

Contrast Stress Perfusion Echocardiography: *Short Cases*

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Disclosures

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- ASPER Foundation
- Definity: Lantheus Medical Imaging Inc.
- Optison: GE Healthcare Inc.
- Vasodilator stress drugs (Adenosine and Regadenoson), Astellas Pharma Inc.

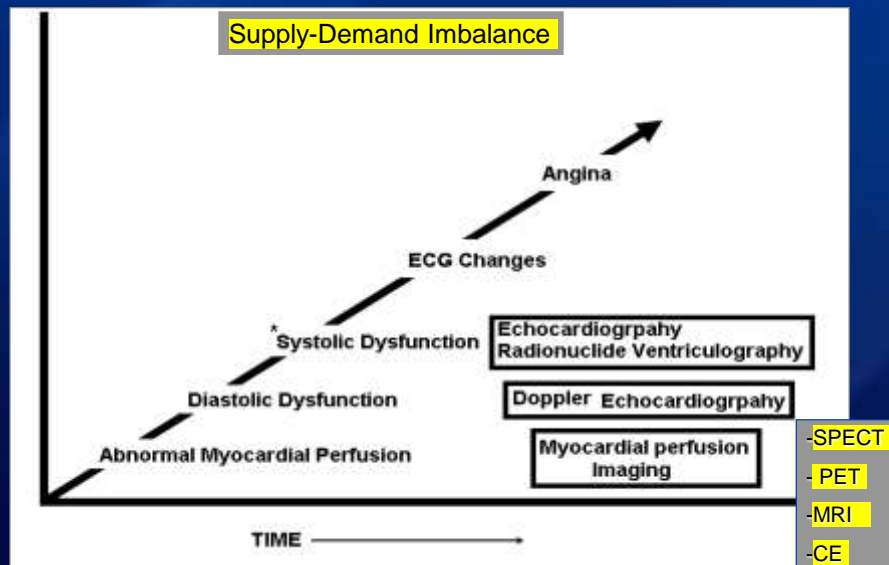
➤ Off-label usage(s) of pharmaceuticals :

- Definity
- Optison
- SonoVue

Outline

- Be Familiar with the Different Stress Myocardial Perfusion Protocols with *mini cases*
- Recognize the Incremental Benefits of Perfusion echo over Wall Motion Assessment

Ischemic Cascade



Nesto et al. Am J Cardiol, 1987

Contrast Echo PERFUSION

❖ Contrast is routinely noted in the myocardium during low MI contrast imaging

❖ Echo Perfusion assess myocardial blood volume and velocity

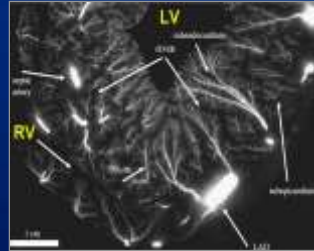
❖ **Off-label use** of approved contrast agents for simultaneous assessment of myocardial perfusion and function

❖ Various Stress Protocols:

Dobutamine

Vasodilators

Exercise/supine Bicycle



- Detection and risk stratification of CAD
- Detection of myocardial viability
- Assessment of CFR by MCE
- Assessment of CFR by contrast-enhanced coronary Doppler imaging

Myocardial Perfusion Echocardiography

simultaneously assess both myocardial function and perfusion

BEDSIDE



Porter TR, Abdelmoneim SS, Belcik T, et al JASE 2014;27:797

Qualitative Analysis of MCE

1. Signal intensity (myocardial blood volume)

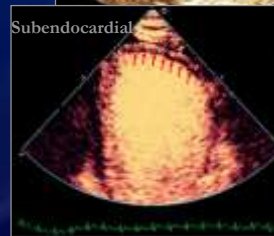
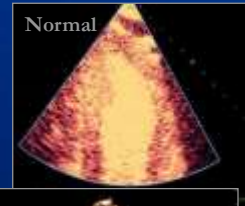
- Brightness
- Pattern (subendo/transmural)
- Location (segments-territory)

2. Rate of filling (blood velocity)

- Number of cardiac cycles
- Mean microbubble velocity = 1 mm/sec
- Ultrasound beam elevation = 5 mm
- Rest : ~ 5 seconds (5-6 cycles)
- Stress: ~ 2 seconds (2-3 cycles)

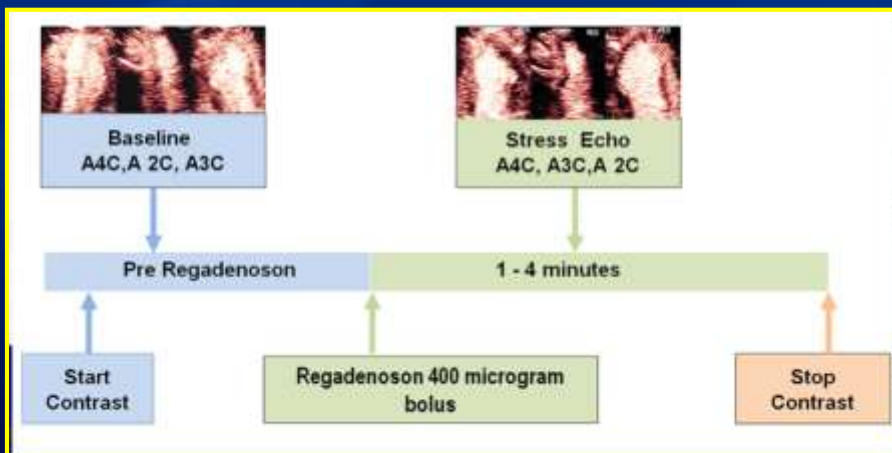
3. Defect vs. Artifact

- False positive
 - Insufficient contrast
 - Shadowing or attenuation
 - Destruction of apical bubbles
 - Drop-out/inadequate image



Wei et al. Cardiol Clin 2004

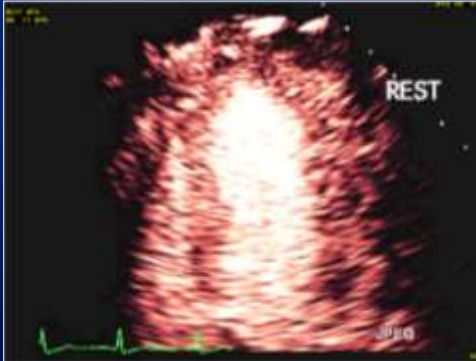
Regadenoson Vasodilator Stress



Abdelmoneim ss , Mulvagh SL et al., JASE 2015:28-1393

Regadenoson Vasodilator Stress Case 1

Rest 2-C



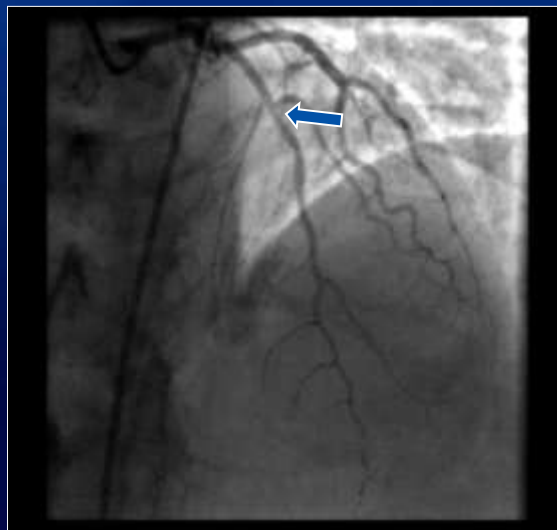
Stress 2-C



Normal WM
Abnormal Perfusion : LAD **reversible**

Regadenoson Vasodilator Stress Case 1

60% LAD



Regadenoson Vasodilator Stress Case 2

Rest 2-C



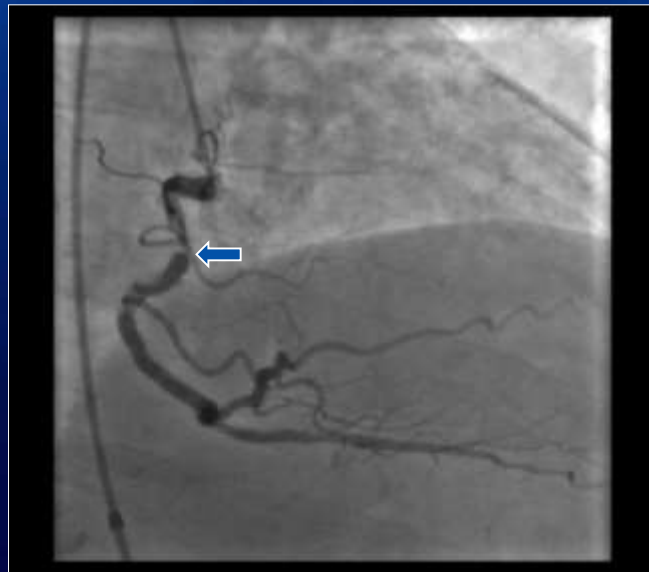
Stress 2-C



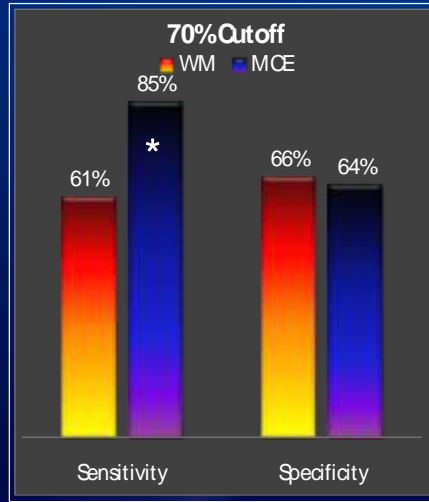
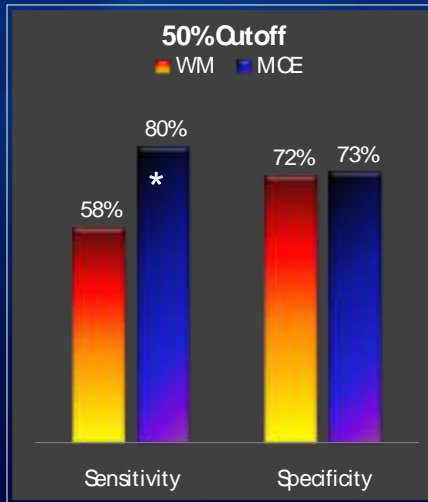
Abnormal WM
Abnormal Perfusion : RCA reversible

Regadenoson Vasodilator Stress Case 2

90% RCA



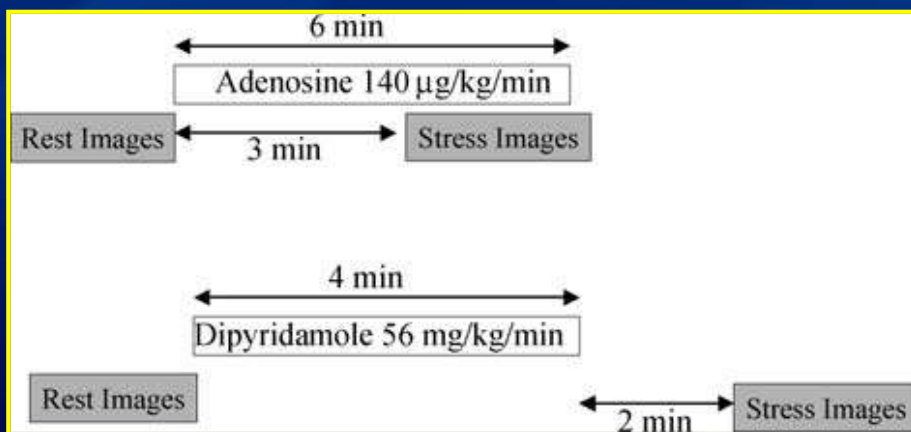
Regadenoson Vasodilator Stress Case 2



*p<0.05 compared to WM

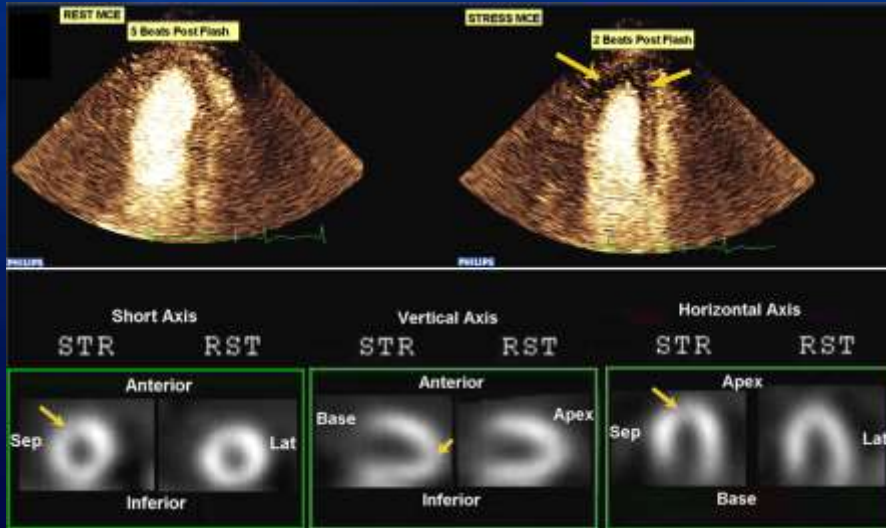
Abdelmoneim SS, Mulvagh SL et al., JASE 2015:28-1393

Adenosine/Dipyridamole Vasodilator Stress Protocol



Porter et al., Cir Cardiovascular Imag, 2011

Adenosine Vasodilator Stress Case 1



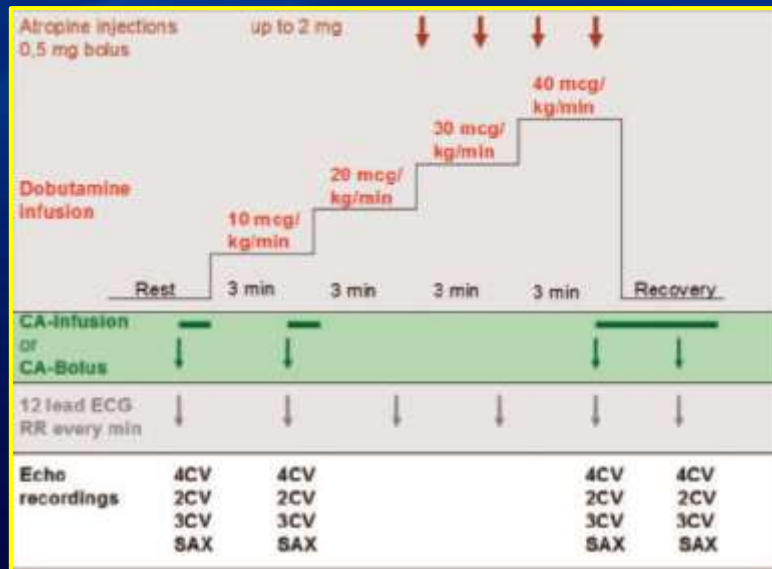
Abdelmoneim SS et al, Heart Vessels. 2010 : 25(2):121-30

Diagnostic Accuracy of stress MPE for detection of CAD during Vasodilators Stress

Patients (n)	Stress method (vasodilator)	Patients undergoing coronary angiography	CAD present	Sensitivity	Specificity	Author	Year
123	Adenosine	15	12	75	67	Heldt et al. ¹¹⁷	2000
25	Dipyridamole	12	12	89	100	Roeders et al. ¹⁰⁸	2003
85	Dipyridamole	70	43	91	70	Plour et al. ¹¹⁷	2004
35	Dipyridamole	35	22	85 (qualitative) 97 (quantitative)	79 (qualitative) 82 (quantitative)	Wolke et al. ¹¹¹	2004
55	Dipyridamole	55	43	86	88	Senior et al. ¹¹¹	2004
52	Dipyridamole	52	22	82	97	Senior et al. ¹¹¹	2005
36	Adenosine	36	35	81	67	Winter et al. ¹⁰³	2004
36	Dipyridamole	36	13	64 (RT imaging) 41 (TR imaging)	93 (RT imaging) 96 (TR imaging)	Tustui et al. ¹²⁶	2005
123	Dipyridamole	123	96	84	56	Jostley et al. ¹¹⁷	2006
47	Adenosine	47	11	91	92	Karaman et al. ¹⁰⁹	2006
128	Dipyridamole	89	42	83	71	Koronkova et al. ¹¹⁰	2006
70	Dipyridamole	40	25	84	93	Lin et al. ¹⁰⁰	2006
43	Dipyridamole	43	33	77	72	Palani et al. ¹¹¹	2006
55	Adenosine	30	32	88	89	Aggeli et al. ¹¹²	2007
63	Dipyridamole	63	25	92	95	Ilkay et al. ¹⁰⁰	2008
662	Dipyridamole	457	368	71	64	Senior et al. ¹¹¹	2009
400	Dipyridamole	316	71	97	74	Galazzi et al. ¹⁰⁹	2009
48	Adenosine	48	37	89	92	Vogel et al. ¹⁰⁰	2009
65	Adenosine	62	41	85	76	Arnold et al. ¹⁰⁹	2010
400	Dipyridamole	400	268	96	66	Galazzi et al. ¹⁰⁹	2010
150	Dipyridamole	150	102	96	69	Galazzi et al. ¹¹³	2010
100	Regadenoson	98	52	80	74	Wortler et al. ¹¹¹	2011
628	Dipyridamole	512	310	75	52	Senior et al. ¹¹¹	2013
100	Regadenoson	100	85	77	74	Atchayaram et al. ¹⁰⁰	2015
Mean (95% CI)	3571	2736	1828	81 (77-89)	79 (72-85)		

Senior R et al, EHJ- CV Imaging , 2017;18,1205

Dobutamine Stress Protocol



Senior R et al, EHJ- CV Imaging , 2017:18,1205

Dobutamine Stress Case 1

- 62 years male
- BMI =28kg/m²
- Known CAD
- Smoker, HTN
- Claudication
- Pre-op vascular surgery

Baseline ECG

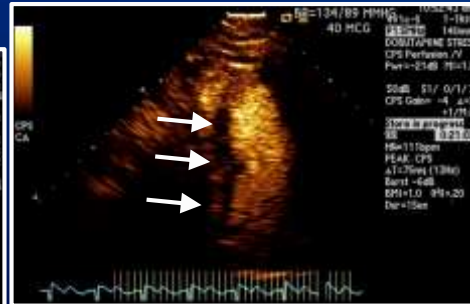


Dobutamine Stress Case 1 LVO

Rest Apical 2 chamber Pre Flash



Stress Apical 2 chamber Post Flash

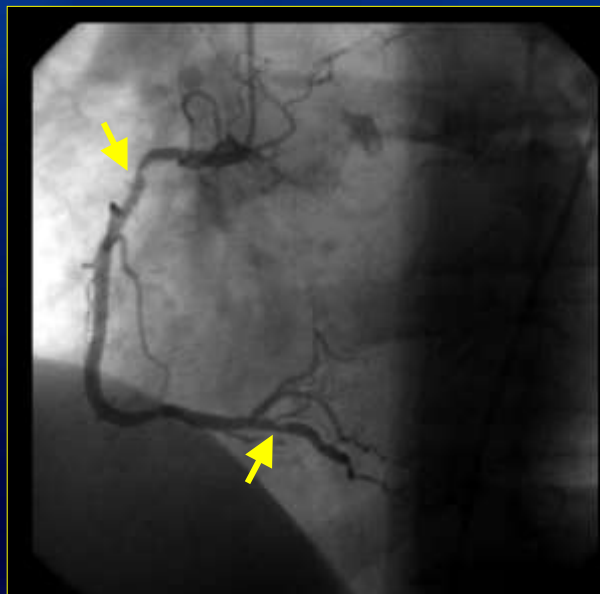


Abnormal WM
Abnormal Perfusion : RCA reversible

Dobutamine Stress Case 1

- Normal left circulation
- dRCA 50%
- PDA 40%
- pRCA 60 %
 (at stent entry)
 /FFR 0.83
 (normal)

- Medical treatment
- Surgery withheld in lieu of GDMT optimization
- Pt enrolled in cardiac rehab program



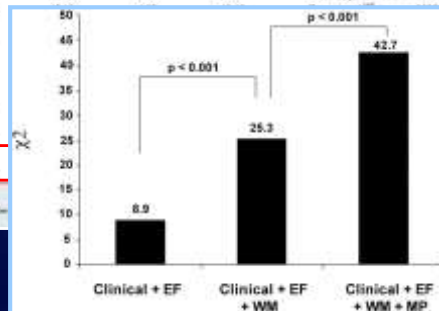
Diagnostic Accuracy of stress Perfusion Echocardiography for detection of CAD During with Dobutamine or Exercise Stress

Patients (n)	Stress method (dobutamine or exercise)	Patients undergoing coronary angiography	CAD present	Sensitivity	Specificity	Author	Year
45	Dobutamine or exercise	45	32	87	66	Cwaig et al. ¹³⁴	2000
100	Exercise (treadmill or bike)	44	28	75	100	Shimoni et al. ¹³⁵	2001
44	Dobutamine	44	44	97	93	Oliszowska et al. ¹³⁷	2003
140	Dobutamine	132	85	81	77	Chiou et al. ¹³⁸	2004
170	Dobutamine	170	127	91	51	Ehrendy et al. ¹³⁹	2004
5250	Dobutamine	532	413	92	61	Aggeli et al. ¹⁴¹	2008
42	Exercise (bike)	42	25	88	88	Miszalski-Janku et al. ¹⁴⁴	2007
61	Exercise (bike)	61	41	93 (quantitative)	80 (quantitative)	Miszalski-Janku et al. ¹⁴⁵	2013
5852 (total)		1070 (total)	795	85 (quantitative) 88 (84-91)	80 (quantitative) 77 (69-85)		

Senior R et al, EIJ- CV Imaging , 2017;18,1205

Prognostic Role of stress Perfusion Echocardiography for detection of All cardiovascular event and Hard Event (death and non fatal MI)

Patients (n)	Stress method	Contrast agent	Follow-up (months)	Total events (n)	Hard events (n)	Annual total event rate (%) normal scan	Annual total event rate (%) abnormal scan	Annual hard event rate (%) normal scan	Annual hard event rate (%) abnormal scan	Author	Year
197	Dobutamine and exercise	Sonosia	17 ± 7	35	12	7.7%	14.9%	2.8%	5.4%	Shah et al. ¹⁷⁹	2015
1024	Dobutamine and exercise	Definity	2.6 years (median)	54	30	1.8%	2.8%	1.2%	3.3%	Porter et al. ¹⁸⁰	2013
1252	Dipyridamole	Sonosia	25	59	38	0.9%	1.9%	0.9%	1.8%	Gellassi et al. ¹⁸¹	2012
87	Dipyridamole	Sonosia	58 ± 79	38	28	2.5%	11.7%	3.3%	11.7%	Anantharam et al. ¹⁸²	2011
202	Dipyridamole	Optison	32 ± 11	109	26	5.4%	26.3%	N/A	N/A	Wejner-Pis et al. ¹⁸³	2011
545	Dipyridamole	Sonosia	12	25	13	0.8%	11.2%	0	6.1%	Gellassi et al. ¹⁸⁴	2011
513	Dobutamine	Definity	33	42	40	1.5%	14.9%	1.5%	14.9%	Hong et al. ¹⁸⁵	2011
287	Dipyridamole	Optison	14 ± 5	22	22	0.9%	19.9%	0.9%	19.9%	Dawson et al. ¹⁸⁶	2009
84	Exercise	Sonosia	48 ± 8	24	10	1.6%	13.1%	N/A	N/A	Miszalski-Janku et al. ¹⁸⁷	2009
399	Dobutamine and Definity	Optison	21	48	46	1.8%					
145	Dipyridamole Dobutamine	Sonosia	8 ± 3	24	4	10.1%					
31	Dipyridamole and Definity	Optison	28	30	1	0					
131	Dobutamine and Definity	Optison	16	33	5	7.7%					
788	Dobutamine and Definity	Optison	22	75	75	1.5%					
TOTAL (3475)				582	393	3.0%					



Tsutsui JM et al: Circulation 112:1444, 2005

Senior R et al, EIJ- CV Imaging , 2017;18,1205

SUMMARY

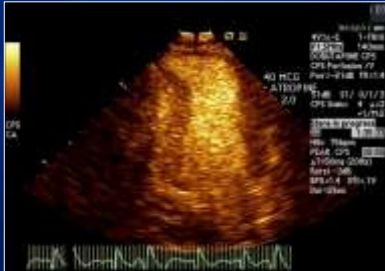
1. CEE is **essential** to clinical echocardiography practice when Echo images are suboptimal
2. UCA are **safe**, have **no radiation** [0 mSv]
3. Contrast **Stress perfusion** Echo **complement wall motion analysis**– incremental information **[yet remains off-label]**
4. Microbubbles and ultrasound **interact**- operator skill--*Learning curve for image acquisition and interpretations*

Thank You !

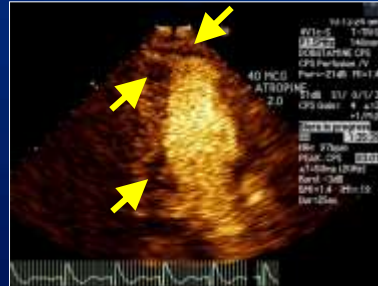


Dobutamine Stress Case 2 Perfusion

Rest Apical 2-C Pre Flash



Rest Apical 2-C Post Flash

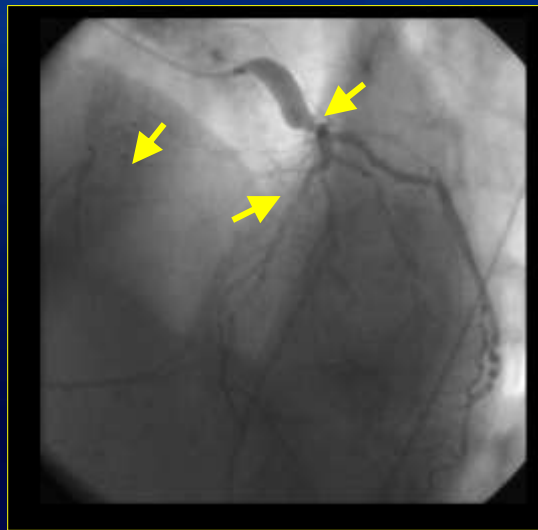


**Abnormal WM
Abnormal Perfusion":
Multivessel CAD**

- LAD **mixed**
- RCA **reversible**
- Cx **reversible (RWMA)**

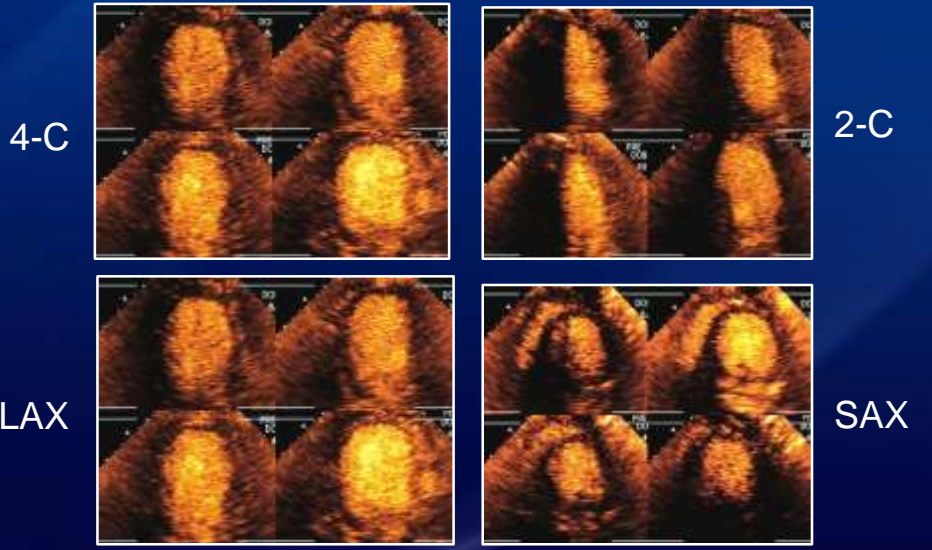
Dobutamine Stress Case 2 Perfusion

LM 50% , Mid LAD 90%, pRCA 100% (collateralized)



Dobutamine Stress Case 3 LVO

62 years old man, preoperative evaluation of SOB



Dobutamine Stress Case 3 Perfusion

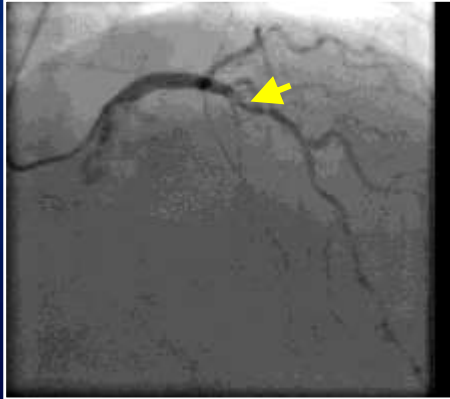


Abnormal WM
Abnormal Perfusion : LAD reversible

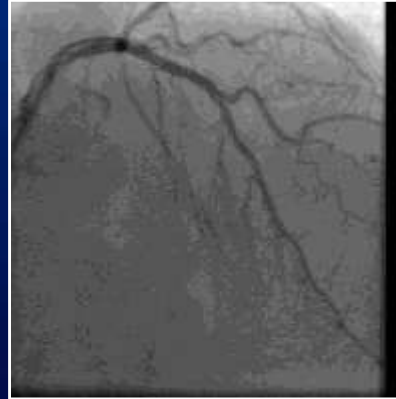
Dobutamine Stress Case 3 Perfusion

LM 50% , Mid LAD 90%, pRCA 100% (collateralized)

Pre-PCI LAD



Post-PCI LAD

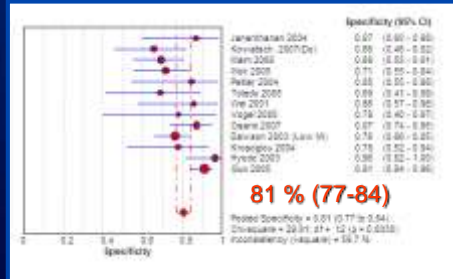
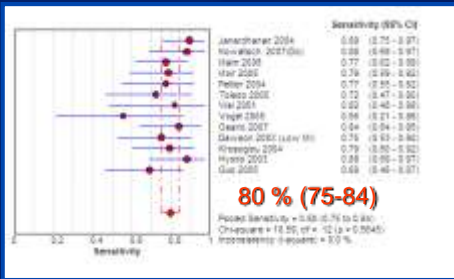


Diagnostic Accuracy of stress MPE for detection of CAD (quantitative analysis on patient Level)

Quantitative myocardial contrast echocardiography during pharmacological stress for diagnosis of coronary artery disease: a systematic review and meta-analysis of diagnostic accuracy studies

Sahar S. Abdelmoneim¹*, Abbtjwan Djobbi², Mathieu Bernier³, Patricia J. Erwin⁴, Grigoris Konradiou⁵, Rony Sedoni⁶, Sharmil Mehta⁷, Ingrid Kocakovic⁸, Szu Jianmang⁹, Talalji Muro¹⁰, Dana Dawson¹¹, Rolf Vogel¹², Kevin Wei¹³, Colin P. West¹⁴, Victor M. Montari¹⁵, Patricia A. Pellikka¹⁶, Samir S. Abdel-Kader¹⁷, and Sharon L. Mulvagh¹⁸

- 13 studies
- **627 patients**
- quantitative analysis in 574 (92%) patients



Abdelmoneim SS et al , Eur J Echocardiogr. 2009 Oct; 10(7):813-25