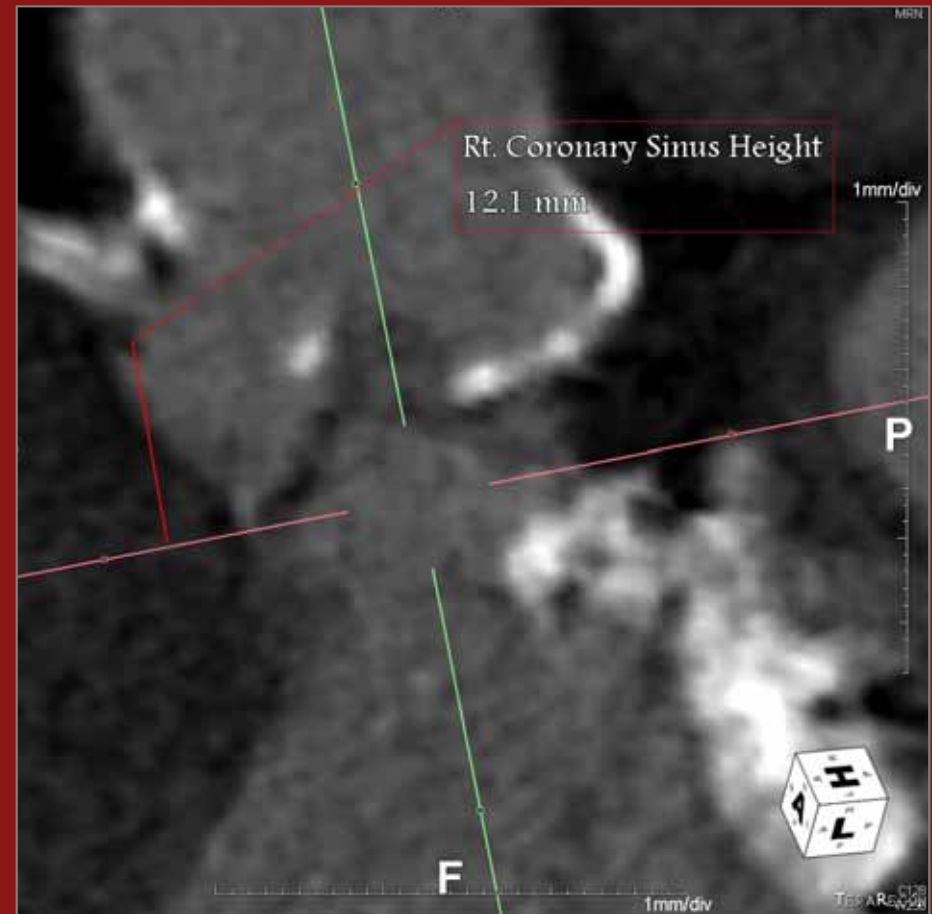
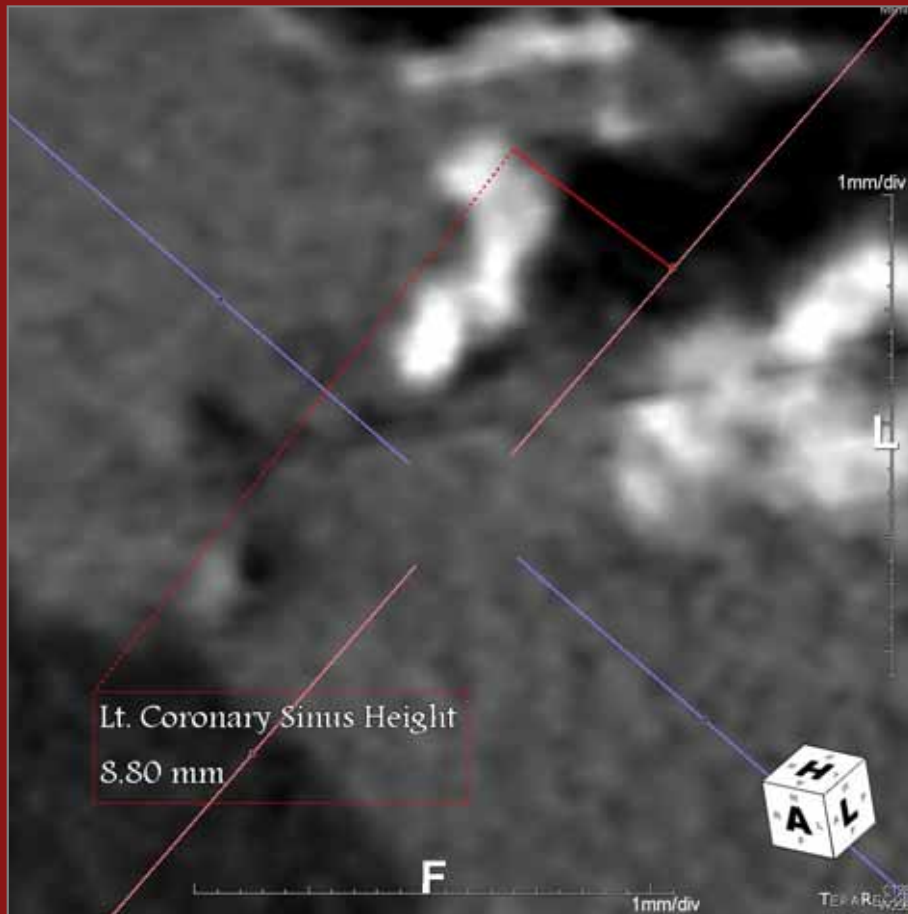
RCA

CT Data 3/24/14



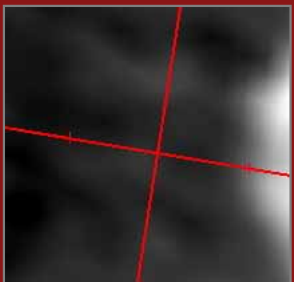
Annulus: 23.4 mm x 17.4 mm; 339 mm²
SOV: 28 x 26mm; STJ: 24 x 20 mm

CT Data 3/24/14



Coronary Heights

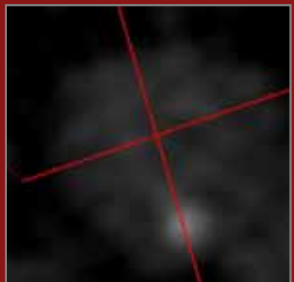
CT Data 3/24/14



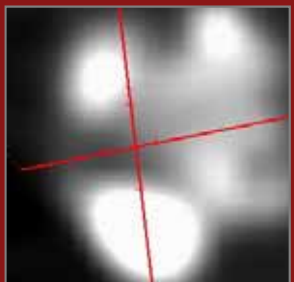
RCIA 11.1 x 5.0mm



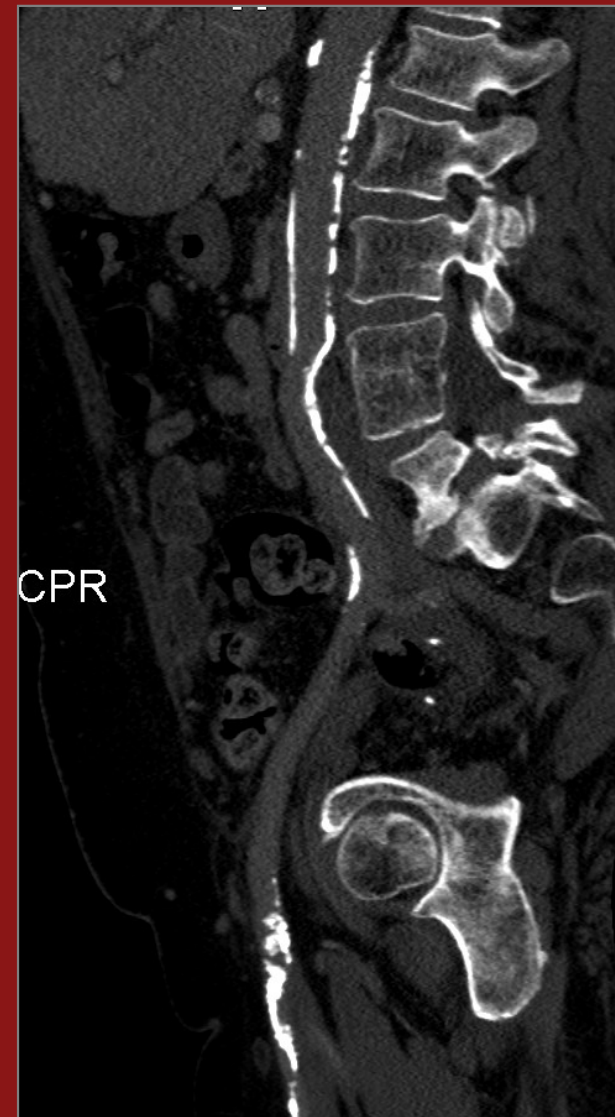
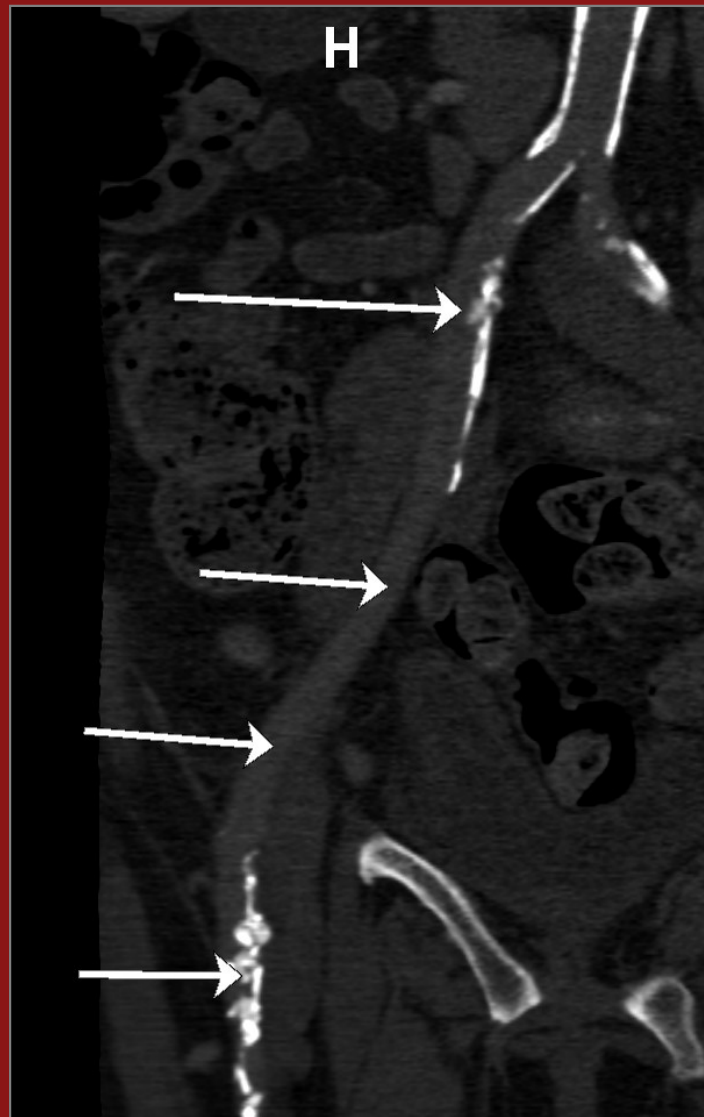
REIA #1 7.6 x 6.1 mm



REIA #2 9.6 x 6.6 mm

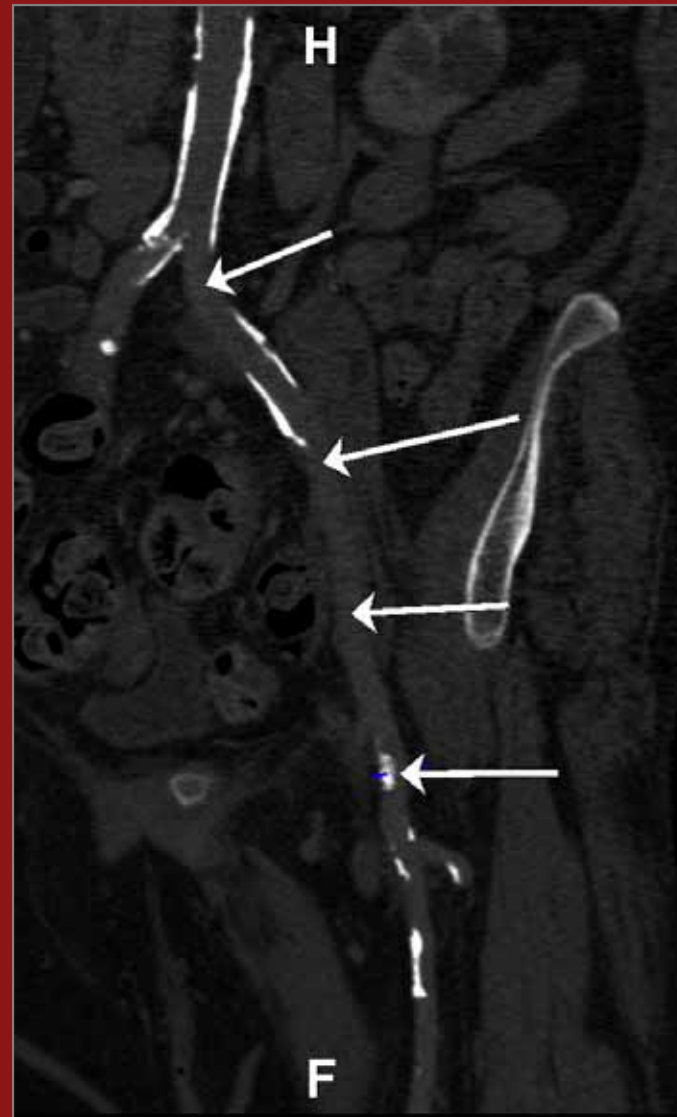


RCFA 3.5 x 2.7 mm

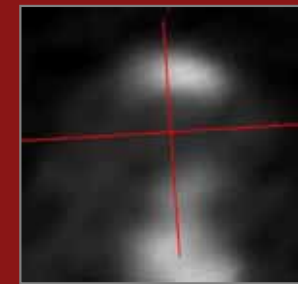


Right Side

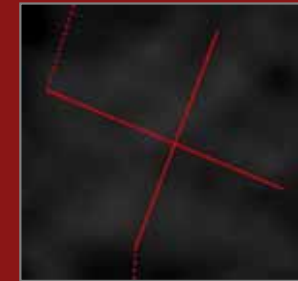
CT Data 3/24/14



Left Side



LCIA 9.1 x 3.4 mm



LEIA #1 9.5 x 8.6 mm



LEIA #2 7.7 x 7.3 mm



LCFA 5.3 x 2.2 mm

Prohibitive Risk Assessment

- Moderate lung disease
- CKD Stage 3
- Frailty

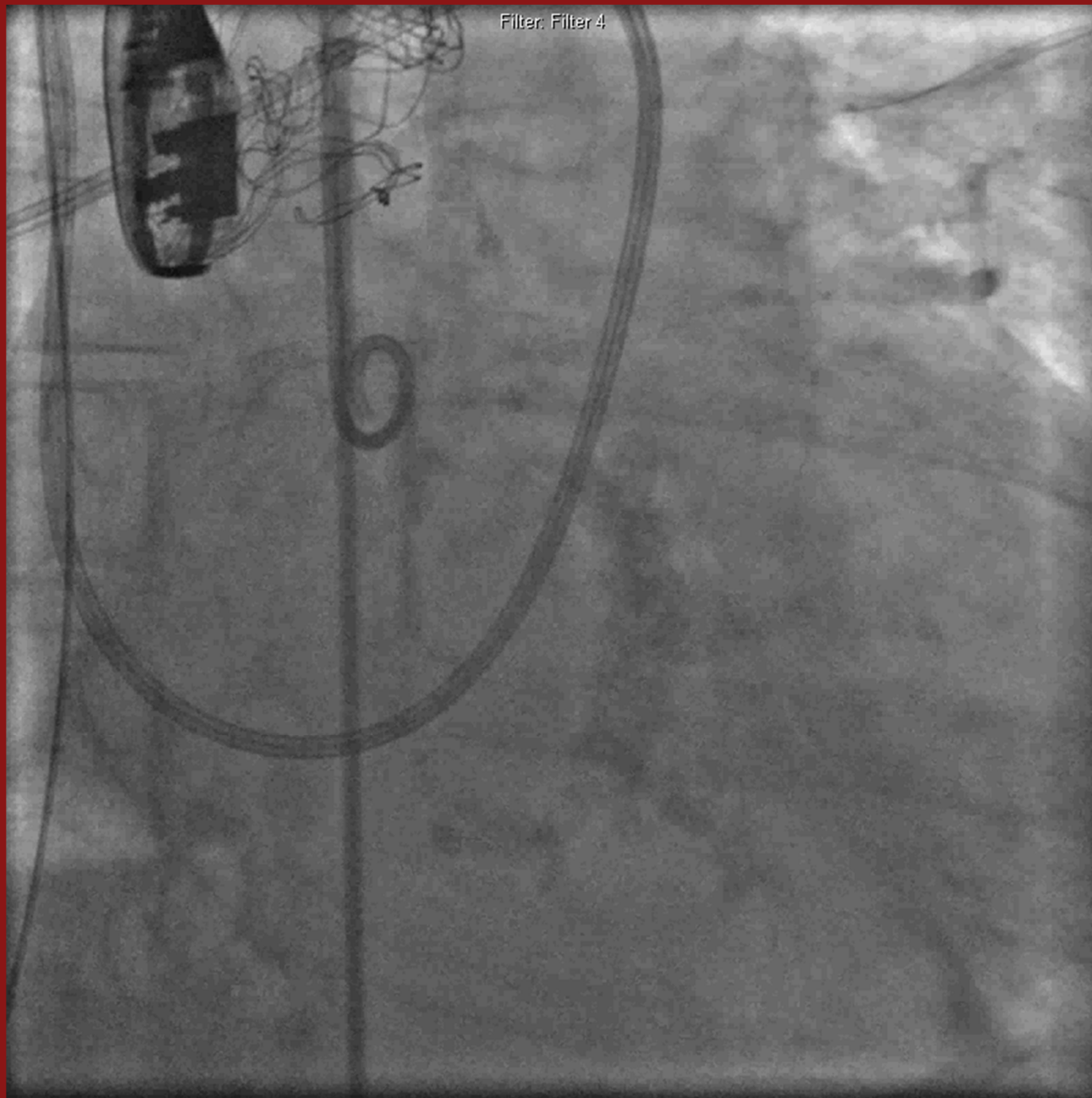
Summary

- 70 year old female
- STS 8.3 %/euroSCORE 4.16%
- Prohibitive Risk (Co-morbidities) Commercial TAVR
- 23 mm THV
- TransAortic approach

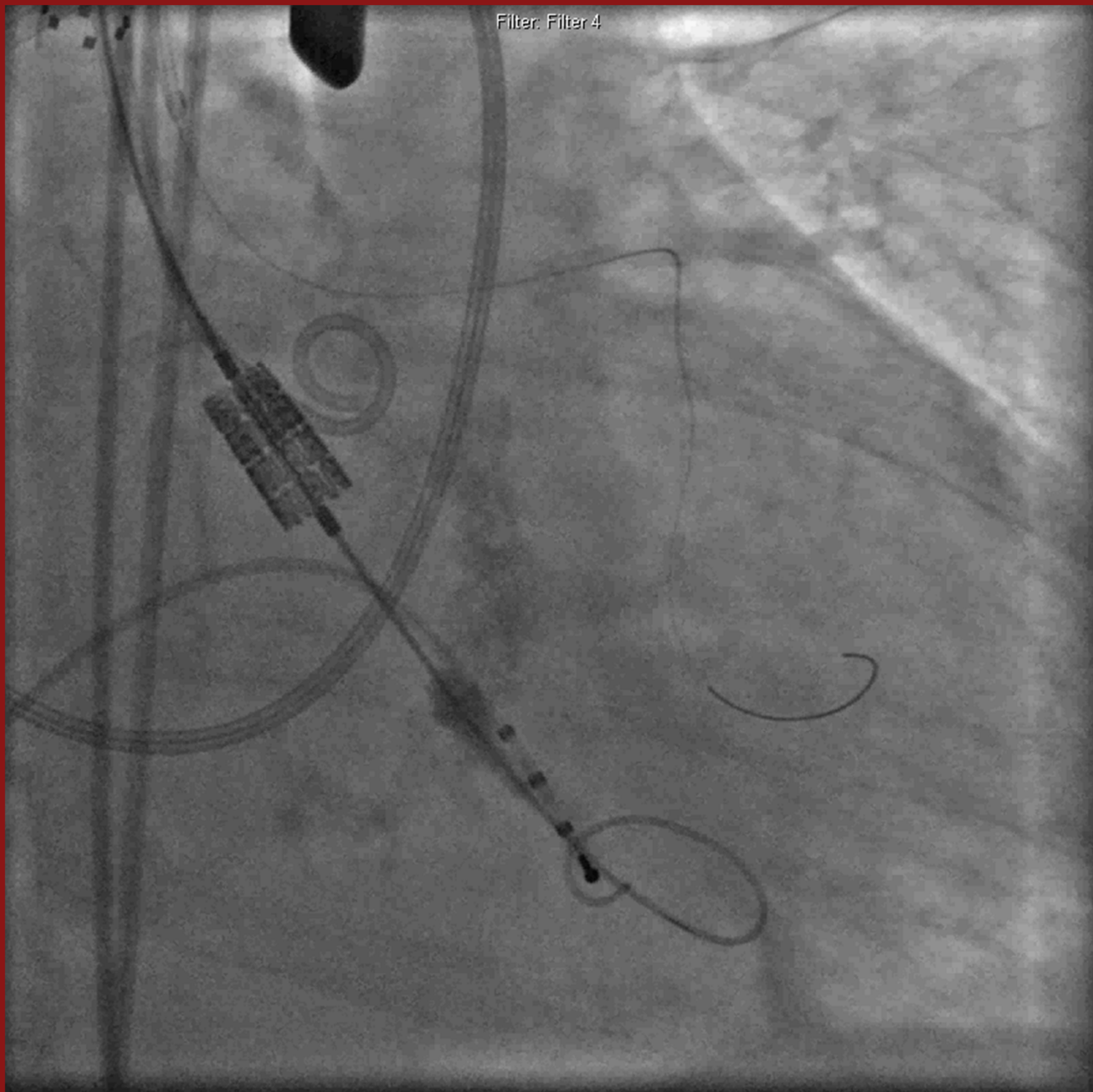
Filter: Filter 4



Filter: Filter 4



Filter: Filter 4



PHILIPS

RD2

MI 0.7

5/20/2014

TIS 0.1

9:11:45 AM

TEE
X7-2t
60 Hz
HD Zoom

Pat. T: 37.0 °C
TEE T: 37.2 °C
0 130 180



2D
Gen
Gn 44
C 48
4/4/0
50 mm/s



PHILIPS
RD2

MI 0.7 5/20/2014
TIS 0.1 9:16:19 AM

TEE
X7-2t
60 Hz
HD Zoom

Pat. T: 37.0 °C
TEE T: 37.2 °C
0 44 180

A semi-circular scale with a needle pointing to the 44-degree mark. The scale is labeled with 0, 44, and 180.

2D
Gen
Gn 50
C 48
4/4/0
50 mm/s



G
P R
3.0 8.0

PHILIPS

RD2

MI 0.5

5/20/2014

TIS 0.6

9:13:49 AM

TEE
X7-2t
20 Hz
12.0cm

Pat. T: 37.0 °C
TEE T: 37.5 °C
0 138 100

P

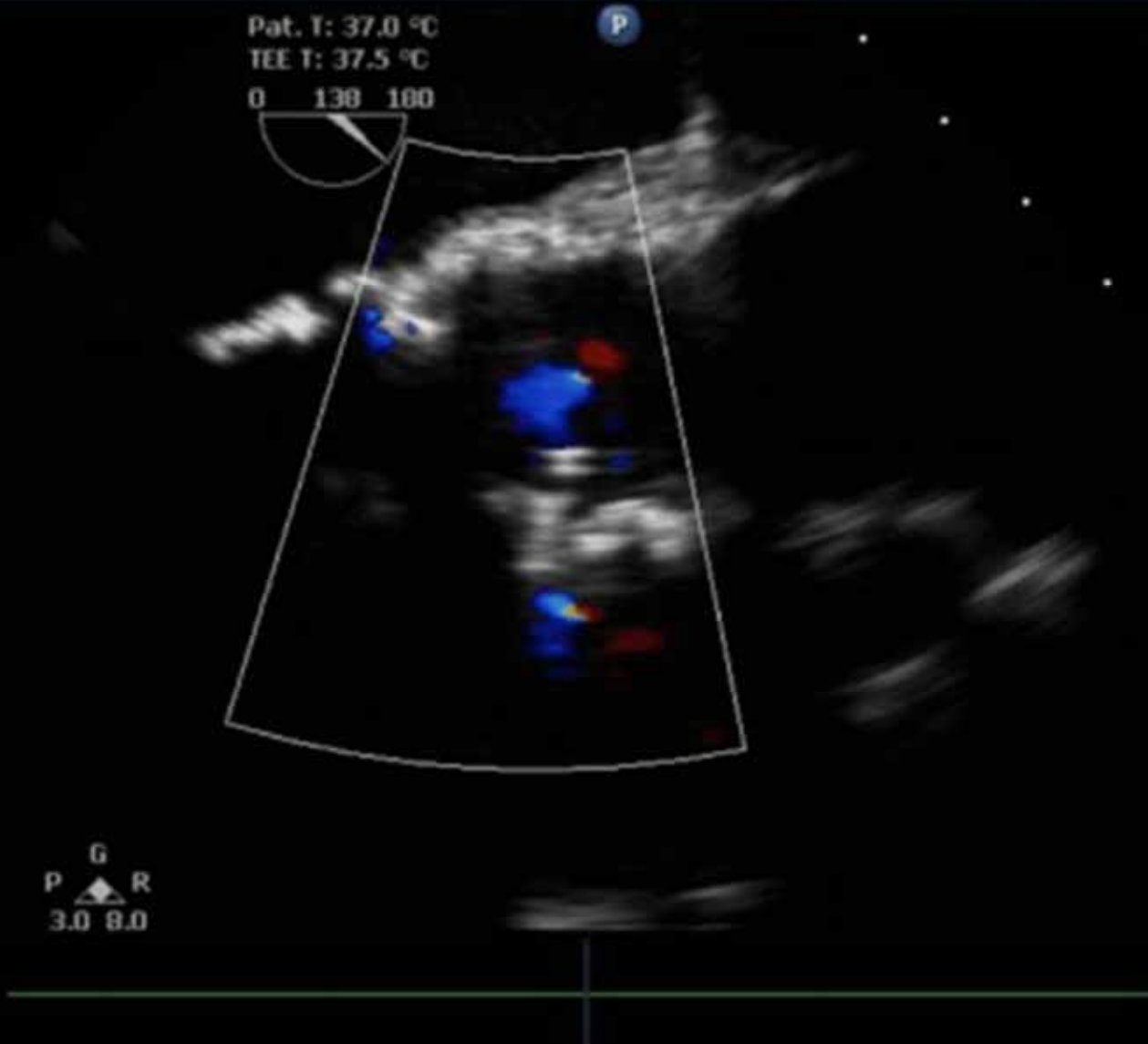
+57



2D
Gen
Gn 44
C 48
4/4/0
50 mm/s

Color
4.0 MHz
Gn 36
4/4/0
Filtr Med

G
P ▲ R
3.0 8.0



PHILIPS

RD2

MI 0.5

5/20/2014

TIS 0.6

9:12:24 AM

TEE
X7-2t
12 Hz
HD Zoom

Pat. T: 37.0 °C
TEE T: 37.4 °C
0 44 180

+40



2D
Gen
Gn 44
C 48
4/4/0
50 mm/s

Color
4.0 MHz
Gn 36
4/4/0
Filtr Med



Incidence of Coronary Obstruction in the Registries

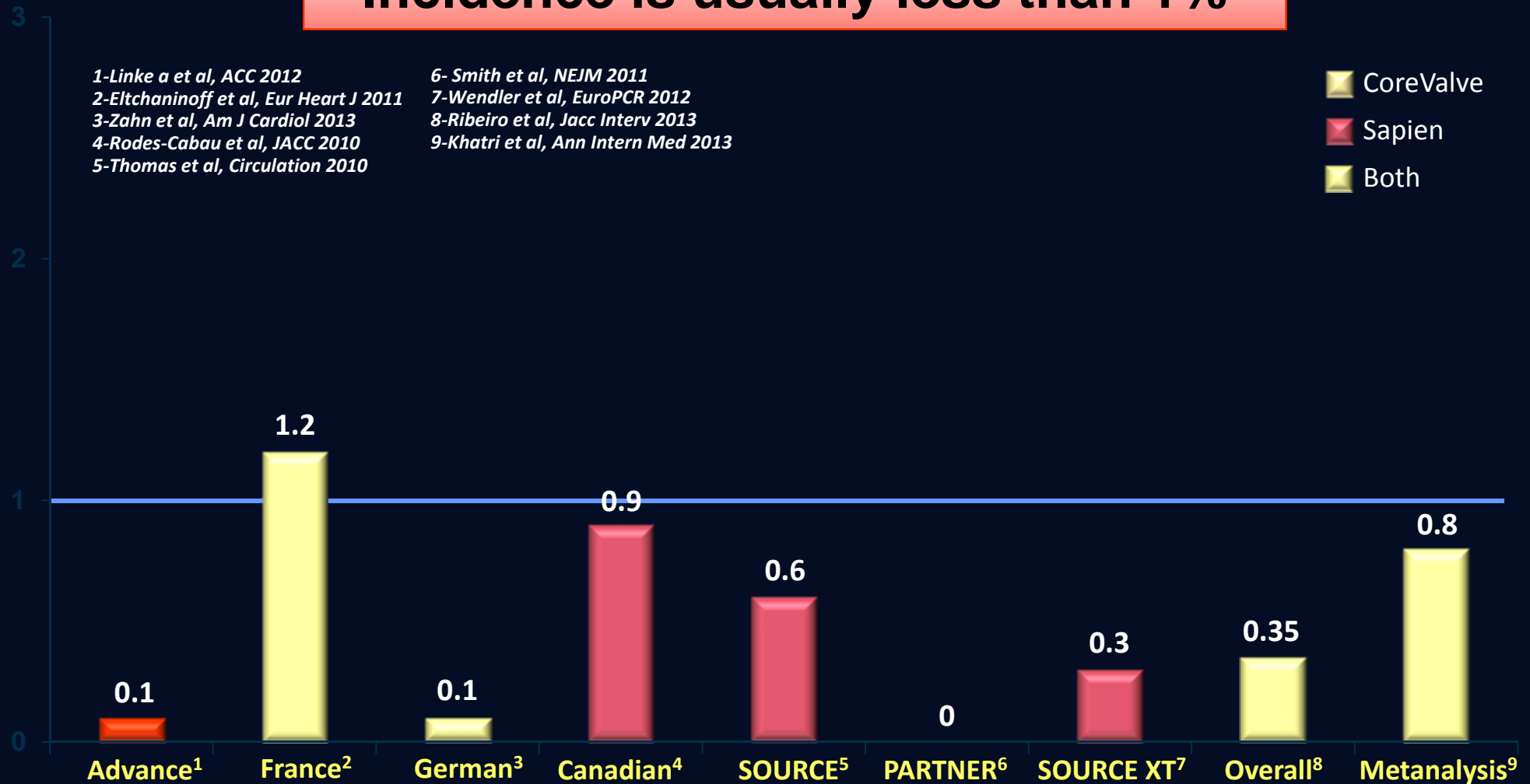
% patients

Incidence is usually less than 1%

1-Linke a et al, ACC 2012
2-Eltchaninoff et al, Eur Heart J 2011
3-Zahn et al, Am J Cardiol 2013
4-Rodes-Cabau et al, JACC 2010
5-Thomas et al, Circulation 2010

6-Smith et al, NEJM 2011
7-Wendler et al, EuroPCR 2012
8-Ribeiro et al, Jacc Interv 2013
9-Khatiri et al, Ann Intern Med 2013

CoreValve
Sapien
Both



Multicenter Registry

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CLINICAL RESEARCH

Interventional Cardiology

Predictive Factors, Management, and Clinical Outcomes of Coronary Obstruction Following Transcatheter Aortic Valve Implantation

Insights From a Large Multicenter Registry

Henrique B. Ribeiro, John G. Webb, Raj R. Makkar, Mauricio G. Cohen, Samir Kapadia, Susheel Kodali, Corrado Tamburino, Marco Barbanti, Tarun Chakravarty, Hasan Jilaihawi, Jean-Michel Paradis, Fabio Sandoli de Brito Jr., Sergio J. Cánovas, Asim N. Cheema, Peter de Jaegere, Raquel del Valle, Paul T.L. Chiam, Raúl Moreno, Gonzalo Pradas, Marc Ruel, Jorge Salgado-Fernández, Rogerio Sarmiento-Leite, Hadi Toeg, James L. Velianou, Alan Zajarias, Vasilis Babaliaros, Fernando Cura, Antonio E. Dager, Ganesh Manoharan, Stamatios Lerakis, Augusto Pichard, Sam Radhakrishnan, Marco Antonio Perin, Eric Dumont, Eric Larose, Sergio G. Pasian, Luis Nombela-Franco, Marina Urena, Murat Tuzcu, Martin B. Leon, Ignacio J. Amat-Santos, Jonathon Leipsic, Josep Rodés-Cabau

Computed Tomography

- **Data on**
 - **Coronary height**
 - **Aortic annulus diameter and area**
 - **Sinus of Valsalva diameter**
 - **STJ diameter**
 - **Severity of valve calcification (Agatston units)**
- **Obtained in those patients with CT performed prior to TAVR**
- **CT exams were evaluated in a central core-lab by 2 investigators**
- **All measurements (except valve calcification) were performed with CT images obtained following contrast injection**

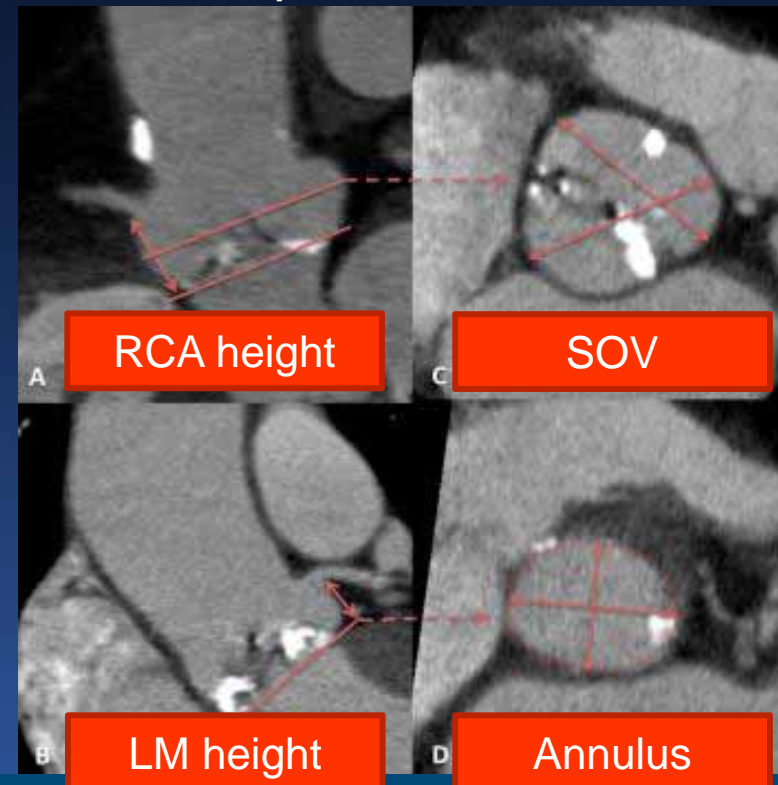
Methods: Computed tomography (CT) data

- 345 patients with no coronary obstruction (control group)
- 28 patients with coronary obstruction with CT data

CT data from both groups
(sinus of Valsalva diameter, coronary arteries height, annulus diameter and area)

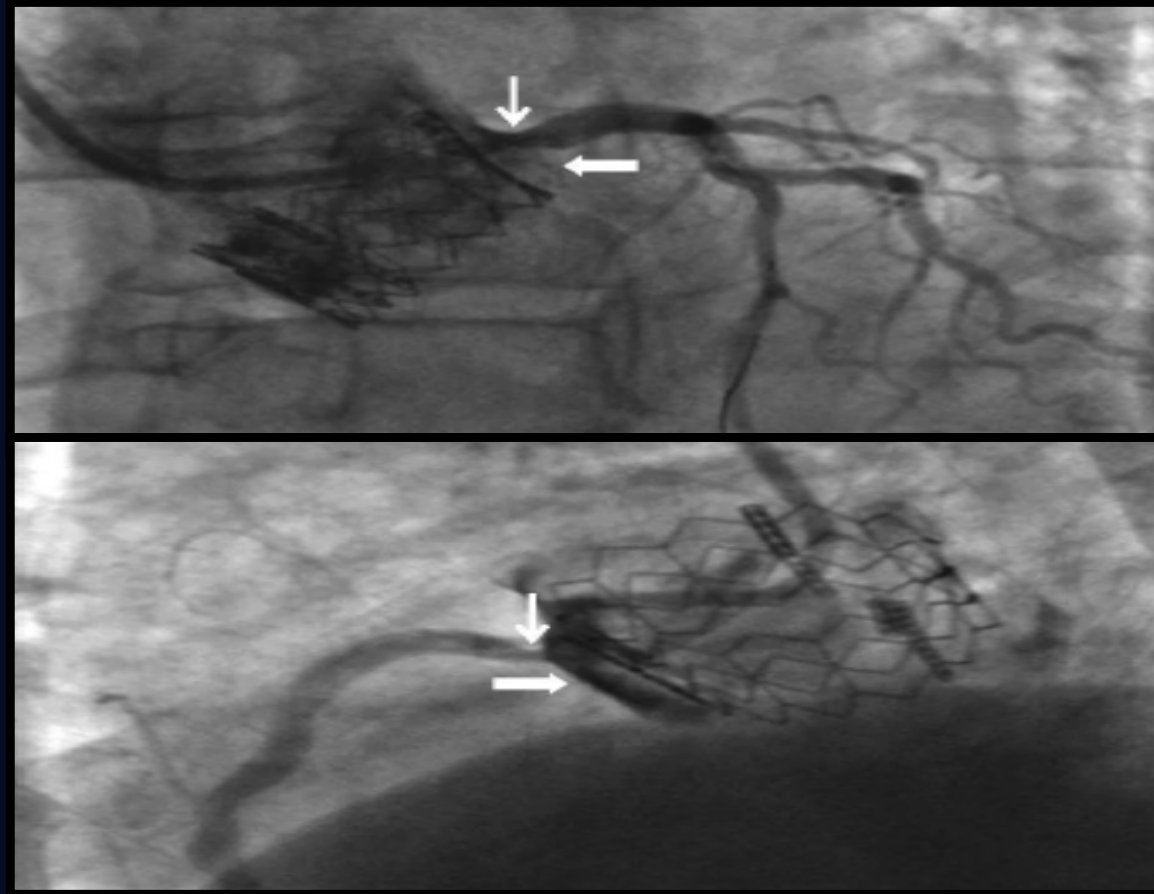
- Case-matching (1:1) for age, gender, prior CABG, valve type and size
- Bootstrap technique (1000 samples with replacement)

Example of CT measurements



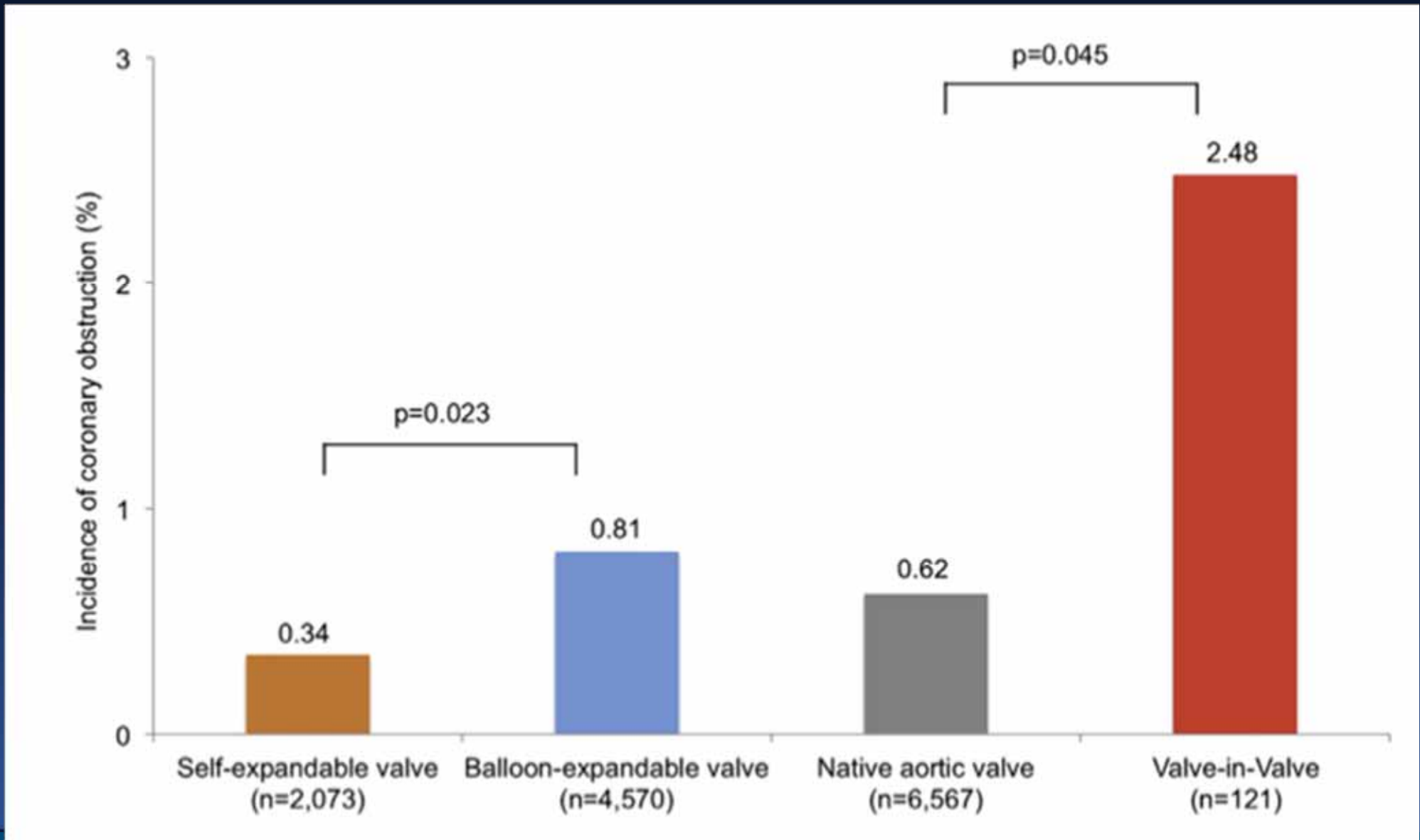
Results

- Of 6688 patients who underwent TAVR in 81 centers
 - 44 cases (0.66%) had an acute coronary obstruction

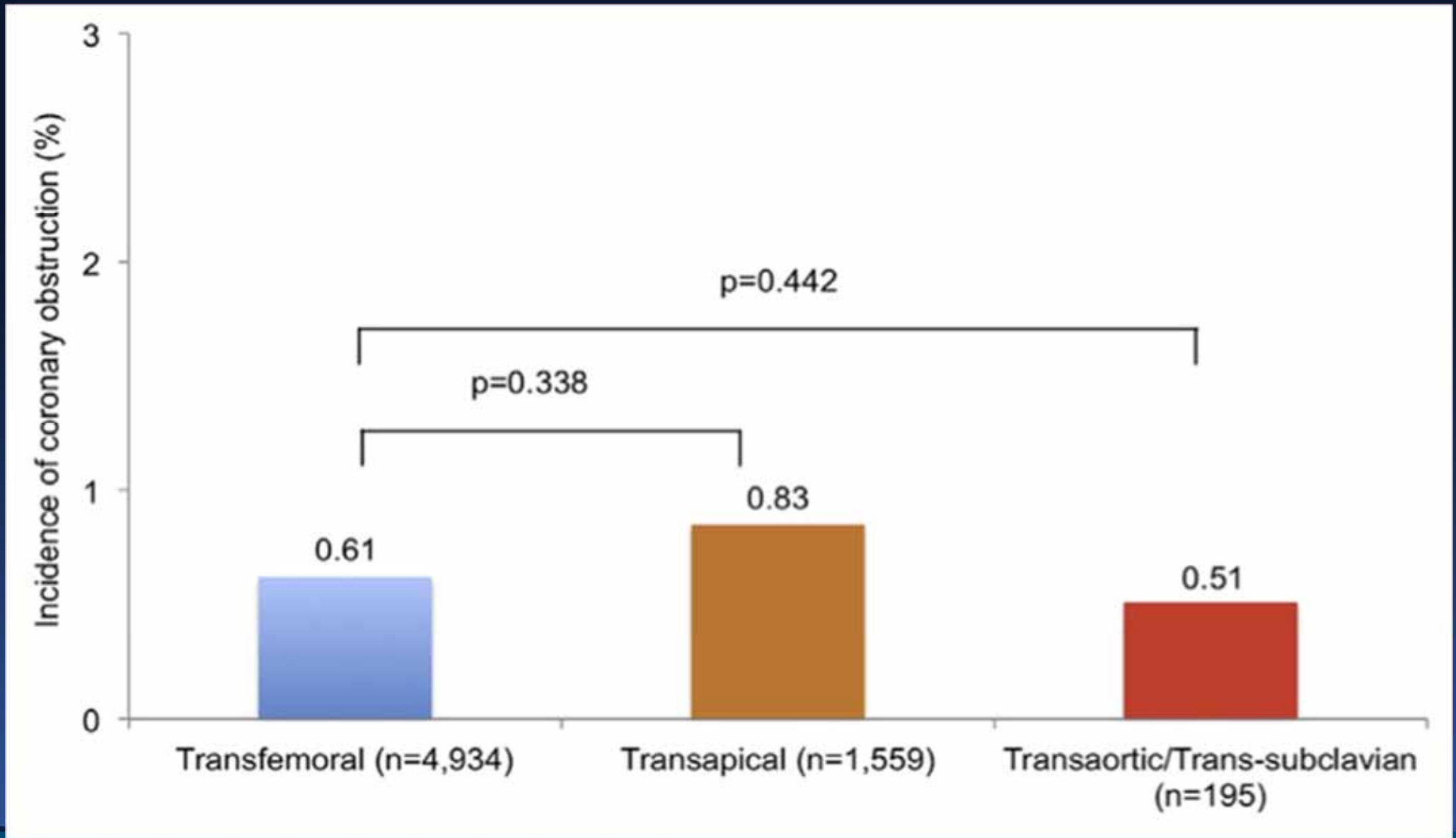


Bagur et al JACC Interv 2009

Incidence of Coronary Obstruction According to Valve Type and Valve-in-Valve Procedure



Incidence of Coronary Obstruction According to the Different Approaches for TAVR



Clinical Presentation and Management

Table 3		Clinical Presentation and Management of Coronary Obstruction Following TAVI (n = 44)
Obstructed coronary artery		
Left coronary artery		39 (88.6)
Right coronary artery		2 (4.5)
Both		3 (6.8)
Timing		
After balloon valvuloplasty		4 (9.1)
After valve implantation		31 (70.5)
After balloon post-dilation		4 (9.1)
Within 24 h following TAVI		4 (9.1)
More than 24 h following TAVI		1 (2.3)
Clinical presentation		
Severe persistent hypotension		30 (68.2)
ECG changes		25 (56.8)
ST-segment elevation		14 (56.0)
Ventricular fibrillation		7 (28.0)
Ventricular tachycardia		3 (12.0)
Atrial fibrillation		2 (8.0)
Left bundle branch block		2 (8.0)
Stenosis severity		
Partial occlusion		25 (56.8)
Complete occlusion		19 (43.2)

Clinical Presentation and Management

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Treatment		
PCI attempted		33 (75.0)
Successful		27 (81.8)
Stent successfully implanted		25 (75.8)
Guidewire protection only		1 (3.0)
Catheter cannulation only		1 (3.0)
Unsuccessful		6 (18.2)
Coronary cannulation failure		2 (33.3)
Wire crossing failure		2 (33.3)
Stent could not be advanced		1 (16.7)
Stent implanted but no flow		1 (16.7)
Type of stent		
Bare-metal stent(s)		6 (24.0)
Drug-eluting stent(s)		17 (68.0)
Bare-metal and drug-eluting stents		2 (8.0)
Urgent CABG		
Conversion to open heart surgery		2 (6.1)

Clinical Presentation and Management

Table 3

Clinical Presentation and Management of Coronary Obstruction Following TAVI (n = 44)

Procedural complications

Need for cardiopulmonary resuscitation 18 (40.9)

Need for hemodynamic support 16 (36.4)

CPB 7 (43.8)

IABP 4 (25.0)

Fem-Fem CPB 3 (18.8)

ECMO 1 (6.3)

Impella 1 (6.3)

Inotropes 30 (68.2)

Valve embolization 2 (4.5)

Need for a second valve 3 (6.8)

Cardiac tamponade 3 (6.8)

Clinical Presentation and Management

Table 3

Clinical Presentation and Management of Coronary Obstruction Following TAVI (n = 44)

30-day outcomes

Myocardial infarction	21 (47.7)
Peak CK-MB, $\mu\text{g/l}$	82.4 (24.3–240.6)
New Q waves*	5 (35.7)
New left bundle branch block	4 (9.1)
New pacemaker	1 (2.3)
Major vascular complications	5 (11.4)
Major or life-threatening bleeding	7 (15.9)
Acute renal failure	9 (20.4)
Dialysis	2 (4.5)
Stroke	4 (9.1)
Death	18 (40.9)
Hospitalization length, days	6 (3–17)

CT Data

- Pre-TAVR CT data were available in 28 of 44 pts with coronary obstruction (63.6%)
- Pts with coronary obstruction exhibited a smaller
 - Aortic annulus area
 - SOV diameter
 - STJ diameter
 - LCA height

Table 4

Computed Tomography Data, According to the Occurrence of Coronary Obstruction Following TAVI

	Coronary Obstruction (n = 28)	Control Subjects (n = 345)	p Value
Annulus diameter, mm	22.9 ± 3.1	24.4 ± 2.9	0.010
Annulus area, mm ²	387 (375–424)	476 (405–560)	0.002
Aortic SOV diameter, mm	28.1 ± 3.8	31.9 ± 4.1	<0.001
Sinotubular junction, mm	25.2 ± 3.1	28.0 ± 3.9	0.003
Relation prosthesis size/annulus	1.09 ± 0.11	1.05 ± 0.09	0.084
Relation SOV/annulus	1.25 ± 0.17	1.31 ± 0.14	0.054
Left coronary height, mm	10.6 ± 2.1	13.4 ± 2.1	<0.001
Right coronary height, mm	12.4 ± 3.2	14.1 ± 2.4	0.003
Left coronary height, mm*	10.4 ± 2.0	13.5 ± 2.0	<0.001
Right coronary height, mm†	11.3 ± 2.1	14.0 ± 2.4	0.048
Calcium score, Agatston units	2,354 ± 1,187	2,872 ± 1,726	0.290

CT Data: Case-Matched Analysis

- In the case-matched analysis
 - The SOV diameter remained smaller (HR 1.37)
 - The LCA height remained lower (HR 2.17)

Table 5

CT Data From the Case-Matched Analysis, According to the Occurrence of Coronary Obstruction Following TAVI

	Coronary Obstruction (n = 27)	Control Subjects (n = 27)	OR (95% CI)	p Value
Annulus diameter, mm	23.0 ± 0.6	23.6 ± 0.4	1.15 (0.92-1.45)	0.510
Annulus area, mm ²	410 ± 18	458 ± 17	1.01 (0.99-1.02)	0.126
Aortic SOV diameter, mm	28.3 ± 0.8	31.3 ± 0.6	1.37 (1.13-1.66)	0.011
Relation prosthesis size/annulus	1.08 ± 0.02	1.05 ± 0.02	0.02 (0.01-3.99)	0.315
Relation SOV/annulus	1.26 ± 0.04	1.34 ± 0.03	20.0 (1.28-333)	0.003
Left coronary height, mm	10.7 ± 0.4	13.3 ± 0.3	2.17 (1.62-2.90)	<0.001
Right coronary height, mm	12.7 ± 0.8	14.2 ± 0.4	1.36 (1.10-1.68)	0.047
Calcium score, Agatston units	2,284 ± 318	2,733 ± 313	1.00 (0.99-1.10)	0.333

Conclusion

- **Coronary obstruction following TAVR is a rare (0.66%) but life-threatening complication (mortality: 40.9%), and it seems more frequent in women, in patients with prior surgical bioprosthesis, and in those who receive a balloon-expandable valve.**
- **Most of the time, the clinical presentation is persistent severe hypotension and EKG changes, such as ST-segment elevation and ventricular arrhythmias.**
- **Low lying coronary ostia (LCA height <12 mm), and a narrow aortic root (<30 mm) are important risk factors of coronary obstruction**

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Conclusion

- **Annulus-LM distance of 12 mm may be a more accurate cutoff than**
 - **The 10 mm cutoff suggested by ACCF/AATS/SCAI/STS**
 - **The 14 mm cutoff suggested by Medtronic (Corevalve)**
- **In this registry, most patients were treated with PCI, with a success rate of 81.8%; nonetheless open heart surgery or mechanical hemodynamic support were still required in a significant number of patients.**
- **Future studies should evaluate other potential anatomical risk factors and the potential for preventive measures such as guidewire protection, pre-emptive stent positioning and also the use of retrievable valves.**

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