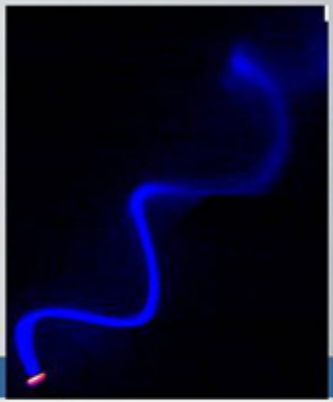
CT –Perfusion: Can it replace MR?

G. Feuchter, MD, Ao. Univ. Prof
Innsbruck Medical University, Austria

CT perfusion



1997 – Electron beam CT

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Herz. 1997 Apr;22(2):63-7

[Quantitative determination of left ventricular myocardial perfusion with electron beam computerized tomography].

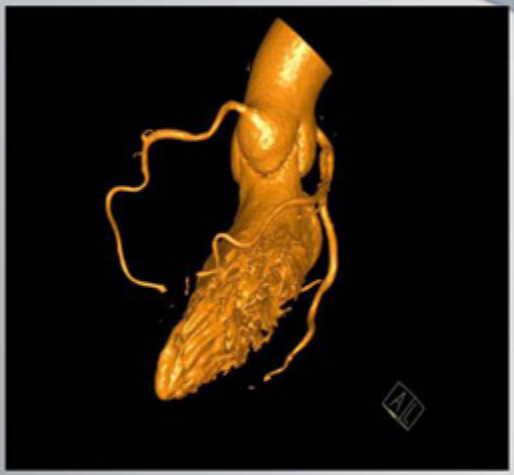
[Article in German]

Rienmüller R, Baumgartner C, Kern R, Harb S, Aigner R, Fueger G, Weihs W.

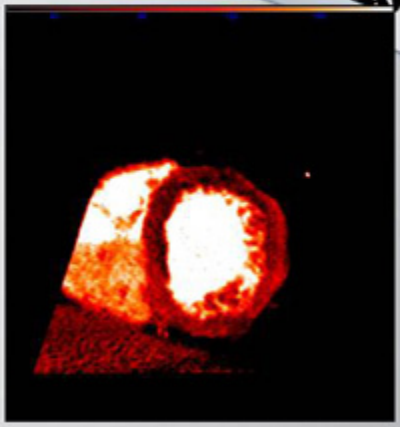
Abteilung für Allgemeine Radiologische Diagnostik, Universität Graz.

Abstract

2003 Multi-slice CT 2009

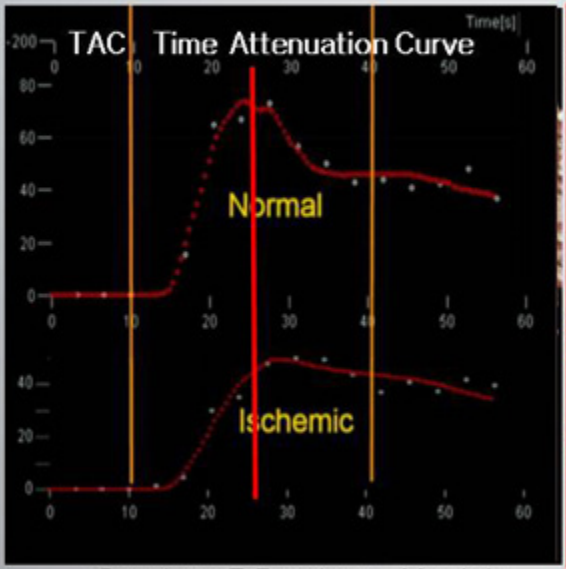


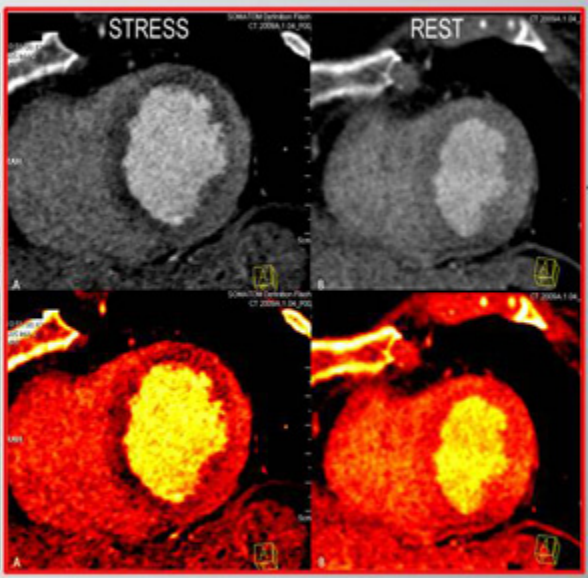
CT-Angio



CT perfusion

CT myocardial perfusion





Courtesy F Bamberg, Munich

4D dynamic

„One-shot“

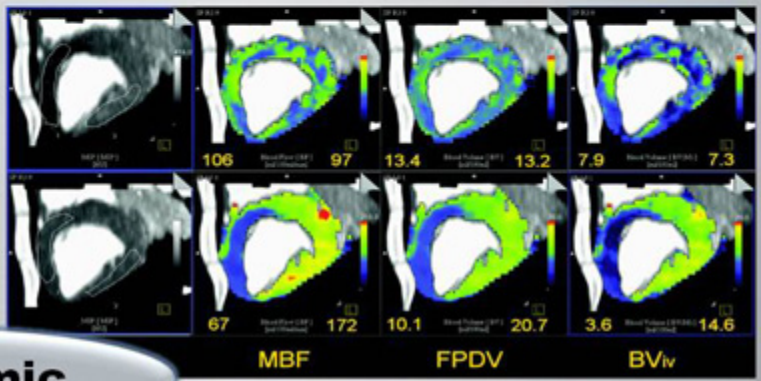
Stress CT perfusion- animal studies

		reference	scanner	results
George JACC 2006	Canine N=8	Microsphere MBF	64-MDCT	Linear relationship
George Invest Rad 2007	Canine N=6	-"-	64 -MDCT	MBF:R=0.91, p=0.001
Christian J Nucl Card 2010	Porcine N=8	-"-	64-MDCT	Coronary flow reserve R=0.94, p=0.001
Mahnken Invest Rad 2010	Porcine N=10	----	128-DSCT	MBF sign. Lower in ischemia
Bamberg 2012	Porcine N=7	Microsphere MBF	128-DSCT	MBF increase during adenosine r=0.67, p=0.001

4D dynamic

128-slice dual source CT perfusion

	ADENOSINE		
	normal	ischemic	p-value
MBF	117.4	74.0	P=0.002
BV	14.9	9.8	P=0.01

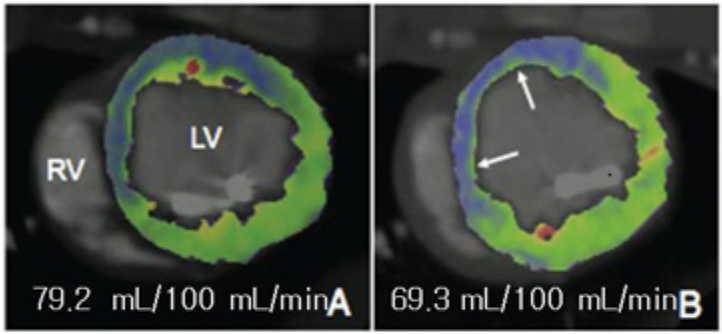


4D dynamic

Mahnken Invest Radiol 20

Myocardial blood flow (MBF)

Rest
50%
stenosis



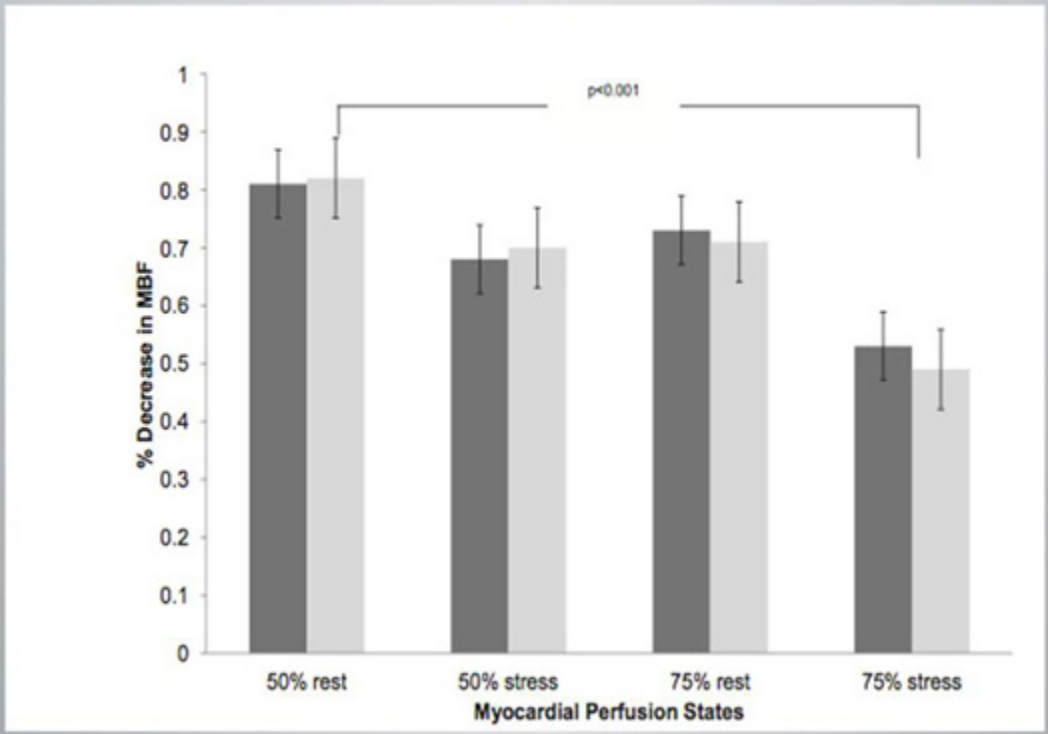
Stress
50%
stenosis

Stress
75%

Stress
continuing
75% sten.

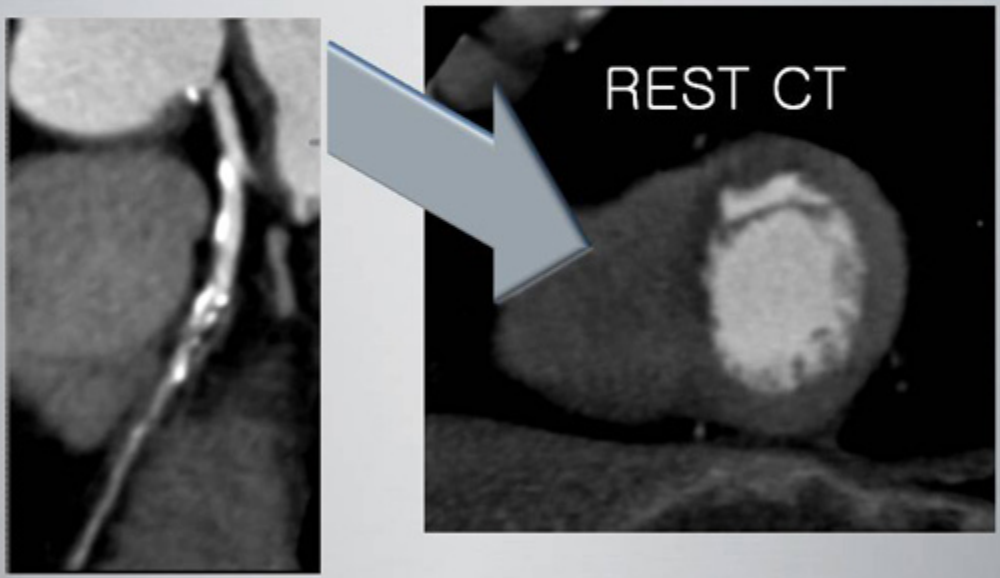
4D dynamic

Bamberg Invest Radiol 2012 (Jan)



Bamberg Invest Radiol 2012 (Jan)

69 YOM
Pressure Pain during tennis and after drinking alcohol 3x at rest
Positive FA
Negative ECG-treadmill stresstest

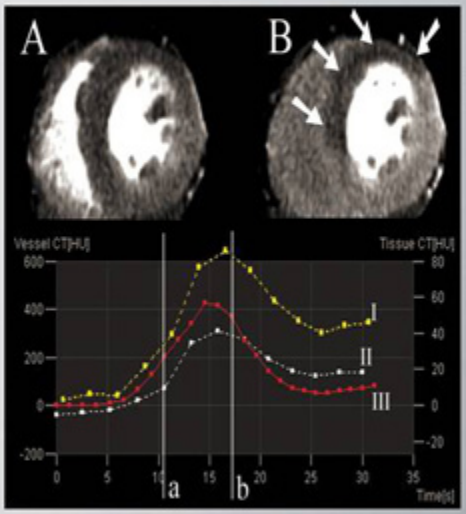


JACC Cardiovasc Imaging. 2010 Aug;3(8):811-20.

Stress and rest dynamic myocardial perfusion imaging by evaluation of complete time-attenuation curves with dual-source CT.

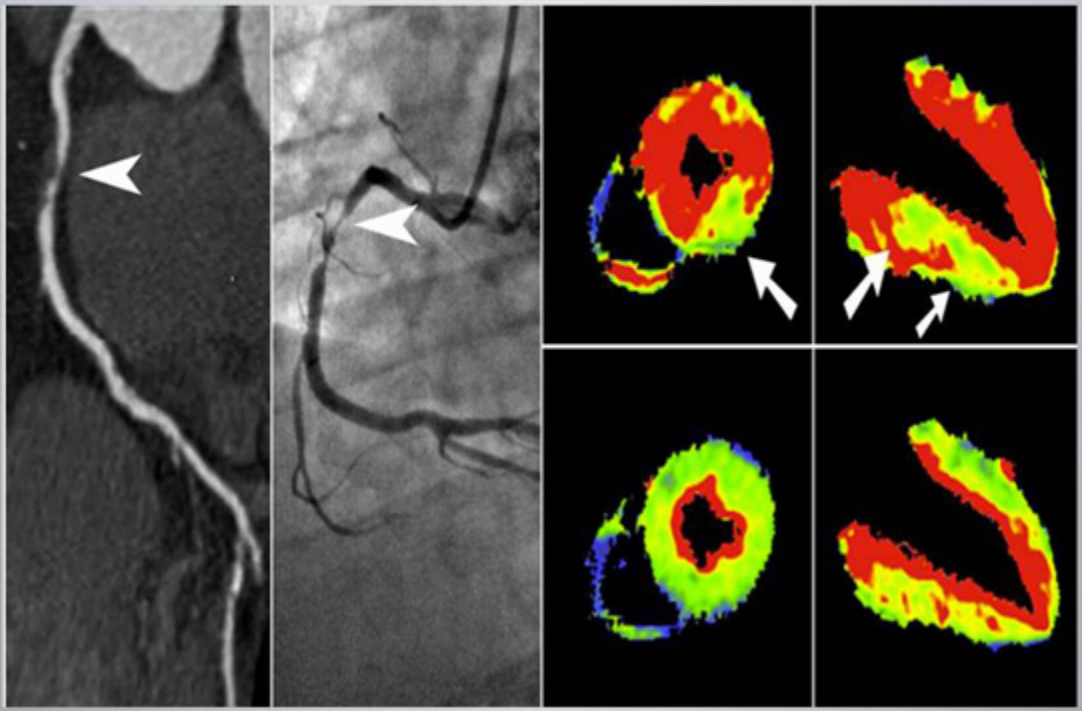
Ho KT, Chua KC, Klotz E, Panknin C.
Department of Cardiology, Tan Tock Seng Hospital, Singapore. DrHoKT@me.com

- 35 patients stress CT MPI protocol.
- Prospectively (ECG)-triggered axial images at 2 rapidly alternating positions.
- a 1.5-fold difference between stress and rest MBF in normal tissue.



4D dynamic

Ho et al JACC 2009;3:811-820

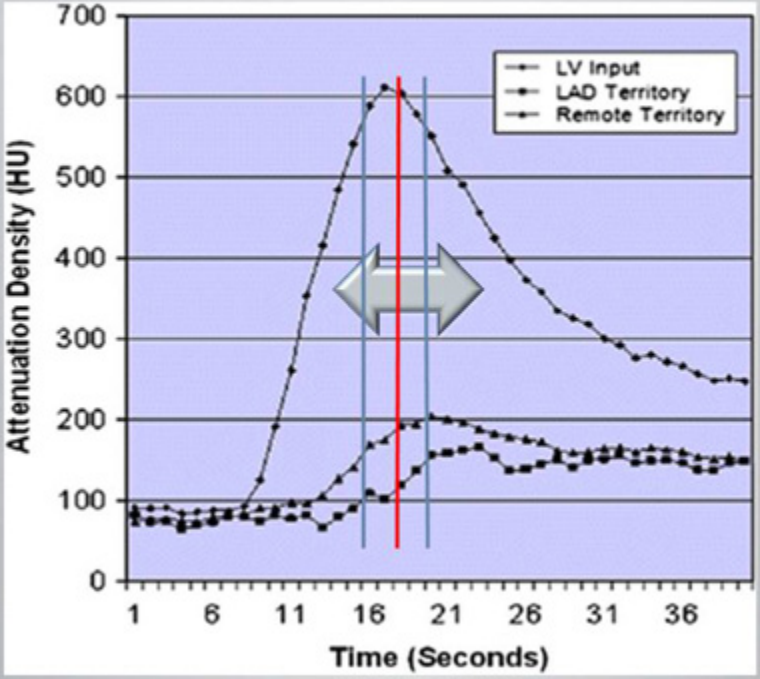


▪radiation dose: 9.15 mSv stress + 9.09mSv rest .

Ho et al JACC 2009;3; 117-21

Time attenuation curve (...

„One-shot“



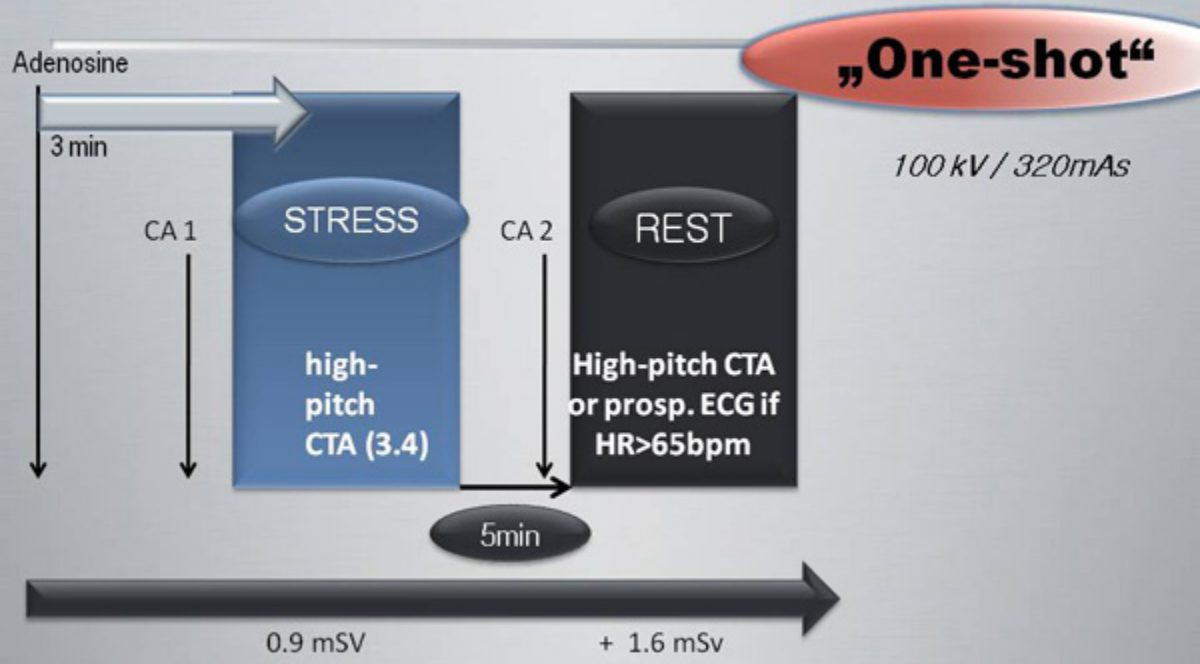
Valdiviezo J Nucl Cardiol 2010 adapted from Georg

Stress CT perfusio

„One-shot“

			pts	ref.	sens	spec	NPV	Radiation mSv
George	*Circ CV Imag 2009*	64-/ 256 row	40	SPECT	79%	91%	92%	
Blankstein	*JACC 2009*	64-DSCT	34	SPECT Inv.Ang	93%	74%		12.7
Cury	*Am J Card 2010*	64-slice	26	IA	88%	79%	93%	14.7
Tamarappoo	*JACC imag 2010*		30	SPECT	Kappa=0.71 ($p < 0.0001$)			
Feuchtner	*Circ imag. 2011 (in rev)*	128-DSCT	30	CMR	96%	88%	94%	2.5
Ko	*AJR 2012*	Dual energy DSCT	45	CTA+ CTP vs IA	93%	85%	91%	16.5

128-DSCT: CTP + CTA



2.5 mSv

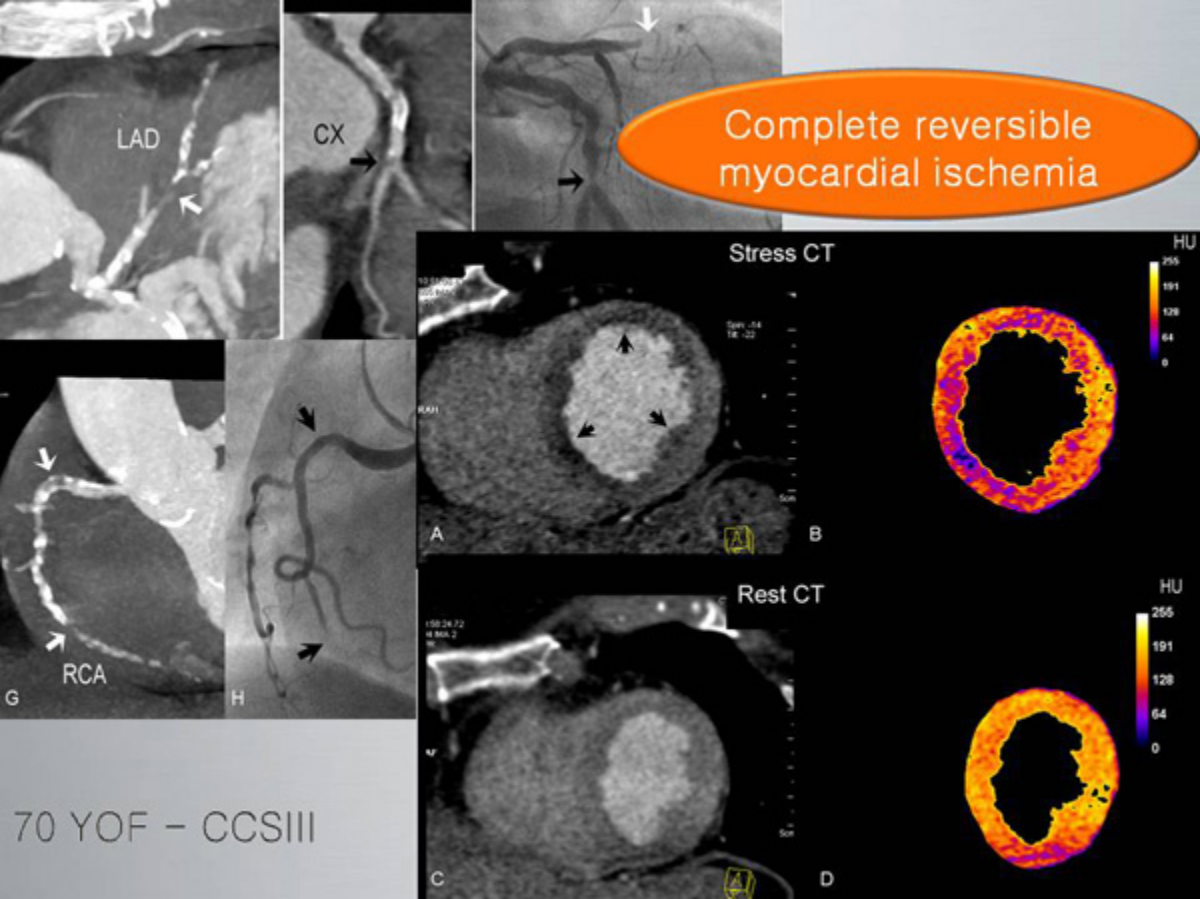
Feuchtner Circ CV Imag 2011

Adenosine stress 128-DSCT perfusion improves accuracy of CT-A vs IA

25 pts, moderate-to- severe CAD

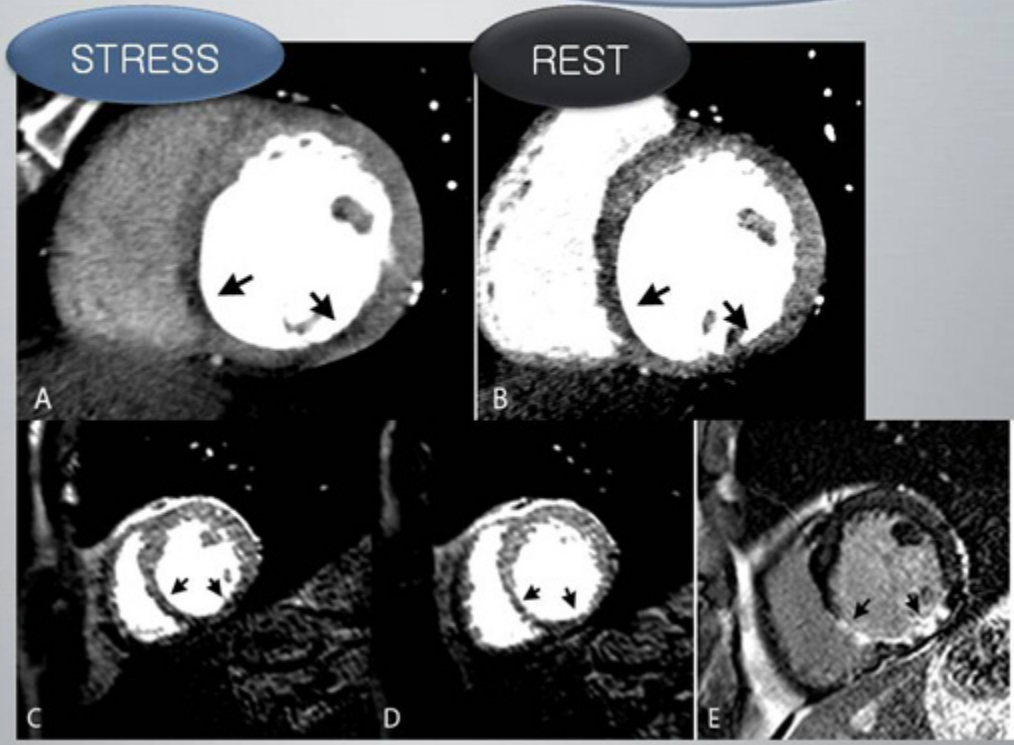
	CTP		CTA >50% stenosis		CTA + CTP
Sens.	98%		98%		100%
Spec.	60%*		27%*		74%*
PPV	91%		84%		97%
NPV	90%*		80%*		100%
Accuracy	**90%**		**84%**		**95%**

Feuchtner Circ CV Imag 2011


LAD
CX
Complete reversible myocardial ischemia
Stress CT
HU
255
191
128
64
0
A
B
RCA
G
H
Rest CT
HU
255
191
128
64
0
C
D
70 YOF – CCSIII

59 YOM
RCA/ CX occlusion

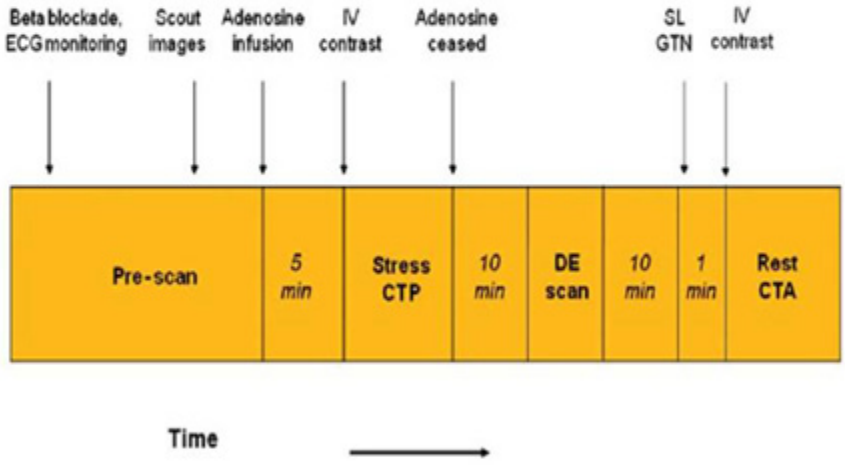
Fixed defect=
myocardial infarct

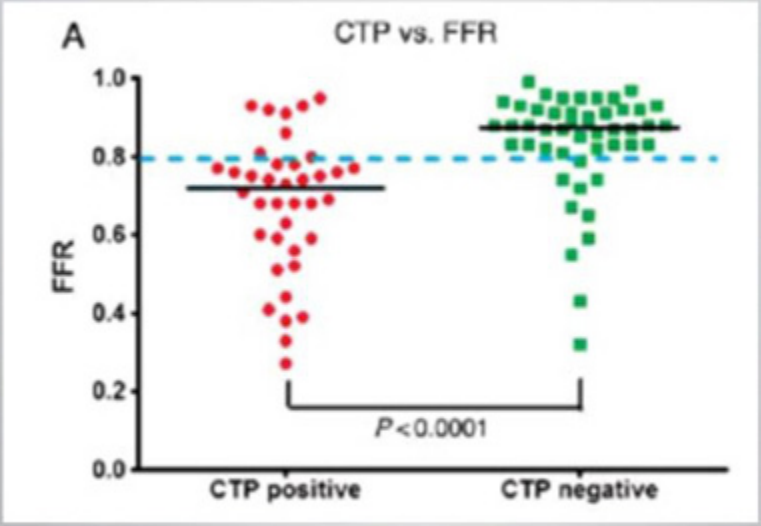


Eur Heart J. 2012 Jan;33(1):67-77. Epub 2011 Aug 2.

Computed tomography stress myocardial perfusion imaging in patients considered for revascularization: a comparison with fractional flow reserve.

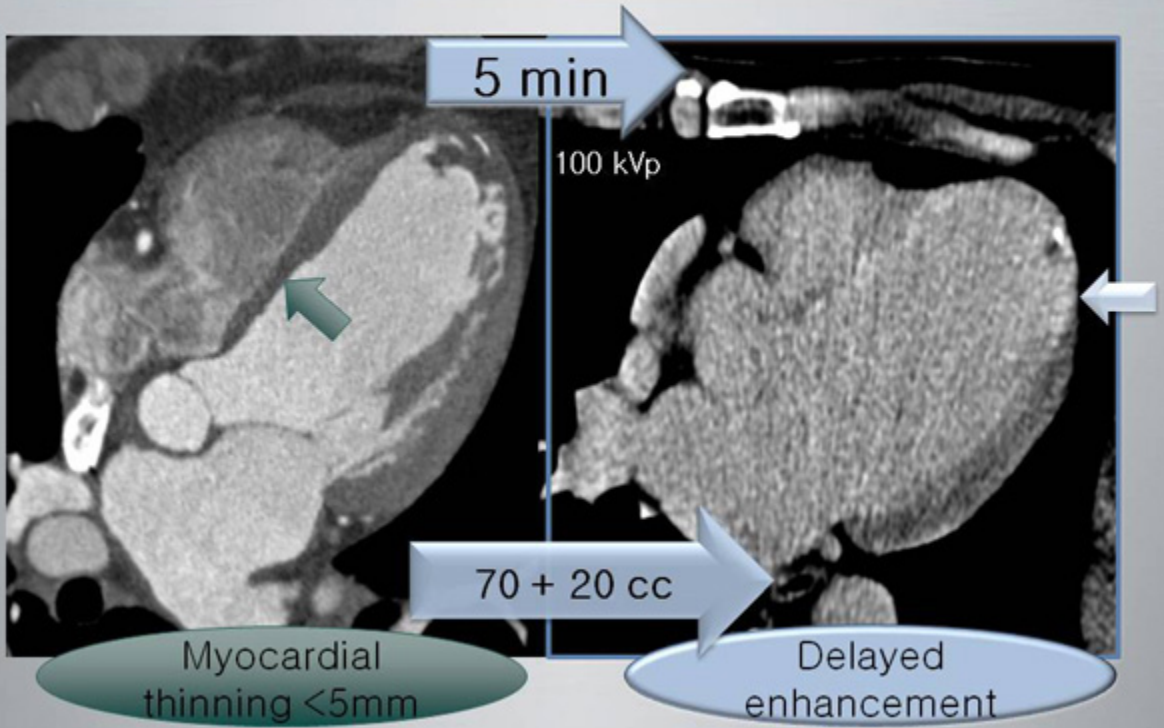
Ko BS, Cameron JD, Meredith IT, Leung M, Antonis PR, Nasis A, Crossett M, Hope SA, Lehman SJ, Troupis J, DeFrance T, Seneviratne SK.
Monash Cardiovascular Research Centre, Monash Heart, Southern Health, 246 Clayton Road, Clayton, 3168 VIC, Australia.

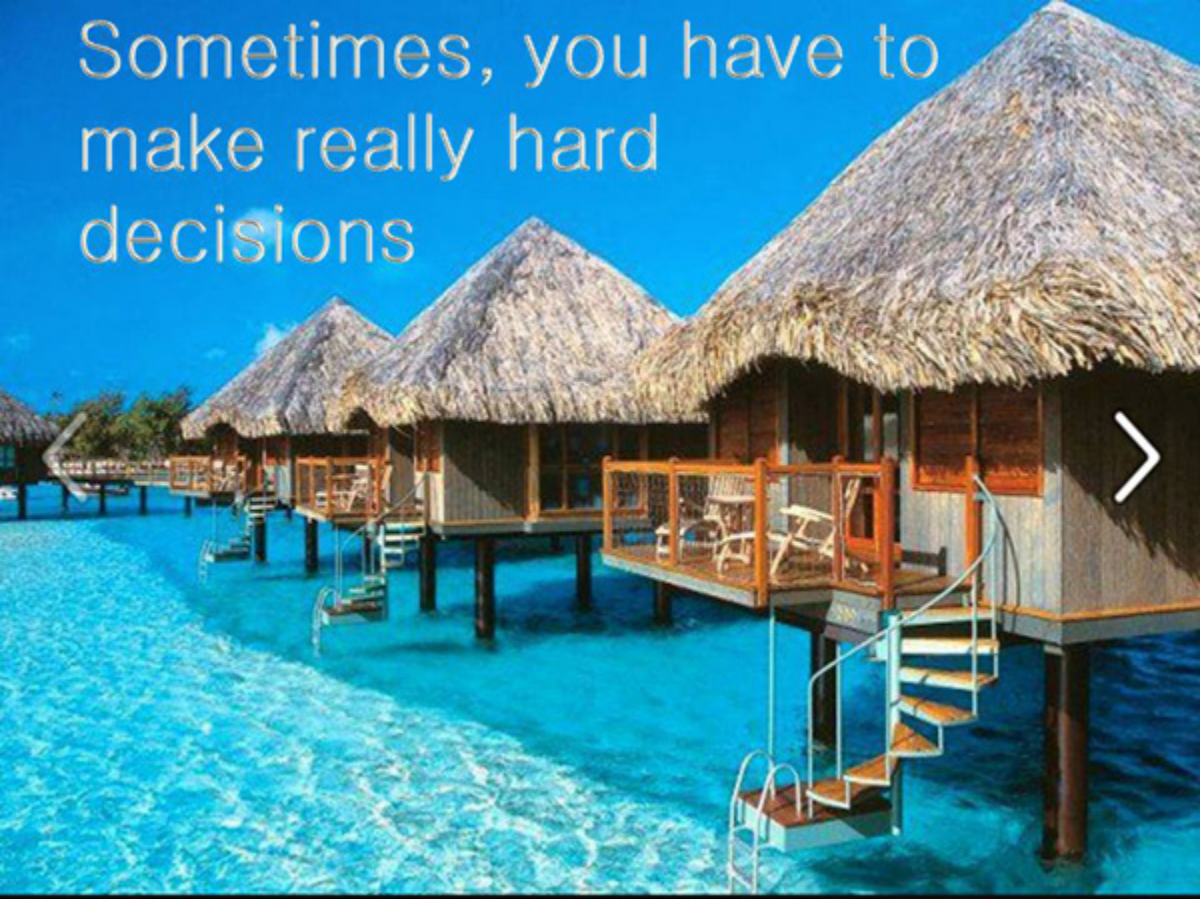




Ko Eur Heart J 2012

Chronic myocardial infarct
Delayed enhancement



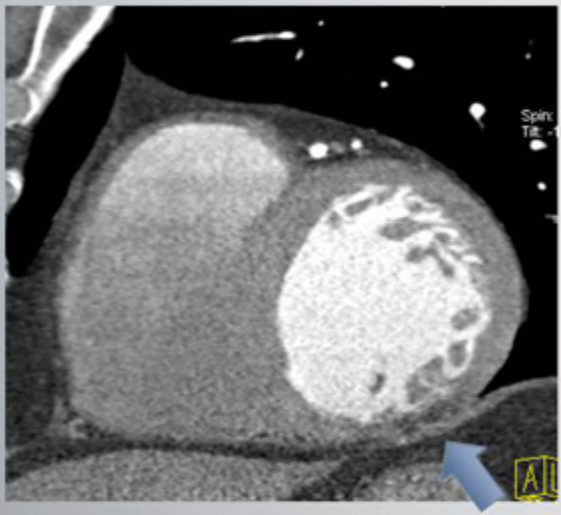

Sometimes, you have to
make really hard
decisions

Stress– or rest first?

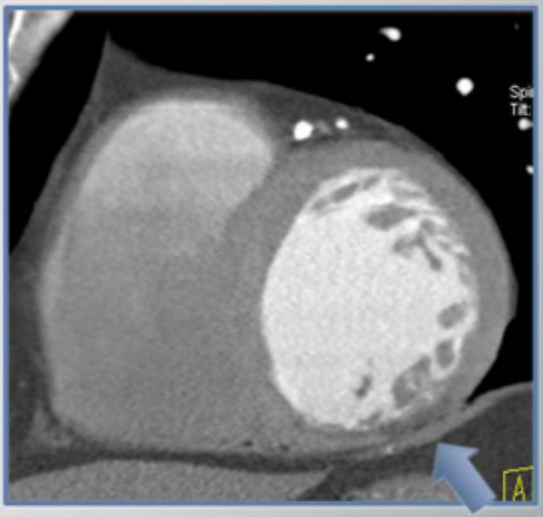
	+	–
STRESS--> REST	higher sens. for ischemia	„DE“ contamination-> lower sens for infarct
	Coronary CTA at rest can be optimized	
REST--> STRESS	Higher sens-infarct	„DE“ contamination: Lower sens for ischemia
	Stress avoided if CTA minimal disease	Pre-Beta blocker: underestimate ischemia

From Techaith and Cury JACC imaging 2011: review

POST PROCESSING

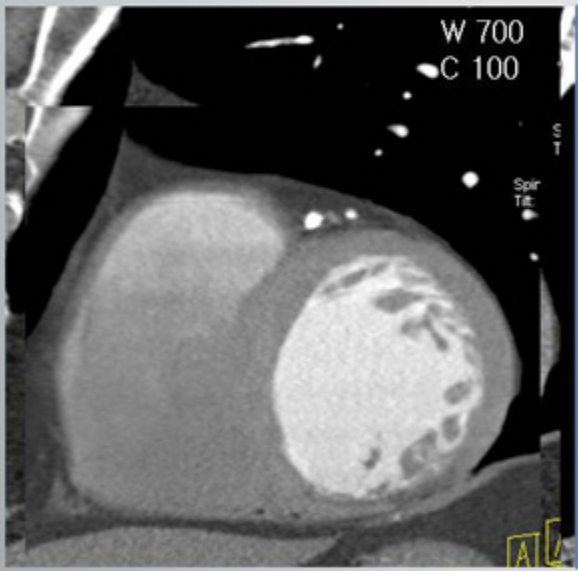


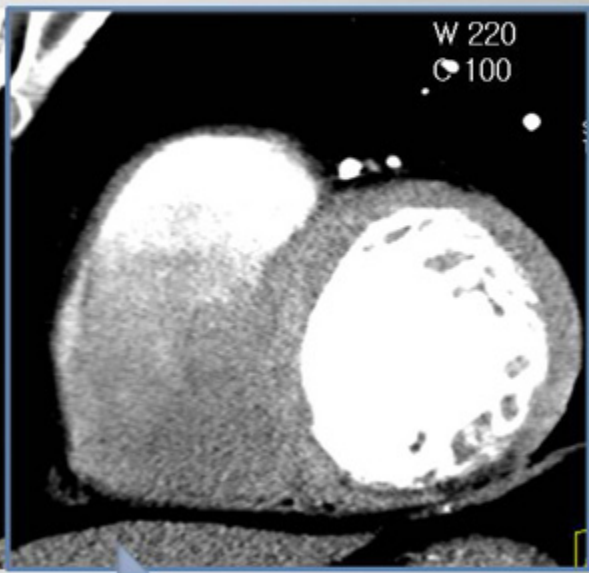
MPR
1 mm



Thick MPR
5mm

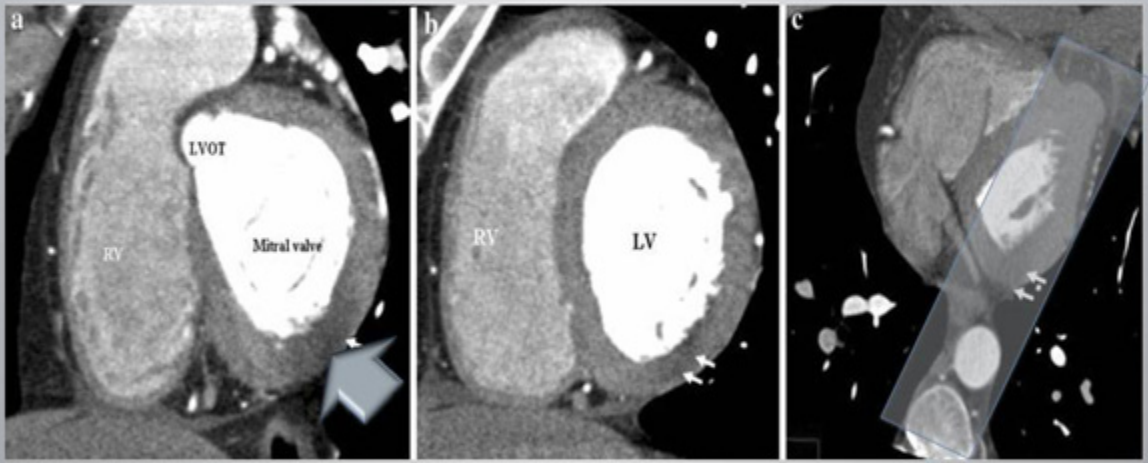
POST PROCESSING





Narrow C/W!

Beam hardening (BH) artifact



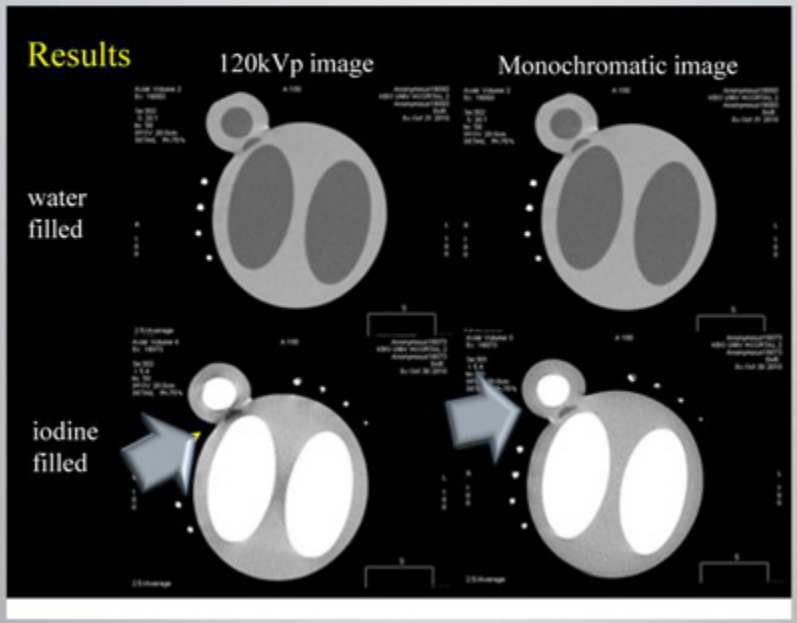
lower CT-attenuation 53 HU

posterobasal

Rodriguez Int j Cardiovasc Imag 2010

Beam hardening correction by fast switching dual spectral energy (80/140kVp)- experimental study

- Monochromatic 70kV better than convent120kVp



Kuribayashi et al 2011, courtesy of V Norlock (GE).

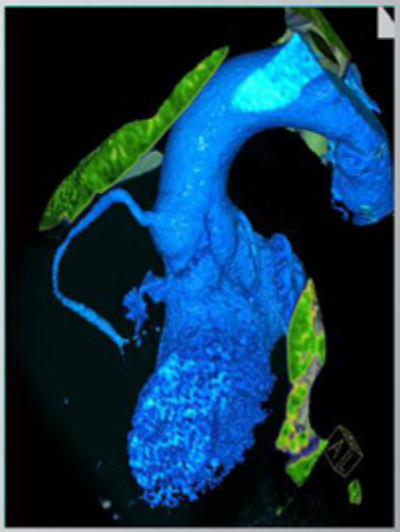
Golden rules

How to distinguish BH-artifact from true perfusion defect

1) does **not** follow myocardial territory

2) loco typico: inferior posterobasal

3) Constant @stress and rest



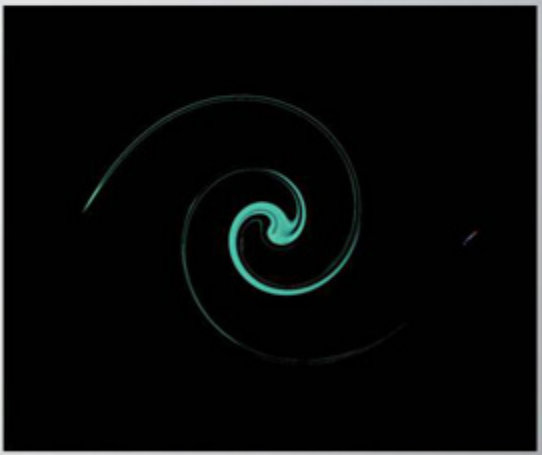
Stress-CT-perfusion- when?

- if CT-Angiography has limitations:

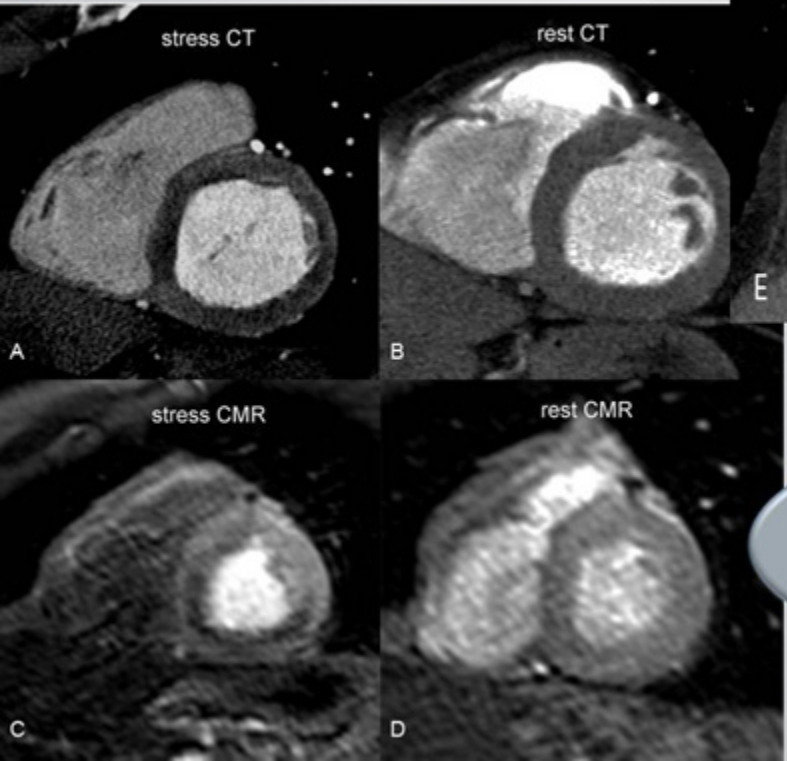
  *intermediate 40-70%stenosis-> ischemia?

  *high-calcium score

  *stents

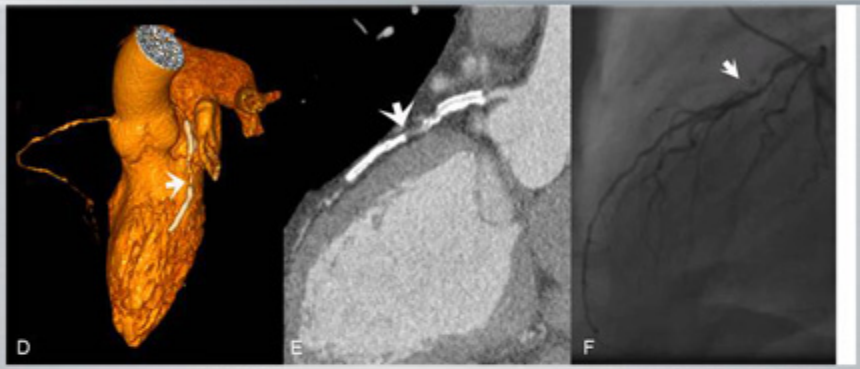


82 YOM, denovo AP CCS II-III.
RCA 60-70% + CX 99%



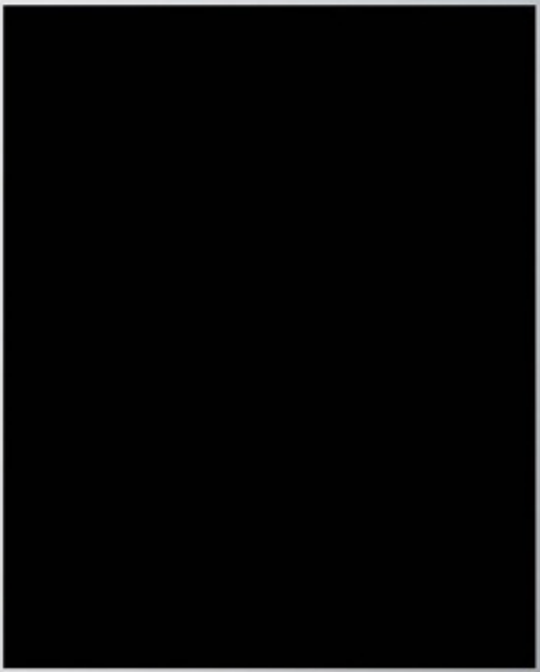
Complete reversible myocardial ischemia

69 YOM- asymptomatic
Prior PTCA /NSTEMI 6 months ago.



Partial reversible ischemia

Conclusion- Can CT replace MR?



Conclusion CT vs MR

- **CT- stress perfusion:**
  - * advantage of CTA (CABG-, CTO-planning)
  - * single-center studies
  - * radiation
  - * spatial resolution of CT > MR

- **CT-Viability (DE)**: alternative to MR