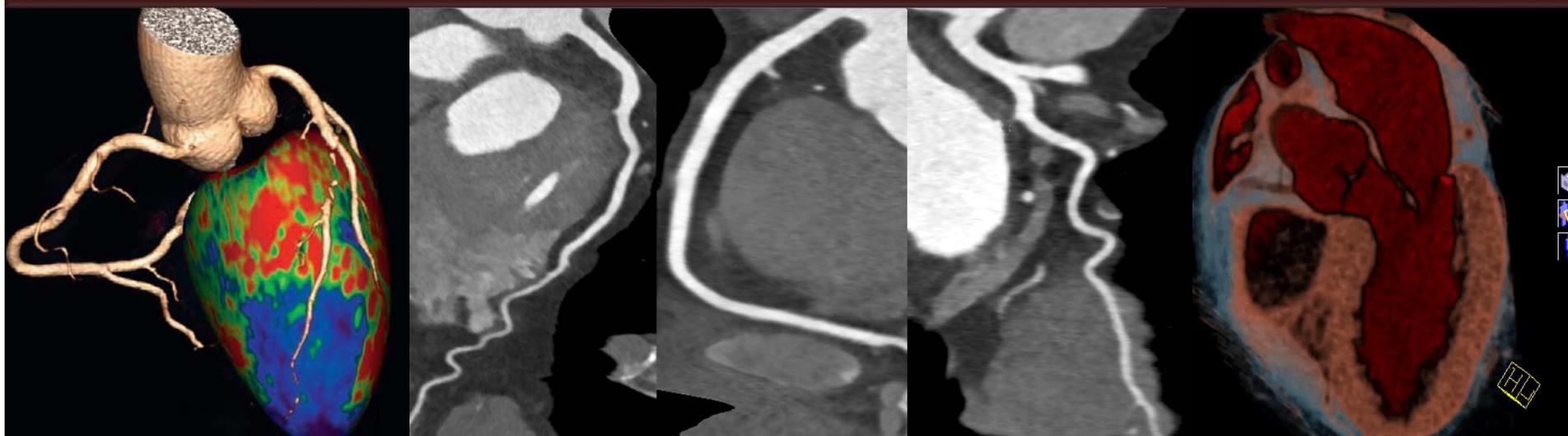


# Avaliação do Coração da Mulher

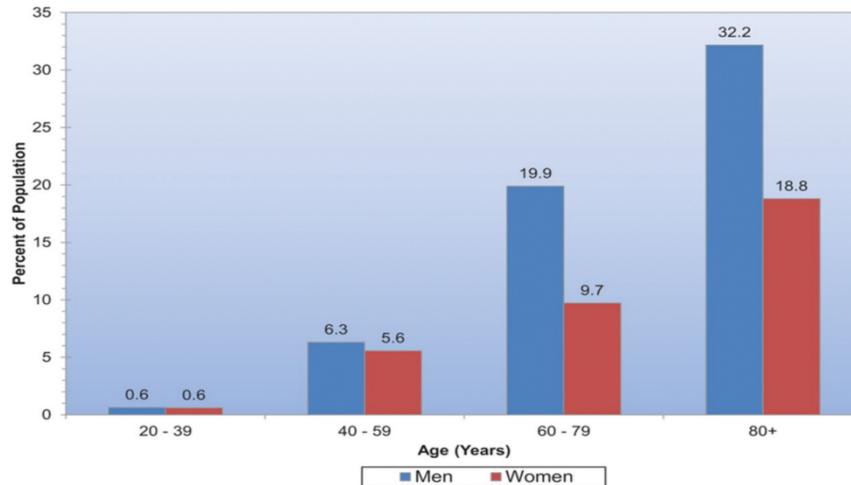
## Ressonância e Tomografia

[ibraim.pinto@grupofleury.com.br](mailto:ibraim.pinto@grupofleury.com.br)

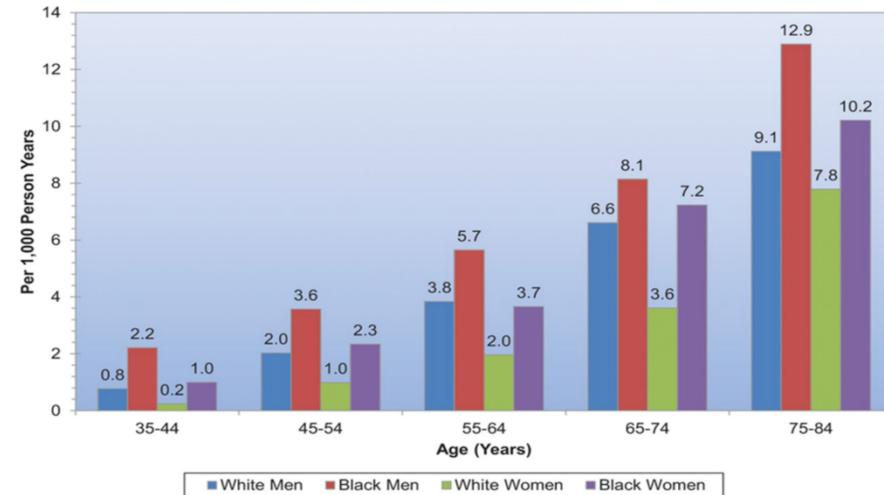


# Testes de imagem e epidemiologia de DAC na mulher

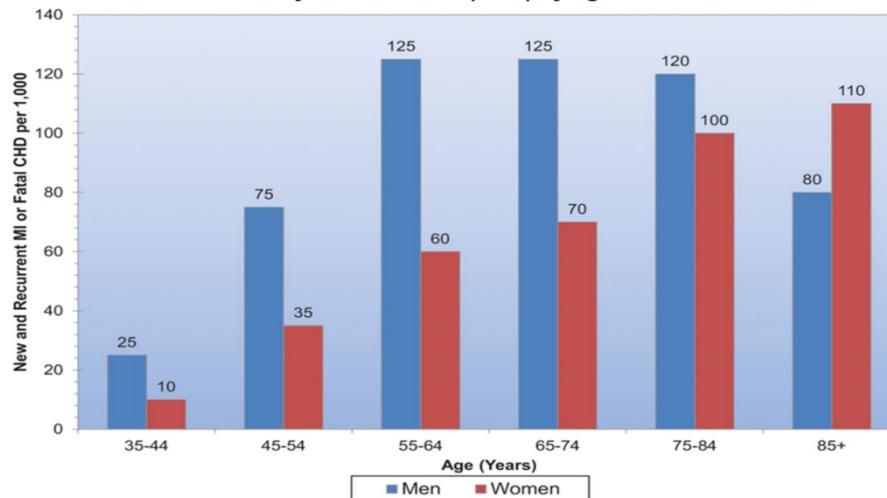
Prevalence of coronary heart disease by age and sex



Incidence of myocardial infarction by age, sex, and race



Annual number of adults per 1000 having diagnosed heart attack or fatal coronary heart disease (CHD) by age and sex



- Principal causa de morte em mulheres
- Aumenta com a idade
- Eventos maiores em mais idosas
- Estratificação pelos modelos clássicos pode subestimar o risco real

Mozaffarian D et al. *Circulation*. 2015;131:e29-e322

[http://www.heart.org/idc/groups/heart-public/@wcm/@sop/@smd/documents/downloadable/ucm\\_449846.pdf](http://www.heart.org/idc/groups/heart-public/@wcm/@sop/@smd/documents/downloadable/ucm_449846.pdf)

## Principais dificuldades diagnósticas na mulher

- Artérias mais finas
- Menor extensão de DAC
- > chance de falsos resultados
- Pensamento “masculino” da DAC
  - Não valorizar achados
  - Desconsiderar lesões

All keys open a door. The trouble is trying to open the wrong door with the wrong key.

- Unknown



## Estratificação de Risco em Assintomáticos: Escore de Cálcio

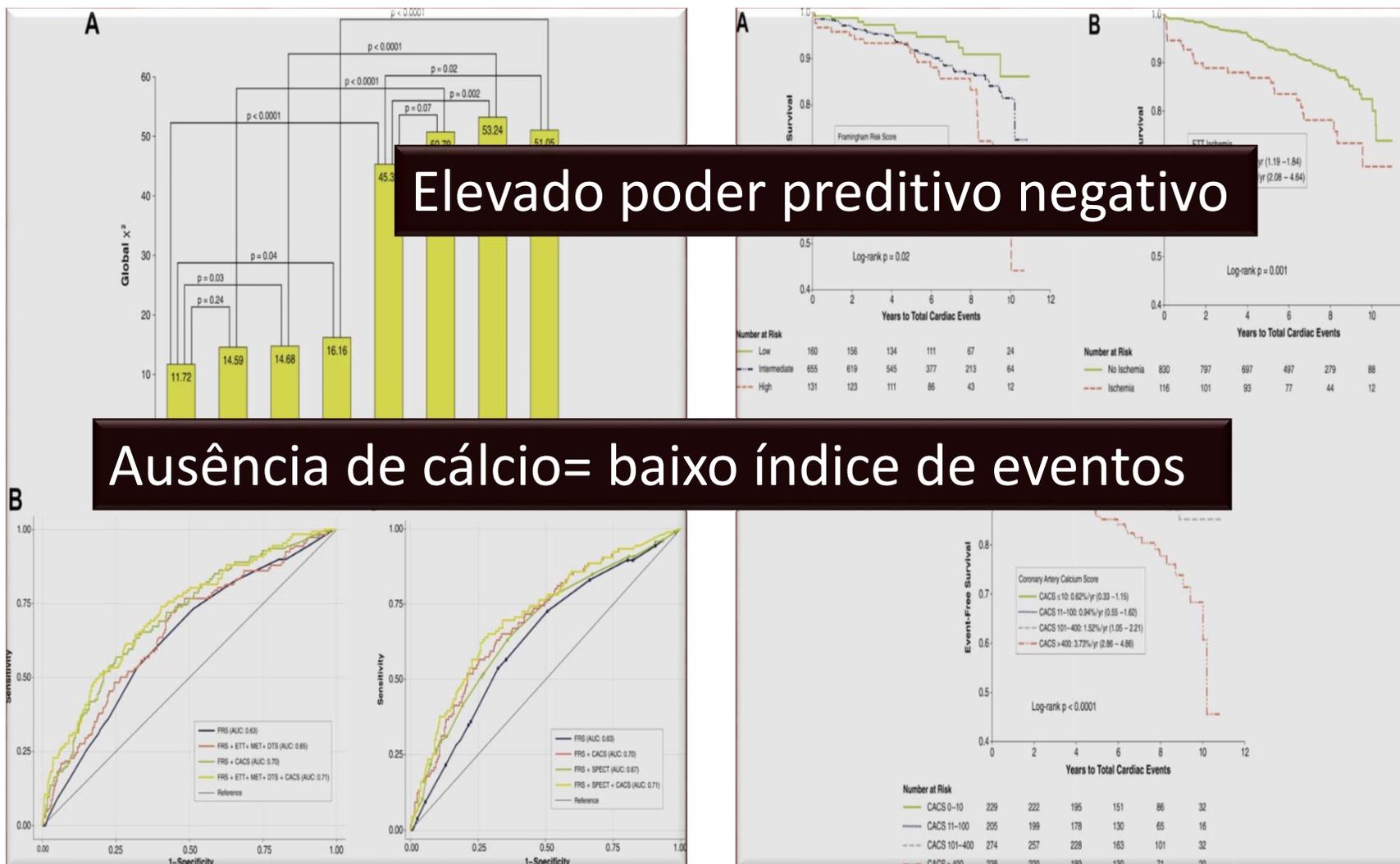
Associação entre cálcio, ATS e DAC

Facilmente identificável ao raio X

Baixas doses de radiação



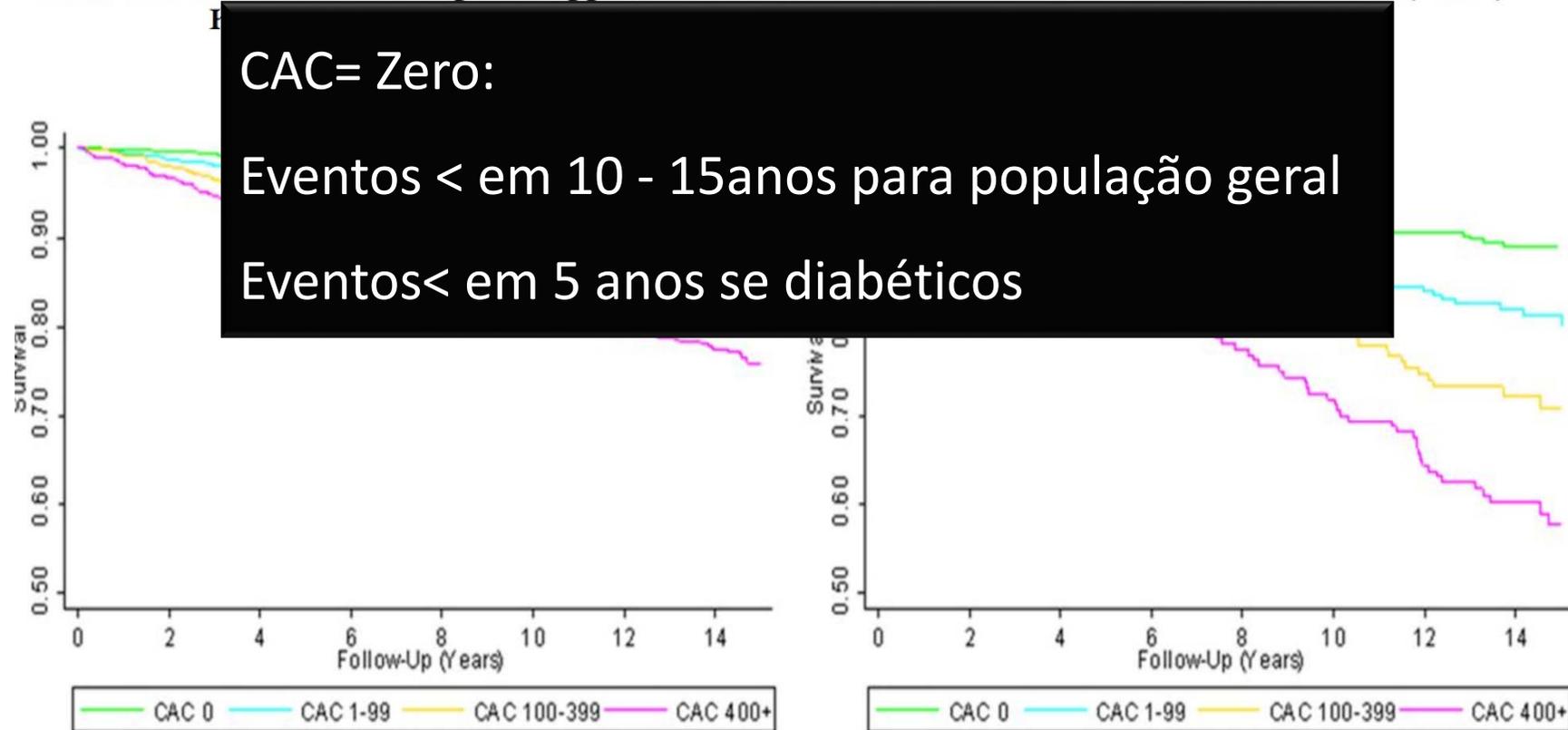
# Escore de cálcio e avaliação de assintomáticos



# Coronary Artery Disease

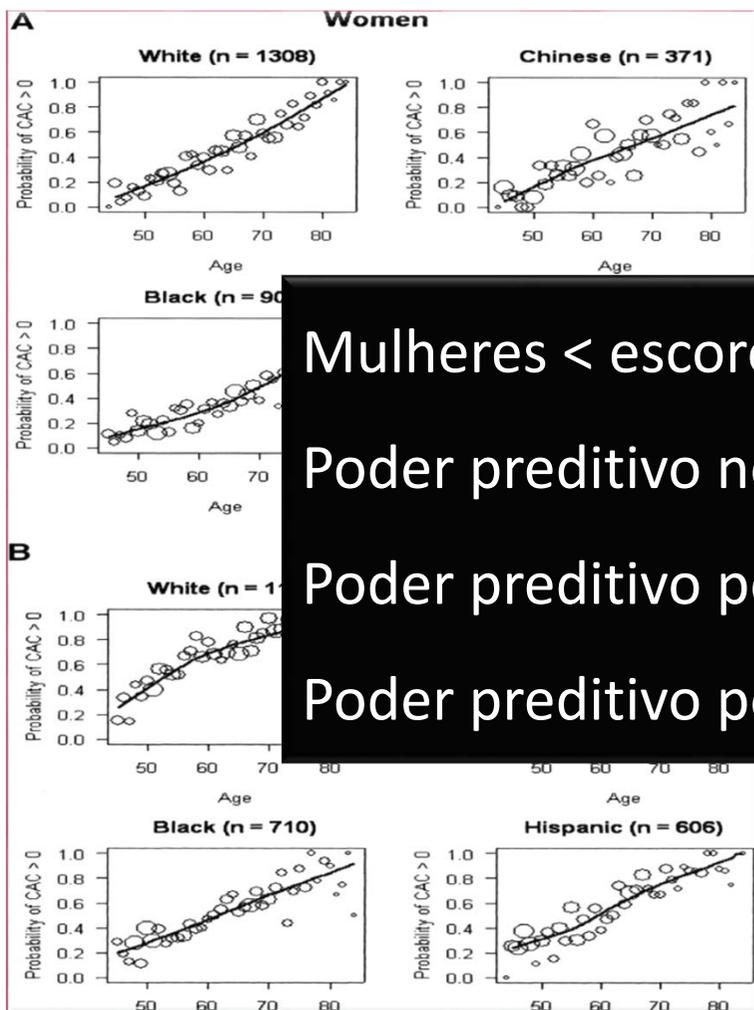
## Absence of Coronary Artery Calcium Identifies Asymptomatic Diabetic Individuals at Low Near-Term But Not Long-Term Risk of Mortality A 15-Year Follow-Up Study of 9715 Patients

Valentina Valenti, MD; Bríain ó Hartaigh, PhD; Iksung Cho, MD;  
Joshua Schulman-Marcus, MD; Heidi Gransar, MS; Ran Heo, MD; Quynh A. Truong, MD;  
Leslee J. Shaw, PhD; Joseph Knapper, MD; Anita A. Kelkar, MD; Sebastiano Sciarretta, MD;



*Circ Cardiovasc Imaging. 2016;9:e004389, originally published February 4, 2016*

## CAC em mulheres: particularidades



Mulheres < escore

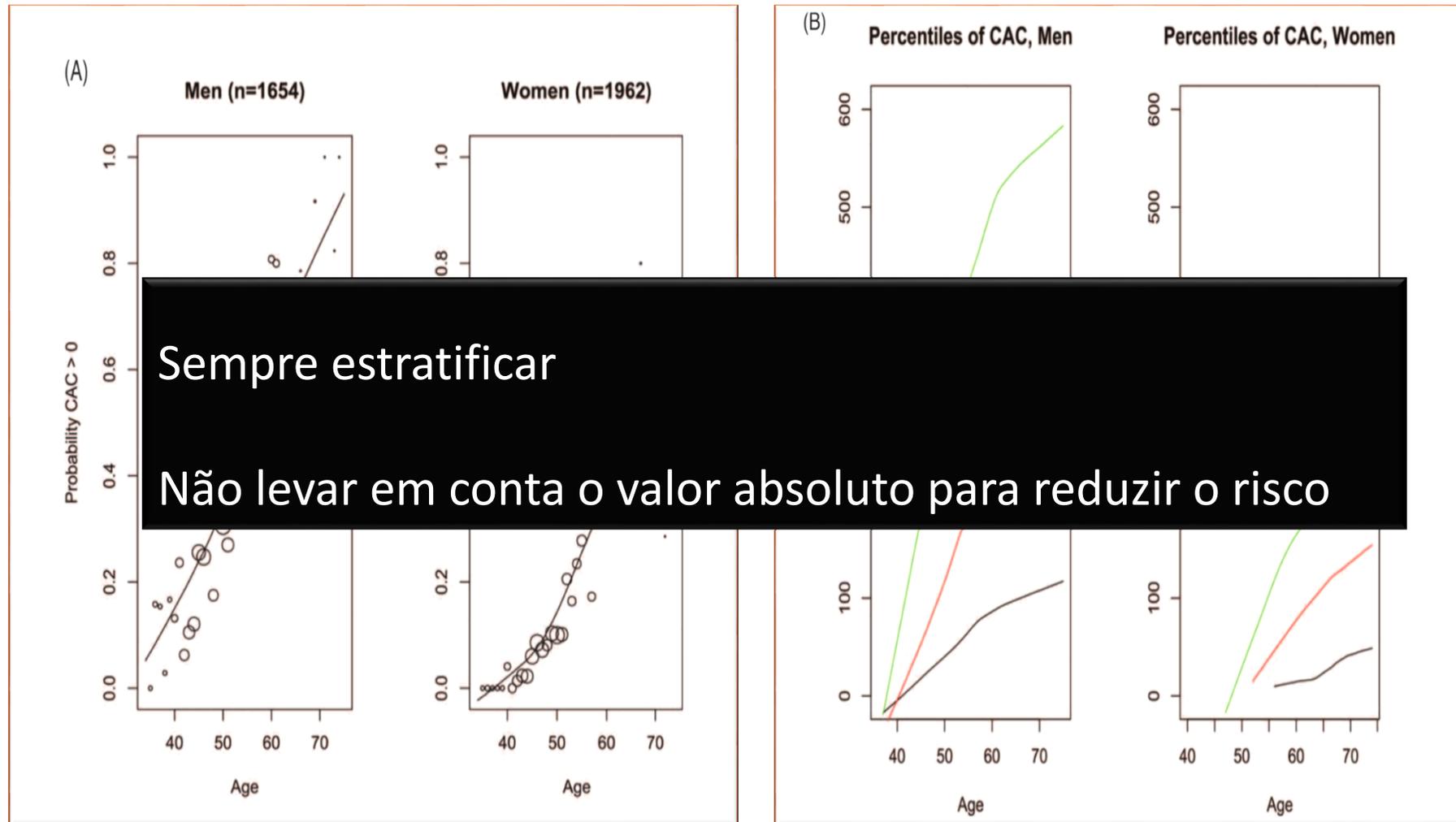
Poder preditivo negativo mantido

Poder preditivo positivos com escores mais baixos

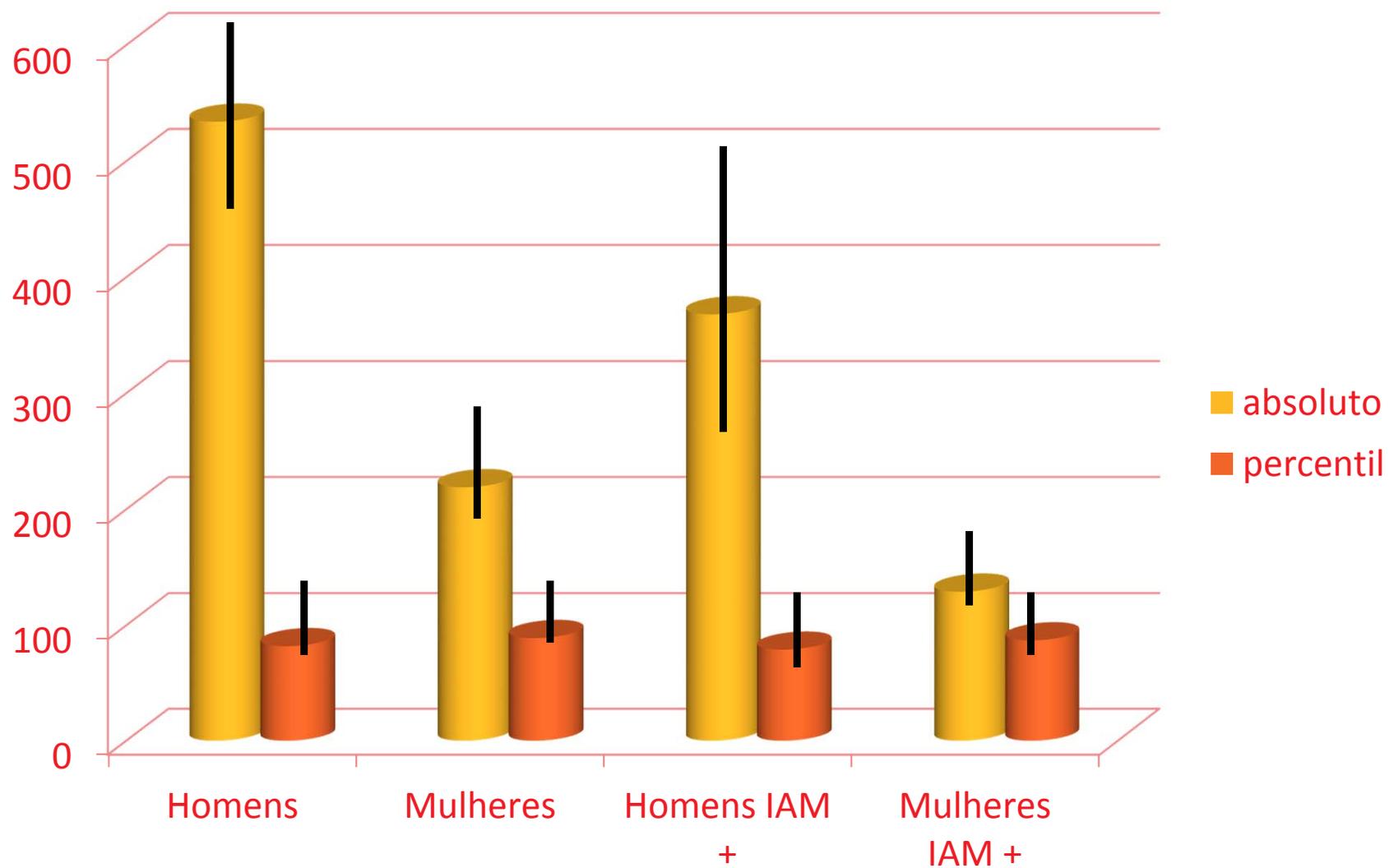
Poder preditivo positivo com > extensão

VESSEL	MALES (n = 85)	FEMALES (n = 53)	P VALUE
LM	46.5 ± 142.9; (0; 0-1,094)	16.7 ± 56.5; (0; 0-358)	<0.167 (ns)
			0.003 (s)
			0.004 (s)
			0.010 (s)
			0.003 (s)
Number of vessels ≥11	2.1 ± 1.5; (2; 0-4)	1.3 ± 1.4; (1; 0-4)	<0.005 (s)
Number of vessels >101	1.2 ± 1.4; (1; 0-4)	0.67 ± 1.0; (0; 0-4)	<0.036 (s)

## CAC em mulheres: peculiaridades



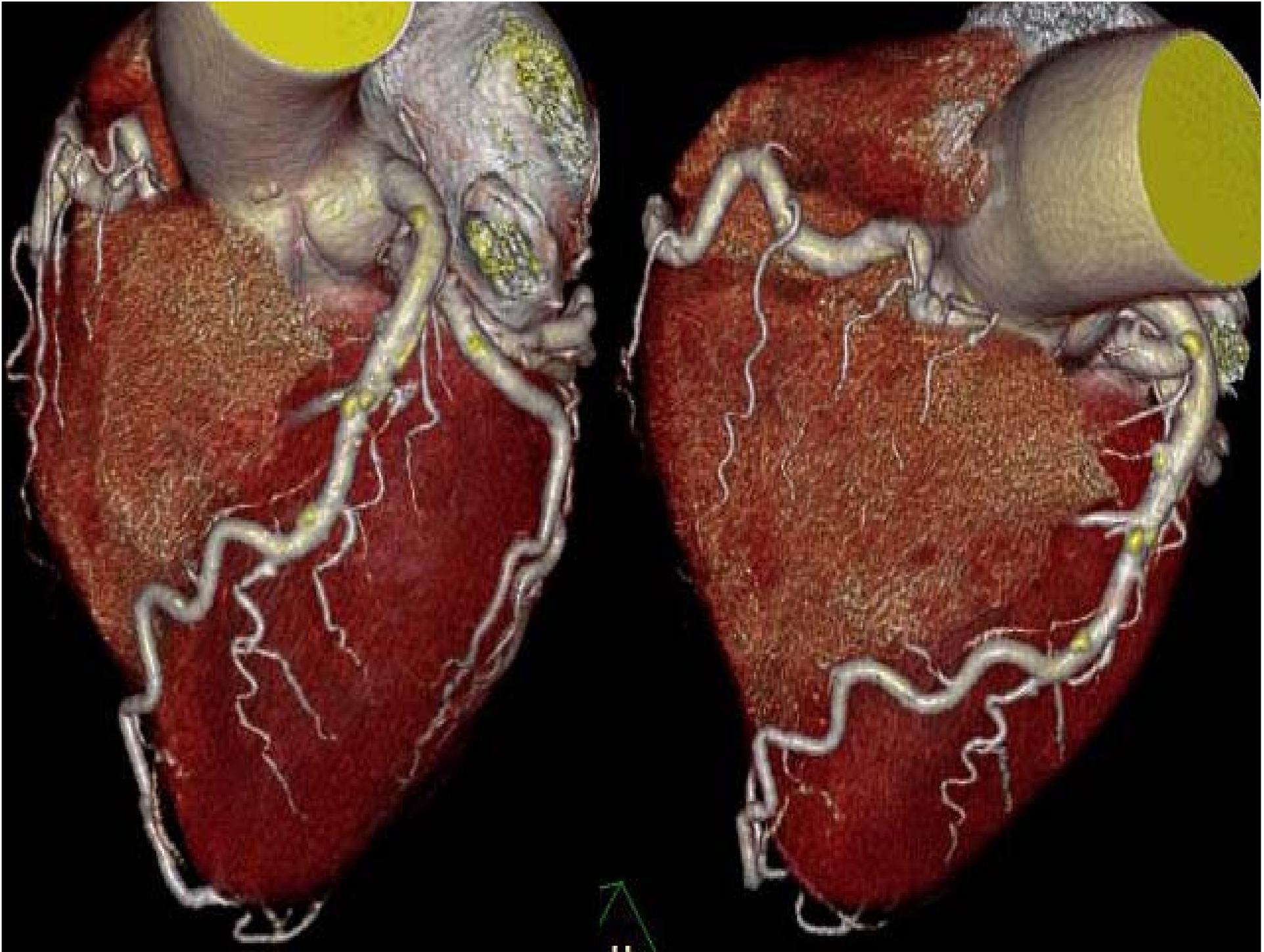
## CAC em Mulheres



## CAC em mulheres: limitação

- Resultados válidos para assintomáticas
  - Sem dor (angina ou dor atípica)
  - Sem alterações a outros exames não invasivos
  - Sem eventos prévios (IAM, intervenção percutânea ou cirúrgica, ...)
- Mulheres: sintomas atípicos

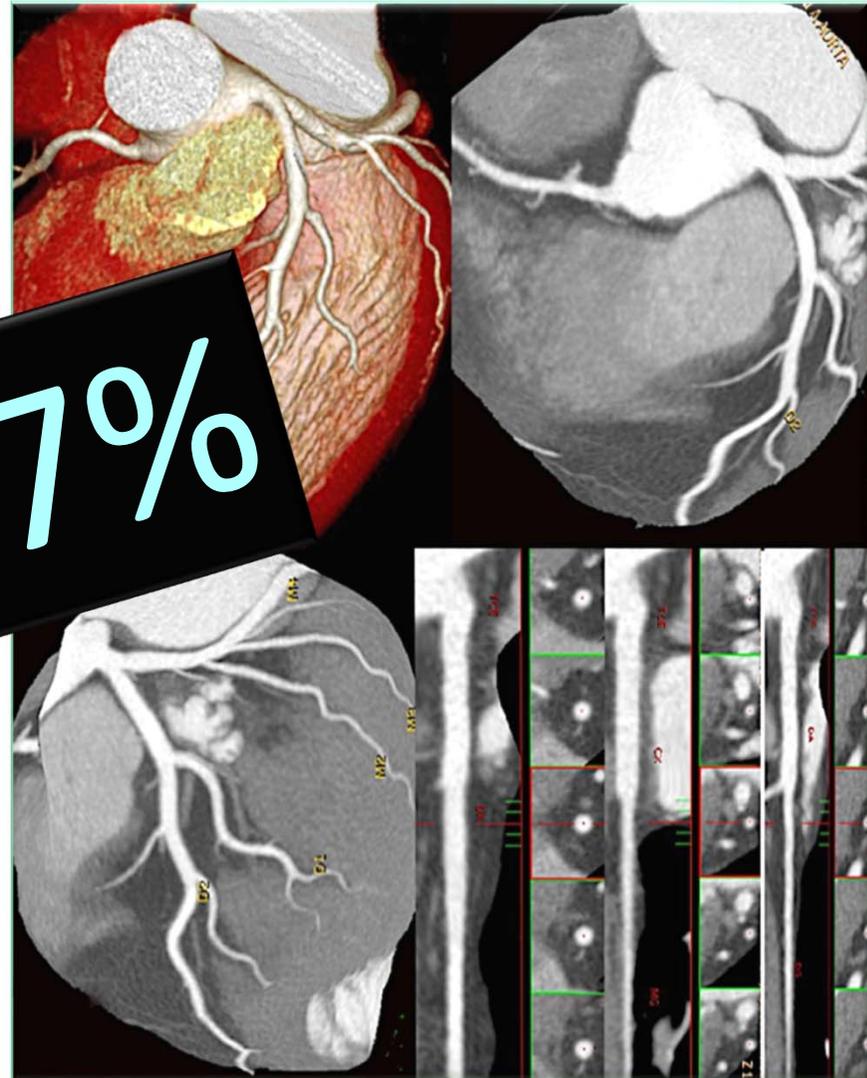
Sintomas mesmo que atípicos – reduzem o valor do escore de cálcio



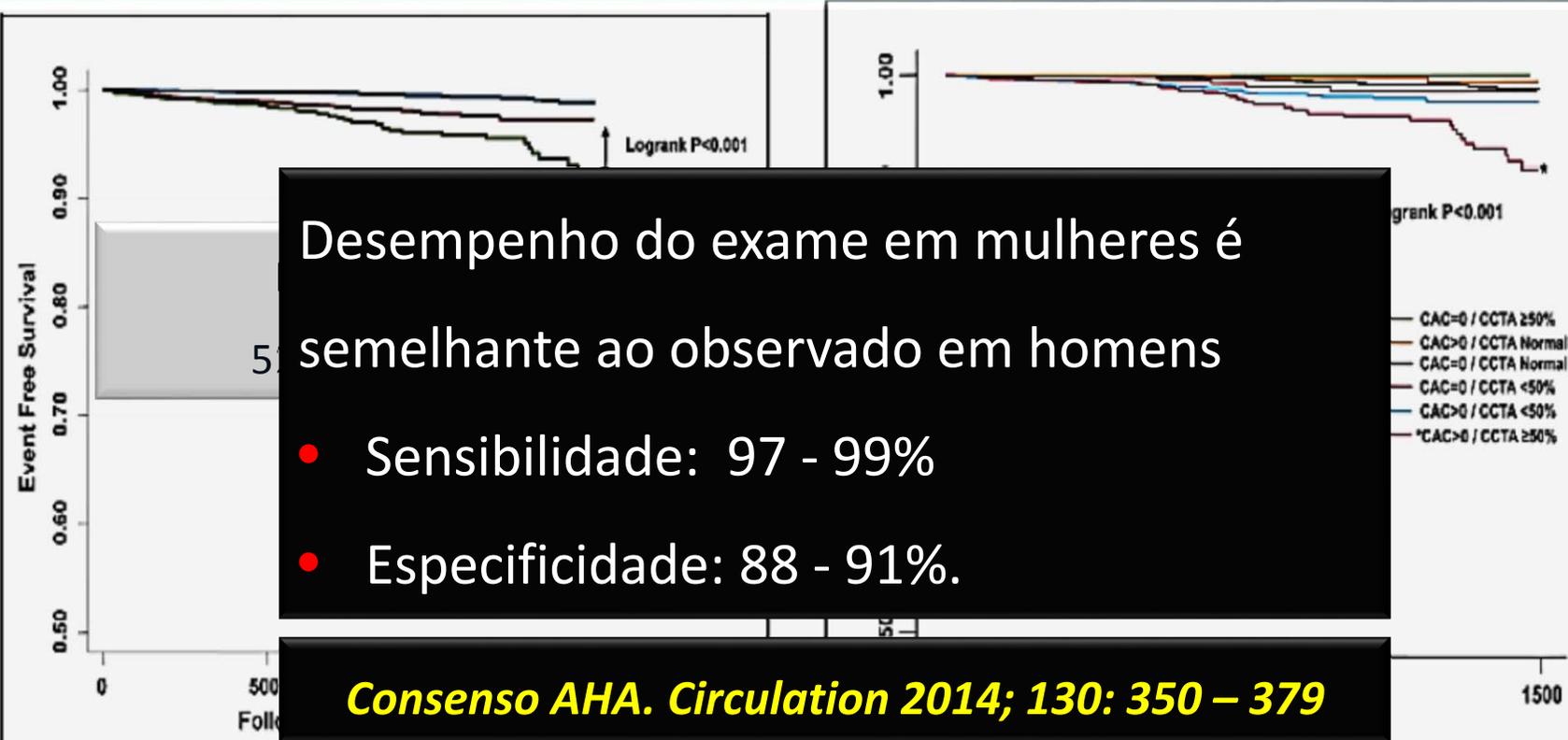
## Tomografia para Análise das Artérias Coronárias

- Anatomia completa
- Cálcio
- Placas não calcificadas
- Excelente para a detecção da presença de estenose significativa
- Identificar DAC em casos de quadro clínico não típico

> 97%



# Angiotomografia e Prognóstico



**Figure 2** All-Cause Mortality-Free Survival

Survival among all patients according to worst coronary artery stenosis on coronary computed tomography angiography demonstrating decreased survival among patients with at least 1 major epicardial vessel with  $\geq 50\%$  stenosis. CAD = coronary artery disease.

**Figure 3** Survival According to CAC Score and Stenosis Severity

All-cause mortality-free survival among patients according to CAC score and the severity of coronary artery disease on coronary CCTA. Abbreviations as in Figure 1.

Villines et al, JACC, 2011; 58: 2533 - 40

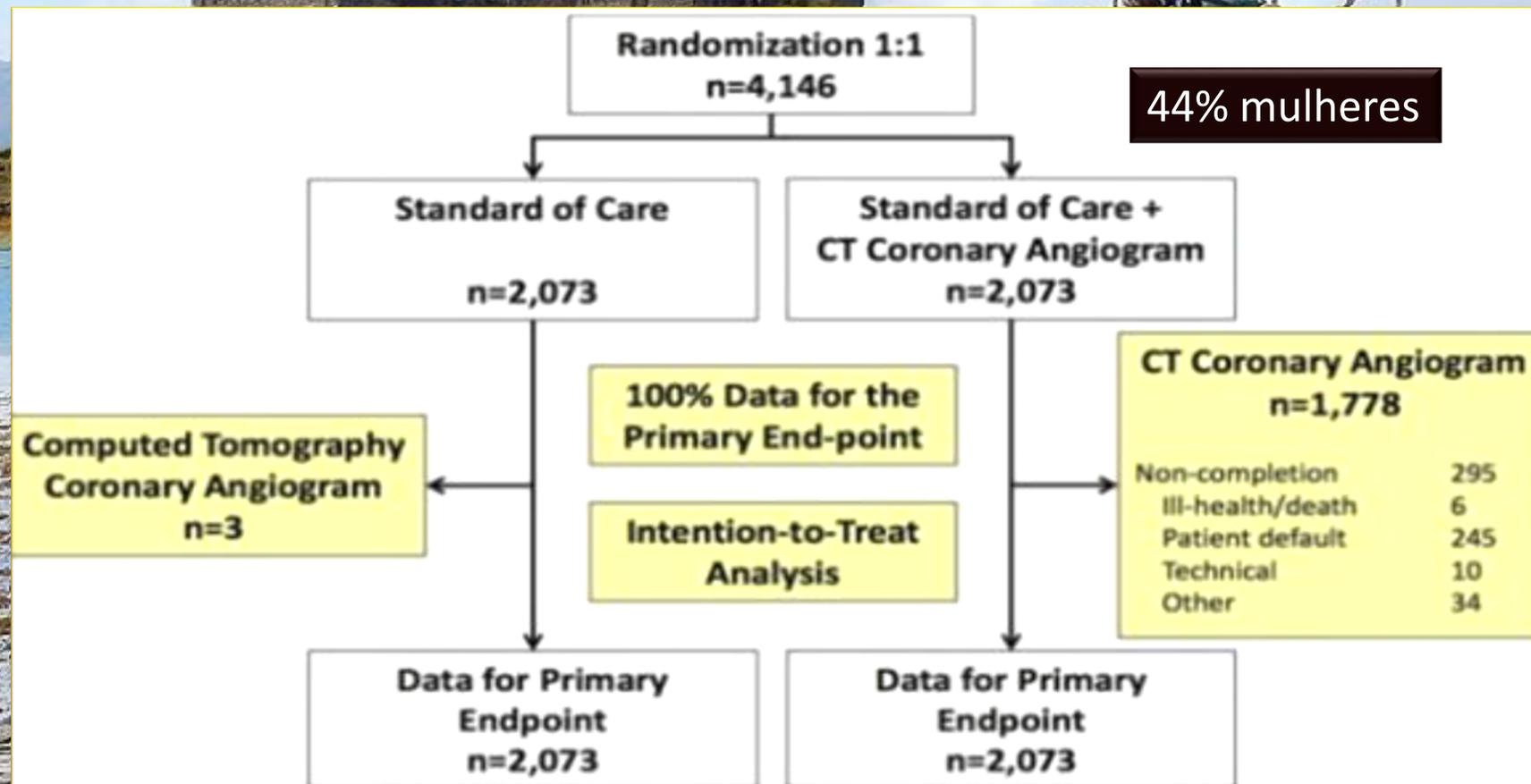




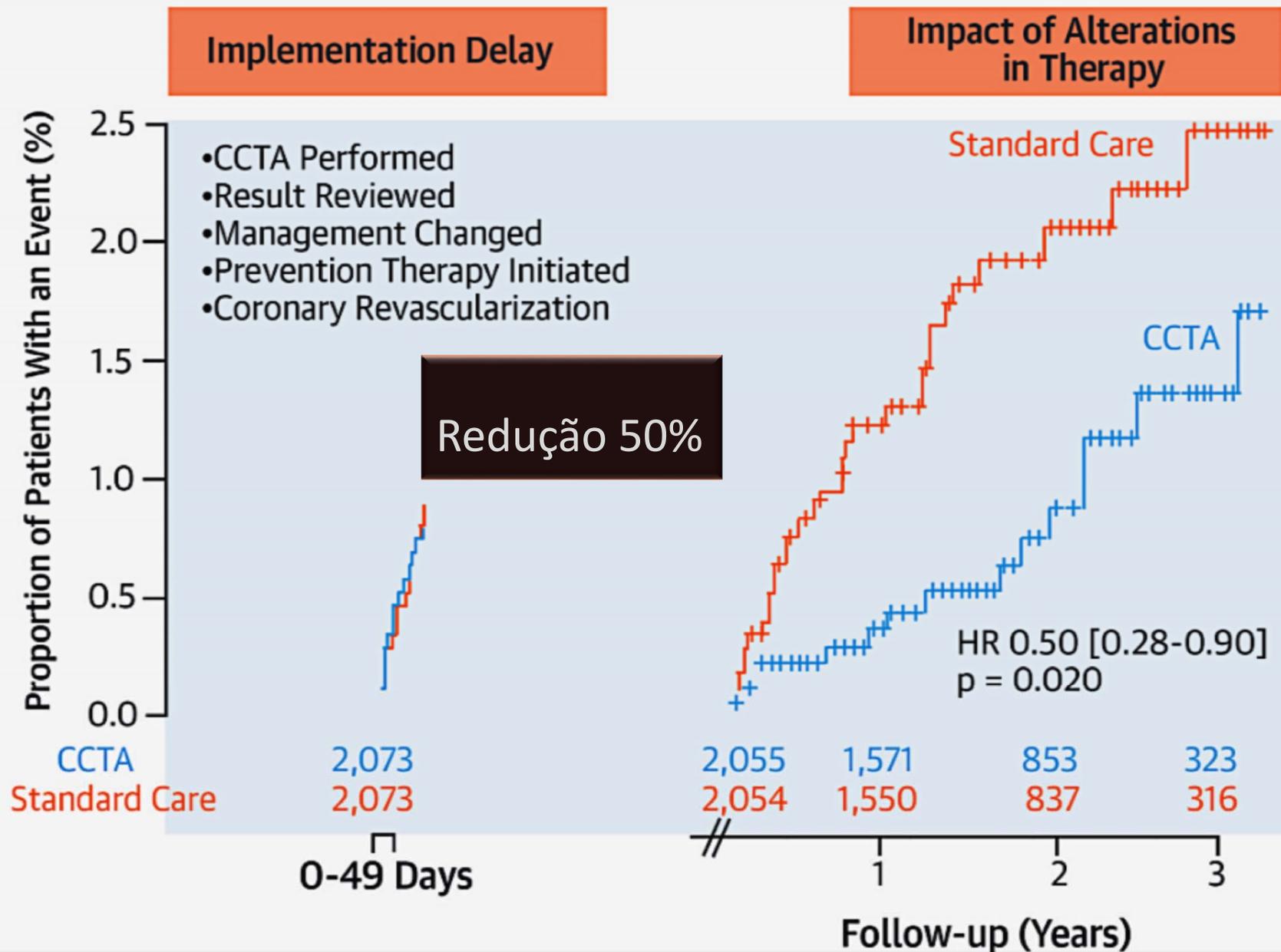
# Scottish COmputed Tomography of the HEART (SCOT-HEART) Trial

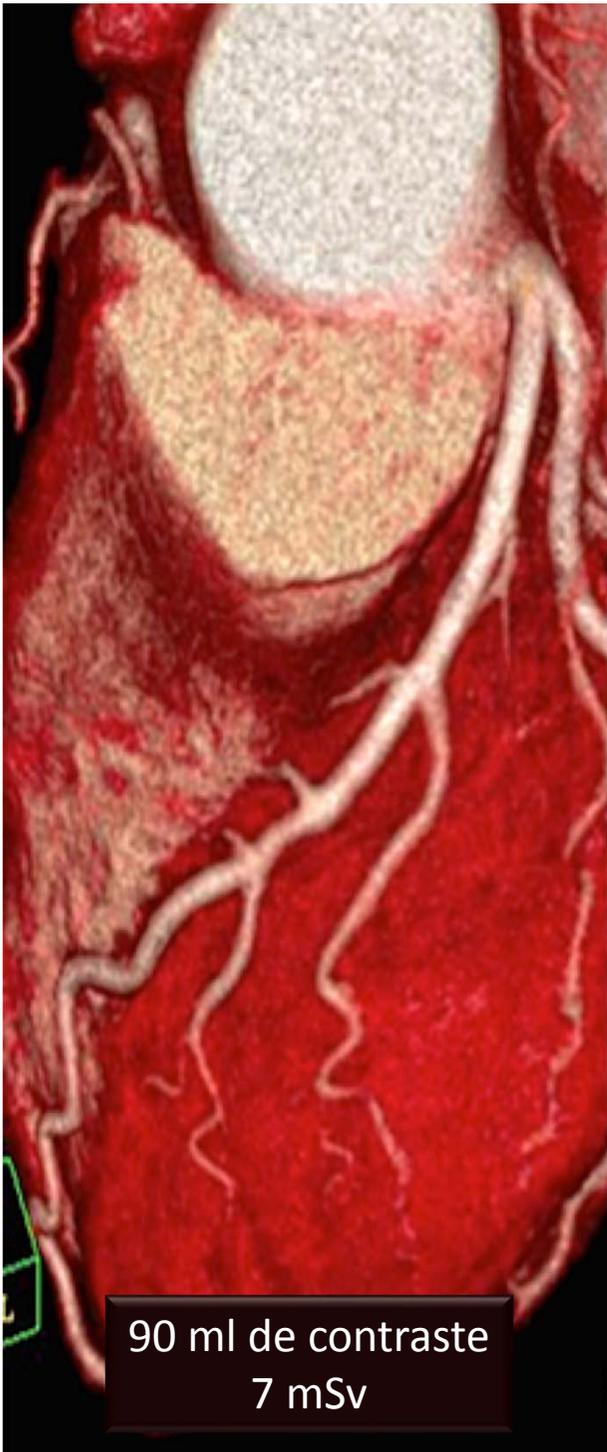


First trial to assess the clinical impact of the addition of CTCA in patients presenting with suspected angina due to coronary heart disease in the Cardiology clinic

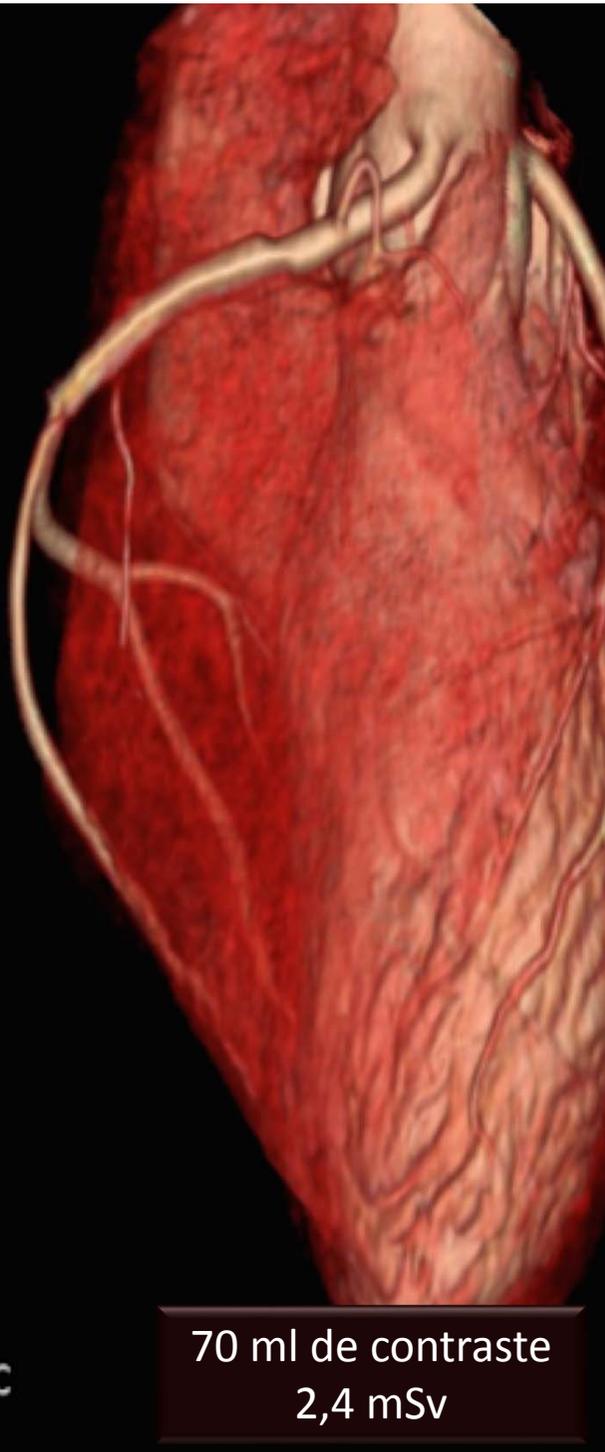


# CHD Death and Non-fatal MI, Post hoc 50-Day Landmark Analysis





90 ml de contraste  
7 mSv



70 ml de contraste  
2,4 mSv



50 ml de contraste  
0,68 mSv

## Tomografia em mulheres – Indicações

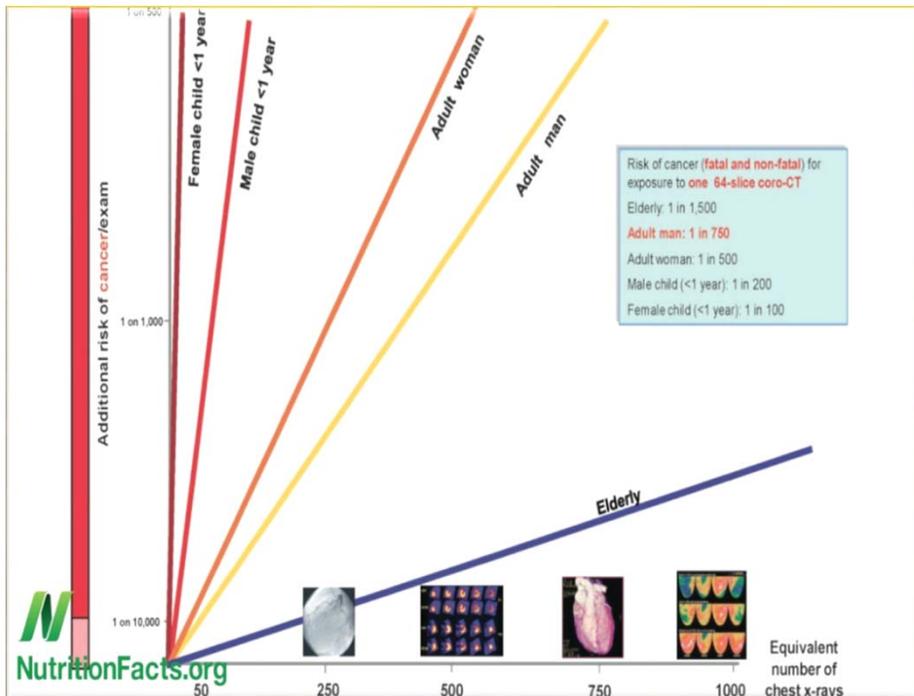
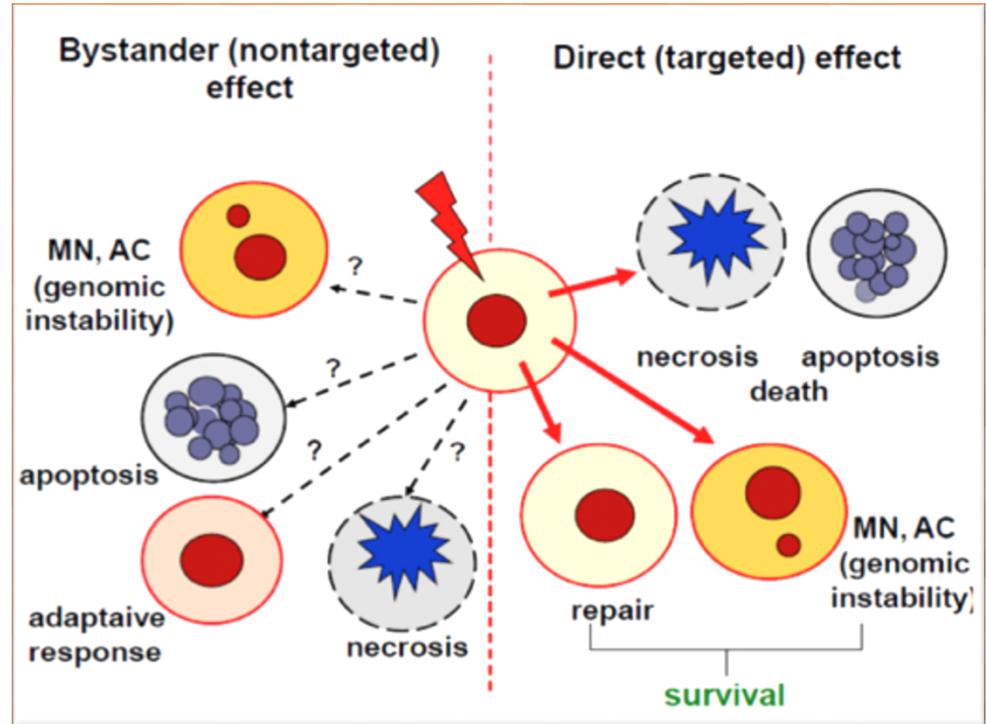
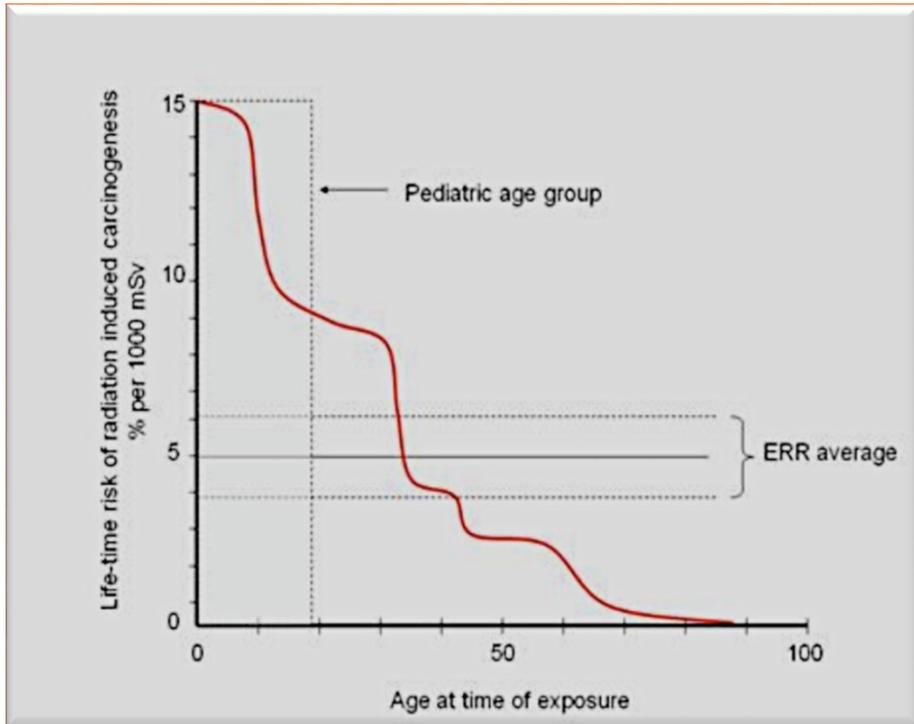
- Risco intermediário, baixo – intermediário (baixo ?)
- Interesse principal: excluir DAC
- Exame inicial em mulheres sintomáticas com alterações ao ECG de repouso, ou com resultados inconclusivos de exames funcionais.
- Resultados conflitantes de exames funcionais (TE vs. SPECT)
- Dor torácica atípica na sala de emergência
  - Insuficiência cardíaca de início recente.
- Sintomas na fase tardia após revascularização do miocárdio
- Suspeita de origem anômala das artérias coronárias
- Mulheres pré menopausa: radiação < 3 mSv.

***Consenso AHA. Circulation 2014;***

***130: 350 – 379***

***Arq Bras Cardiol 2014; 103, Nº 6,***

***Suplemento 3***



**RADIATION EFFECTS**

Measurements in millisieverts (mSv). Exposure is cumulative.

**HIGH RISK**

- Potentially fatal radiation sickness. Much higher risk of cancer later in life.
- 10,000 mSv: Fatal within days.
- 5,000 mSv: Would kill half of those exposed within one month.
- 2,000 mSv: Acute radiation sickness.

**MODERATE RISK**

- No immediate symptoms. Increased risk of serious illness later in life.
- 1,000 mSv: 5% higher chance of cancer.
- 400 mSv: Highest hourly radiation recorded at Fukushima. Four hour exposure would cause radiation sickness.
- 100 mSv: Level at which higher risk of cancer is first noticeable

**TOLERABLE LEVELS**

- No symptoms. No detectable increased risk of cancer.
- 20 mSv: Yearly limit for nuclear workers.
- 10 mSv: Average dose from a full body CT scan
- 9 mSv: Yearly dose for airline crews.
- 3 mSv: Single mammogram
- 2 mSv: Average yearly background radiation dose in UK
- 0.1 mSv: Single chest x-ray

**EYES** High doses can trigger cataracts months later.

**THYROID** Hormone glands vulnerable to cancer. Radioactive iodine builds up in thyroid. Children most at risk.

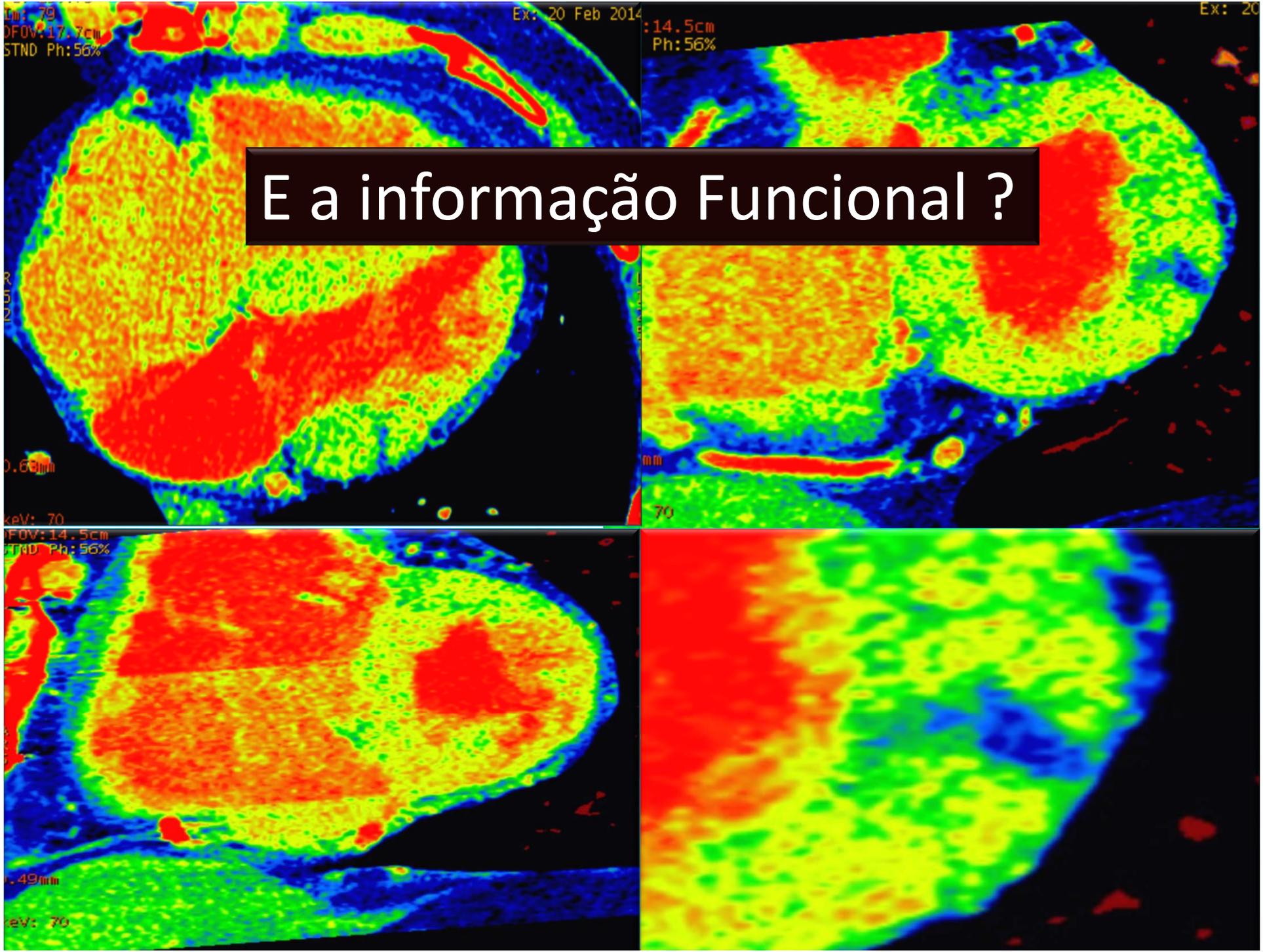
**LUNGS** Vulnerable to DNA damage when radioactive material is breathed in.

**STOMACH** Vulnerable if radioactive material is swallowed.

**REPRODUCTIVE ORGANS** High doses can cause sterility.

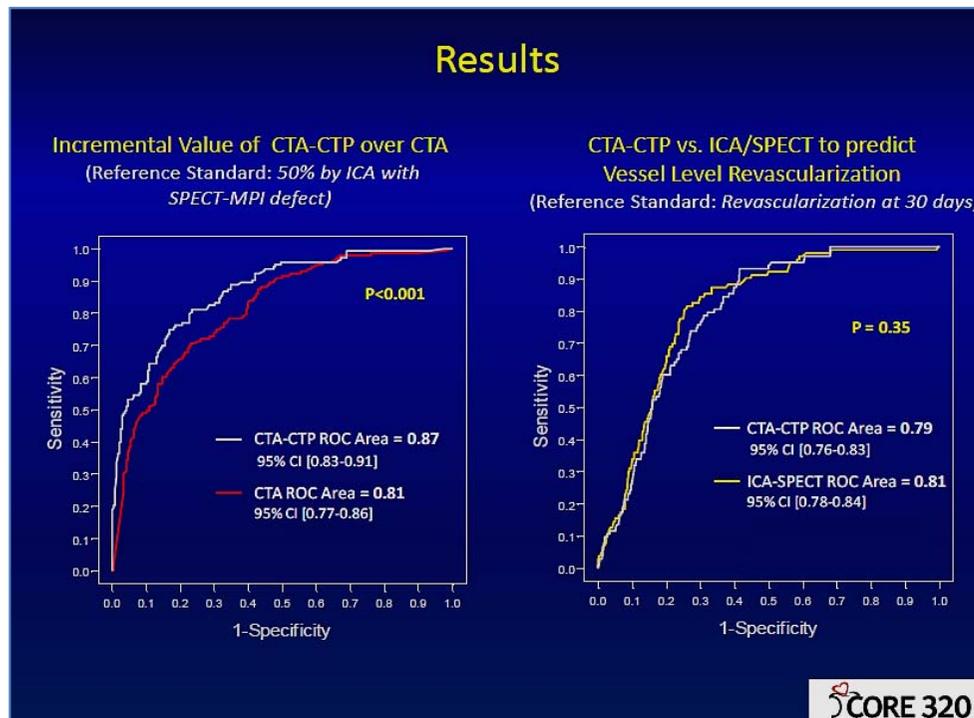
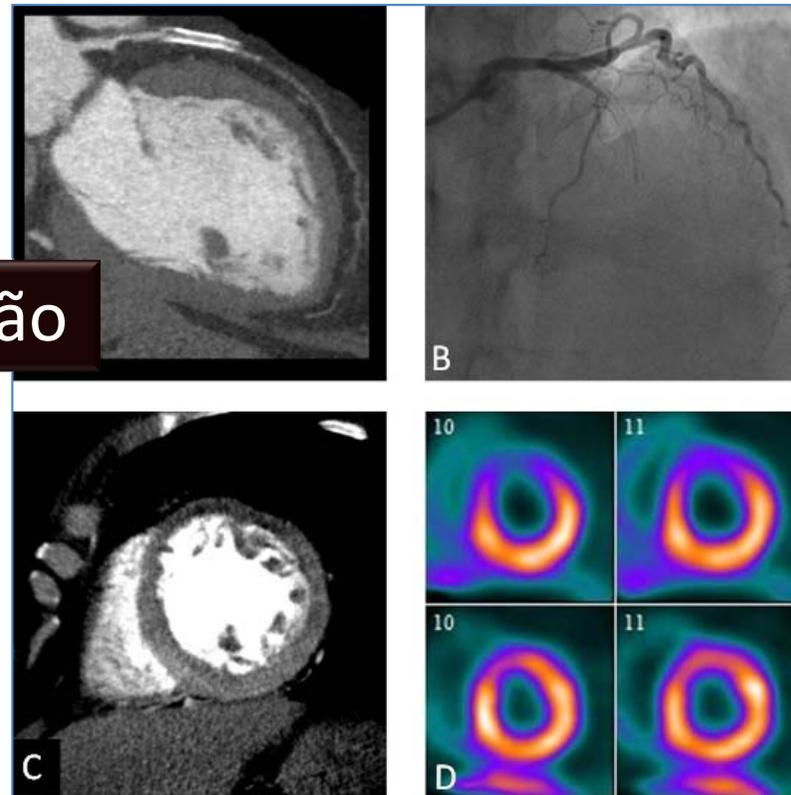
**SKIN** High doses cause redness and burning.

**BONE MARROW** Produces red and white blood cells. Radiation can lead to leukaemia and other immune system diseases.



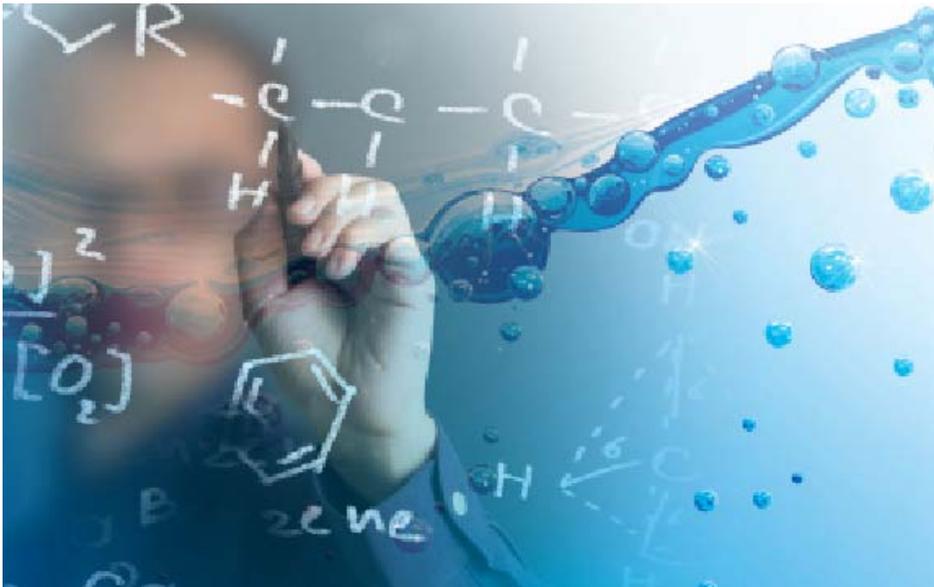
E a informação Funcional ?

- CORE 320
- 16 centros – 8 países
- 391 **Dupla exposição à radiação**
- MDCT + Perfusão CT vs. Cine + SPECT



Aumento da área sob a curva de 0,81 para 0,87

*Lima, et al, ESC 28 / 08 / 2012*



**Pipe details**    Metric    Imperial

Manning's coefficient  
0.012 Steel

Length in feet  
500.000 ft

Internal diameter  
4.026 inch

Fluid depth (uniform flow)  
3.000 inch

Drop in feet  
1.500 ft

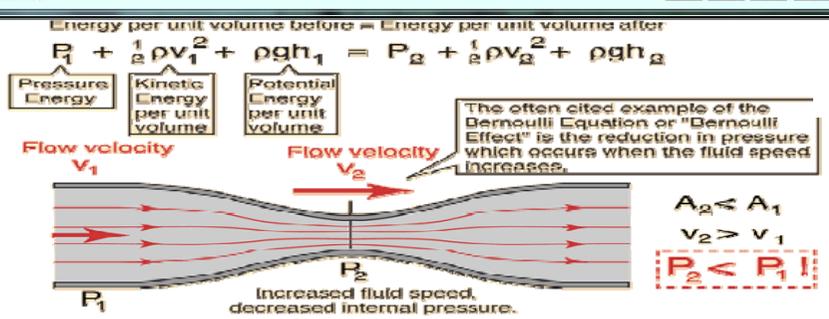
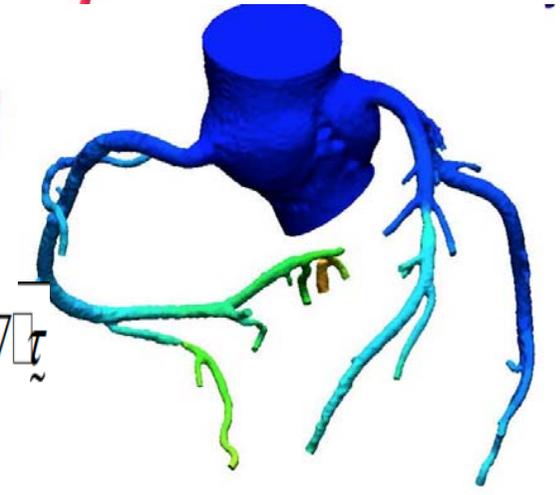
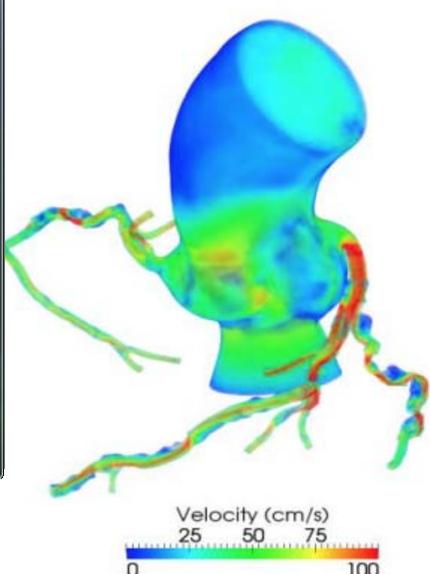
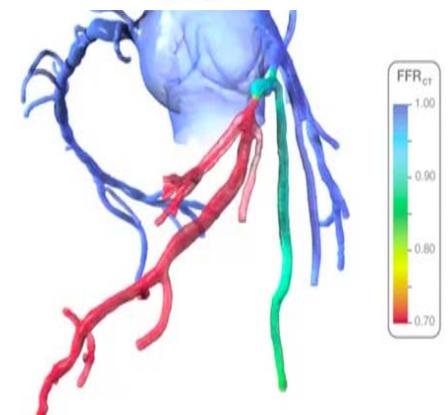
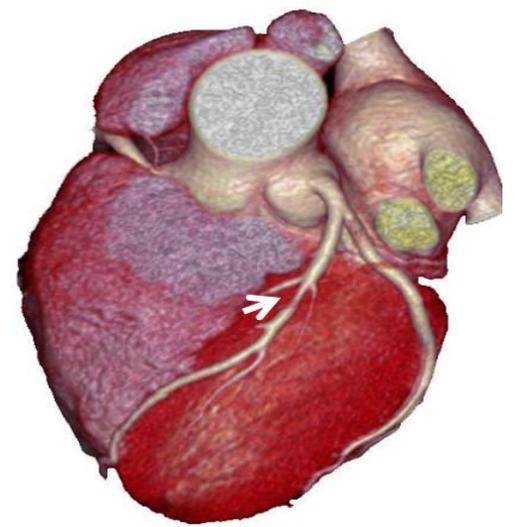
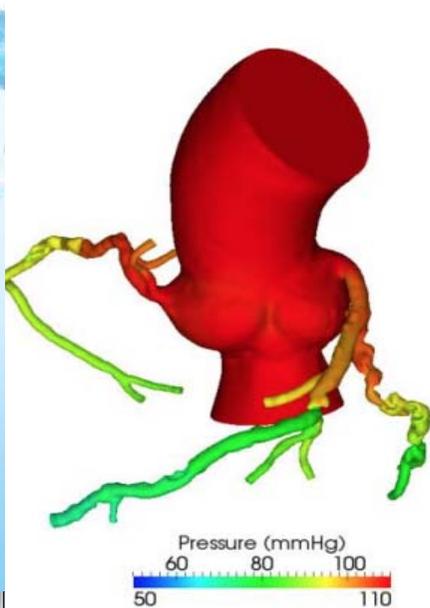
Increase  
Reduce

Results

- Water flow rate
- Water depth
- Volume and weight
- Length expansion

Fluid cross section area	Fluid velocity
0.070648 ft <sup>2</sup>	1.472 ft/s
Wetted perimeter	Fluid surface width
8.387 inch	3.509 inch
Hydraulic radius	Froude number
1.213 inch	0.528 - tranquil flow
Water flow rate	Slope ratio (angle)
6.240 cu.ft/min	0.003000 (0.172°)

Calculate water flow rate

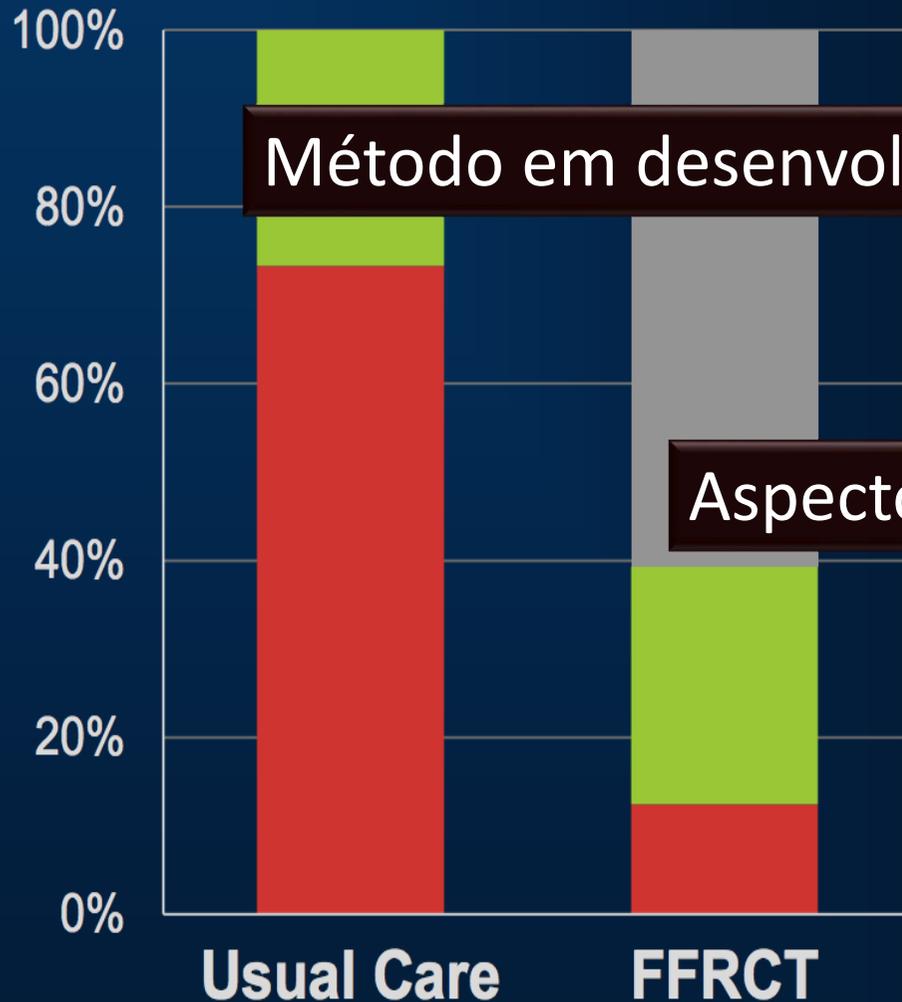


$$\rho \vec{v}_t + \rho \vec{v} \cdot \nabla \vec{v} = -\nabla p + \nabla \cdot \vec{\tau}$$

$$\nabla \cdot \vec{v} = 0$$

## Planned ICA

■ No-Obs CAD ■ Obs CAD ■ No ICA



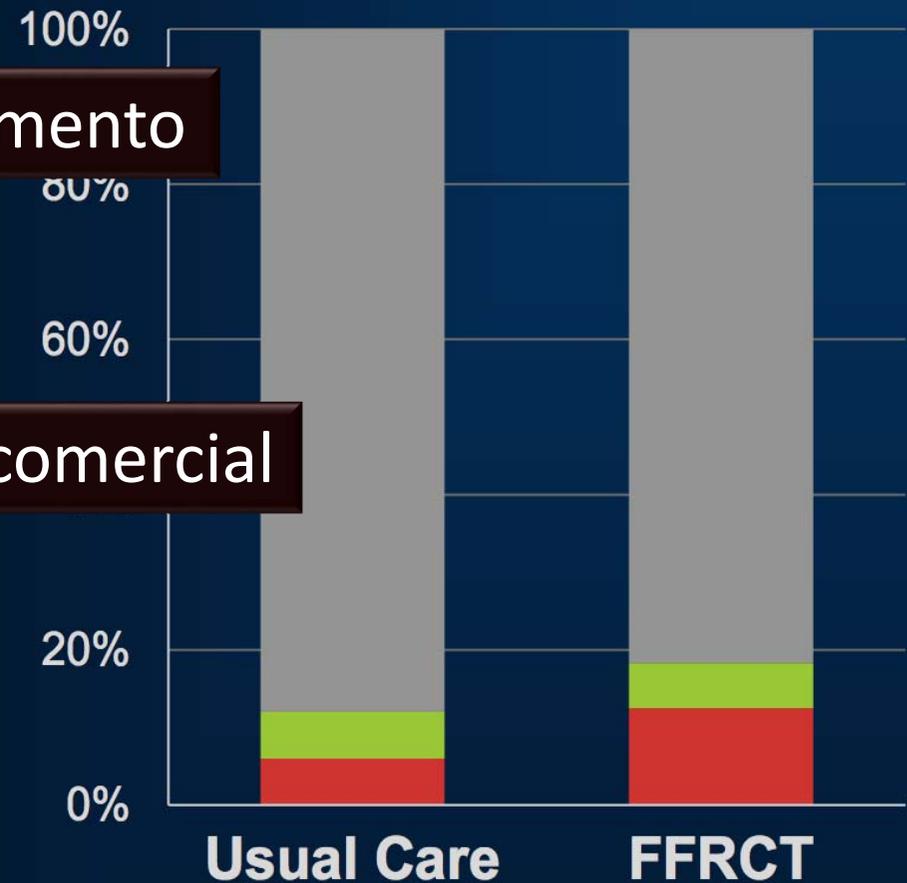
Método em desenvolvimento

Aspecto comercial

N (%): 137 (73.3)      24 (12.4)  
**P < 0.0001**

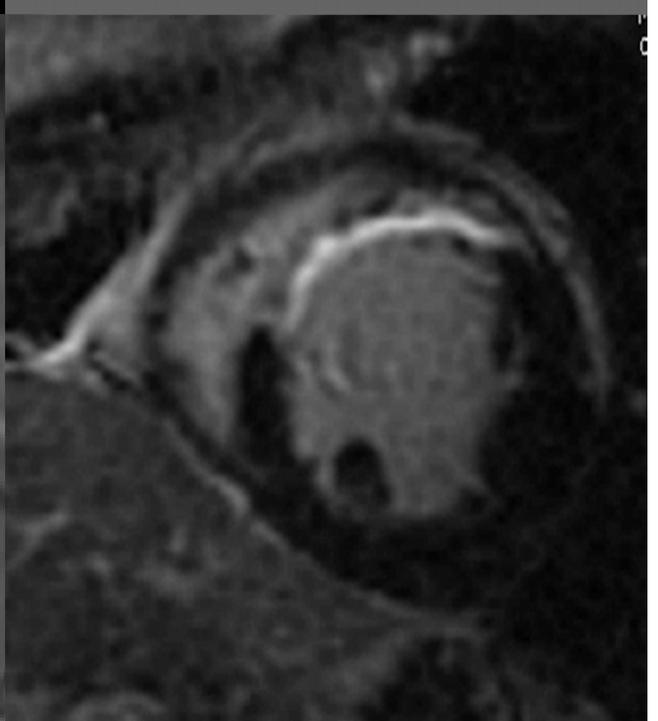
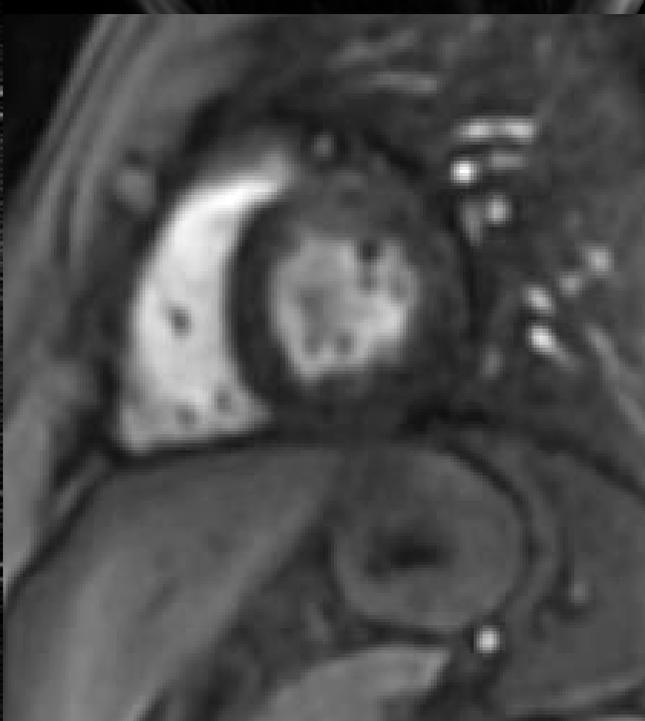
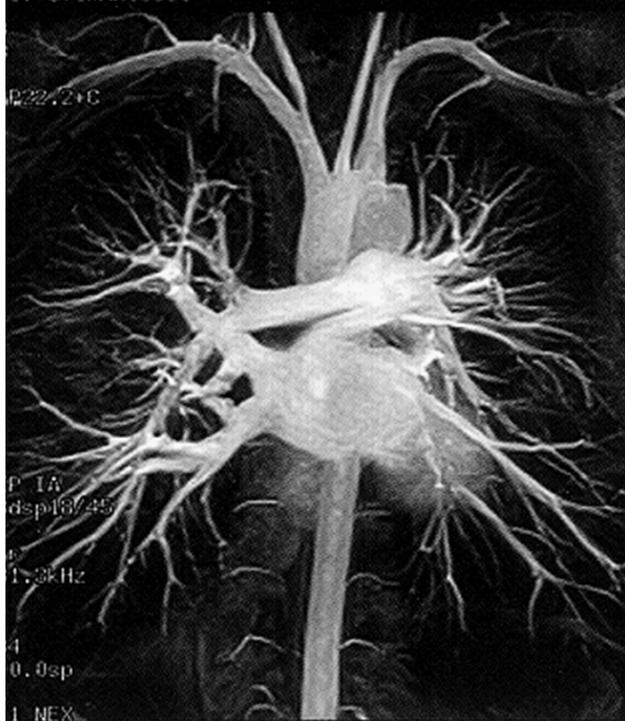
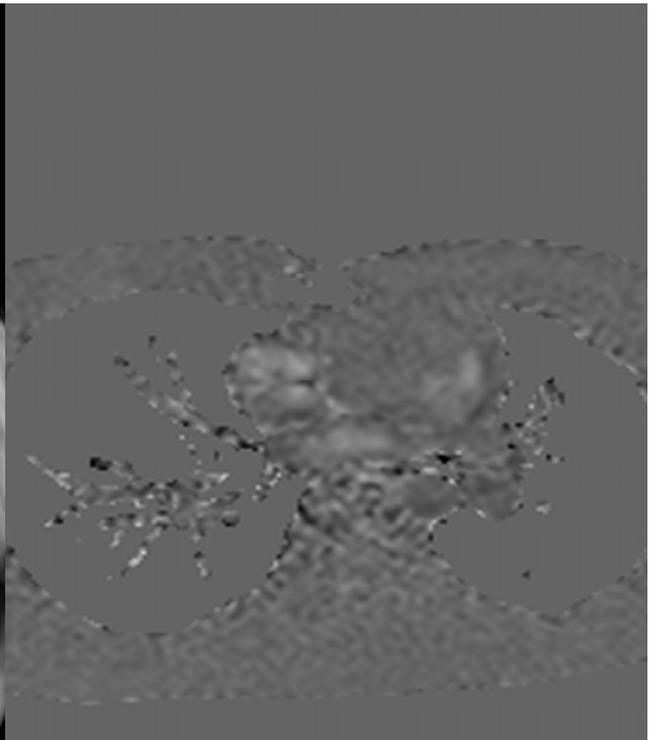
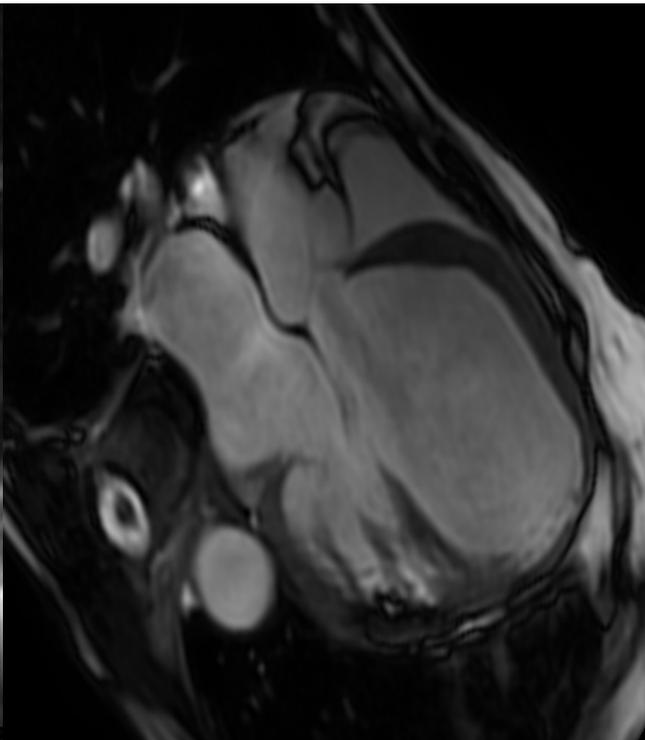
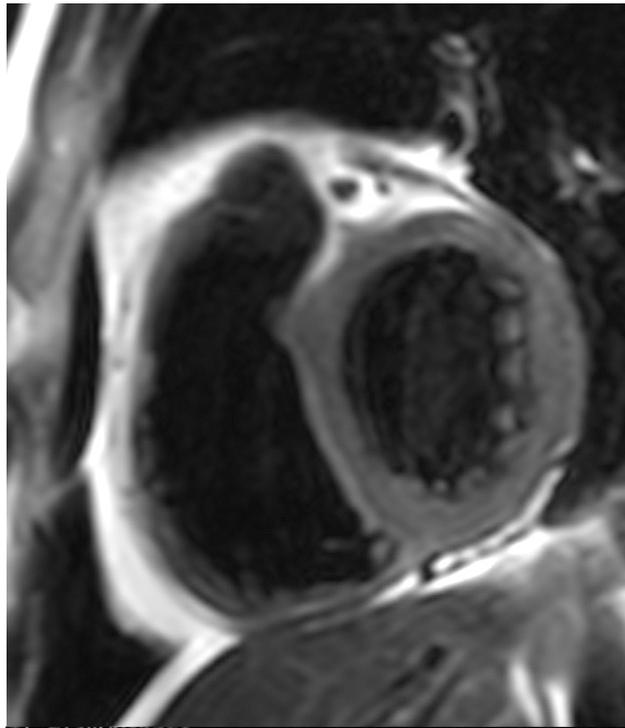
## Planned NI Test

■ No-Obs CAD ■ Obs CAD ■ No ICA

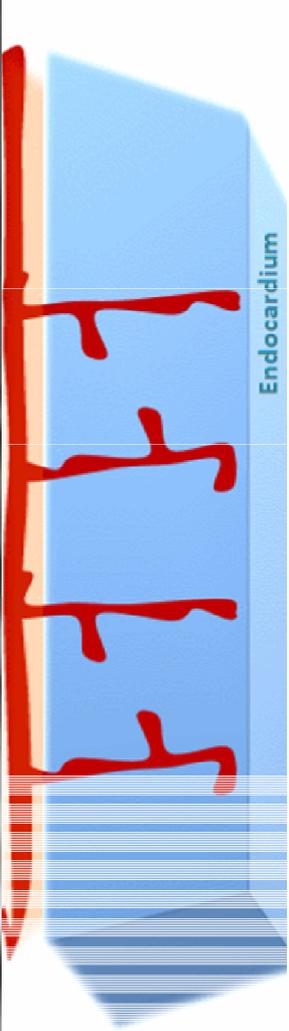
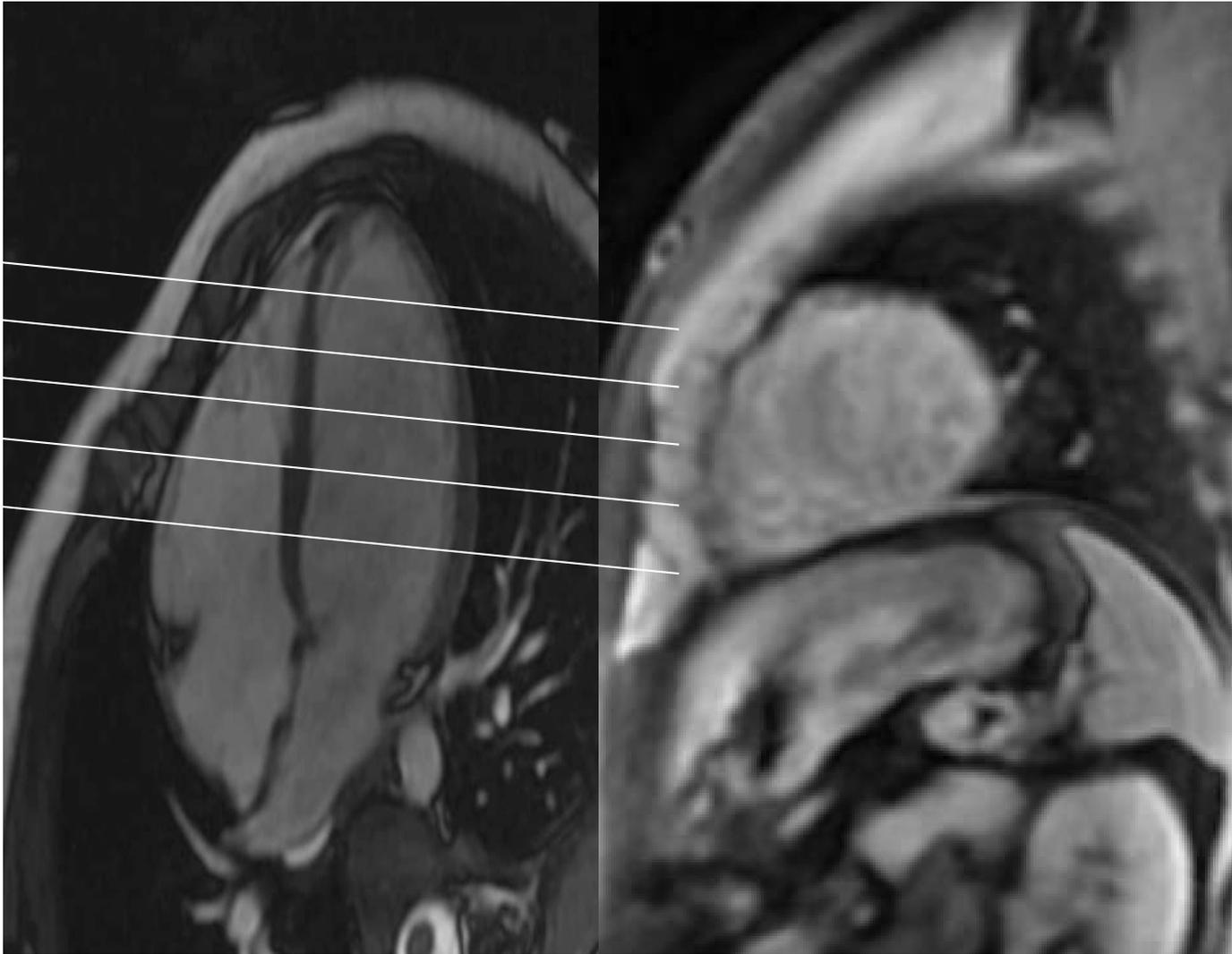


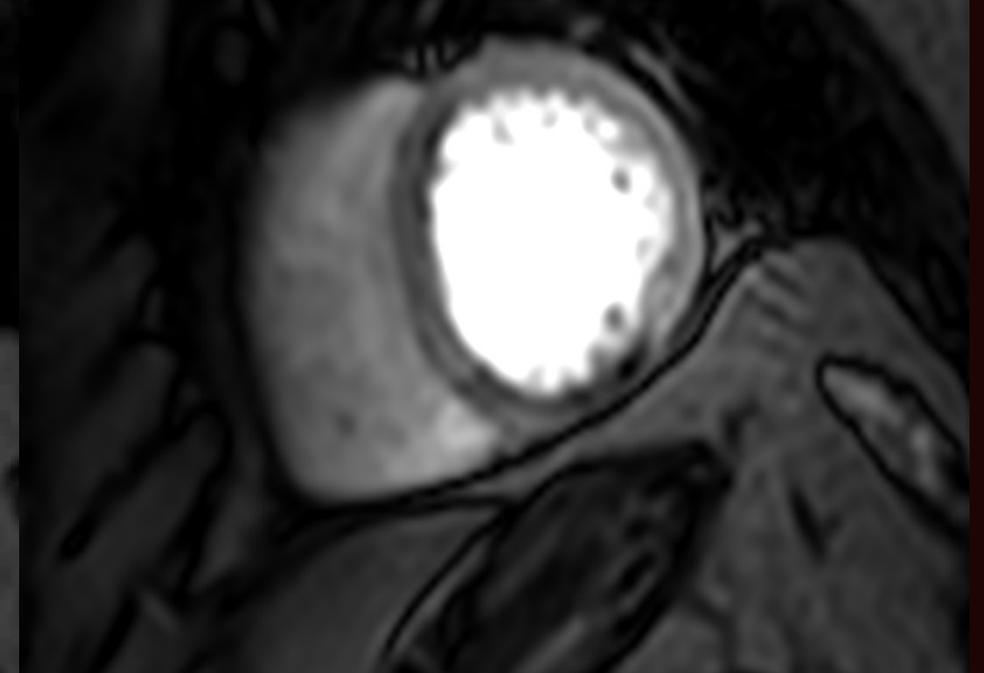
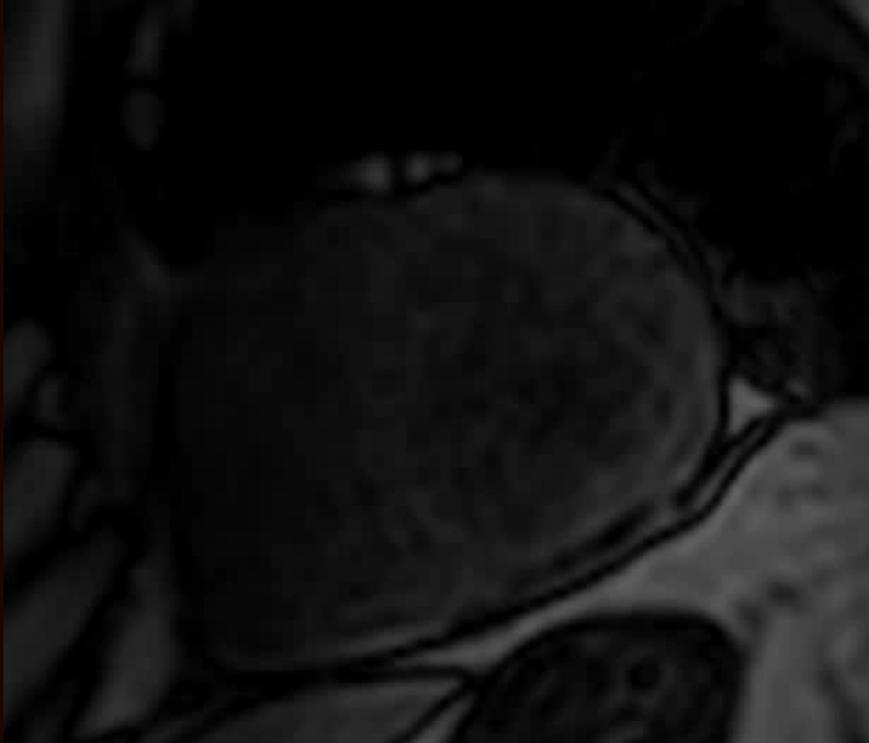
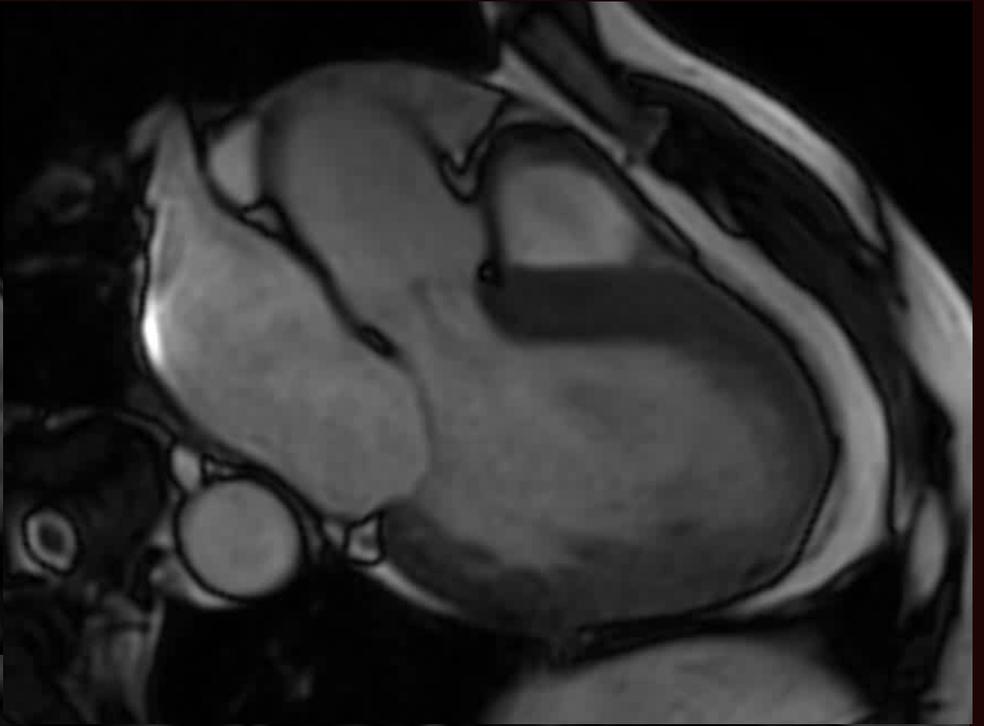
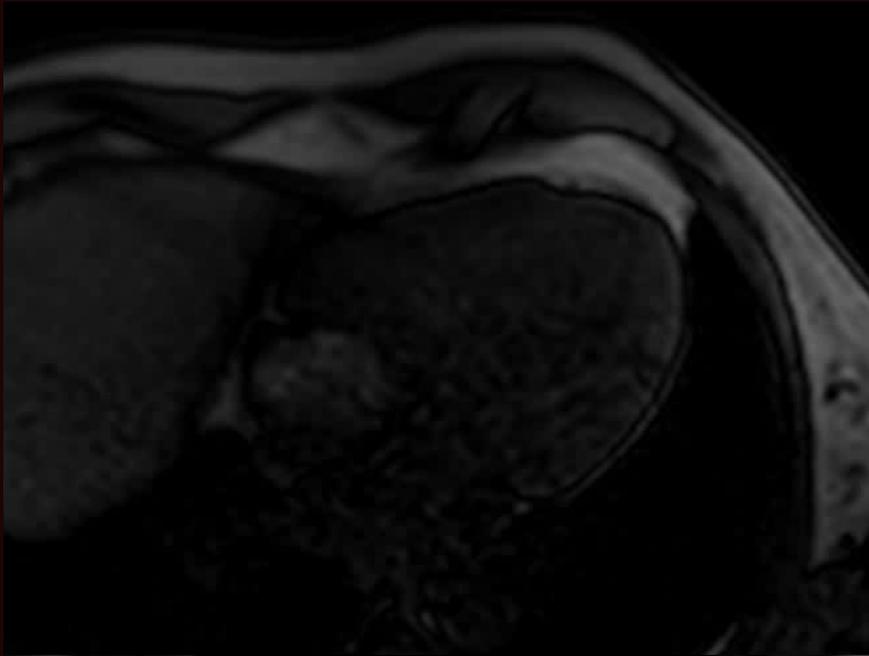
N (%): 6 (6.0)      13 (12.5)

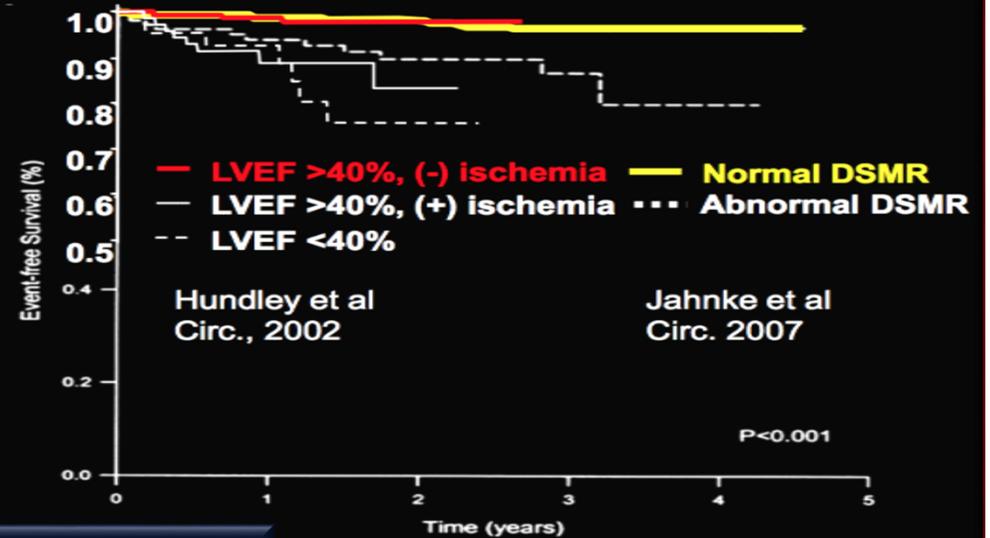
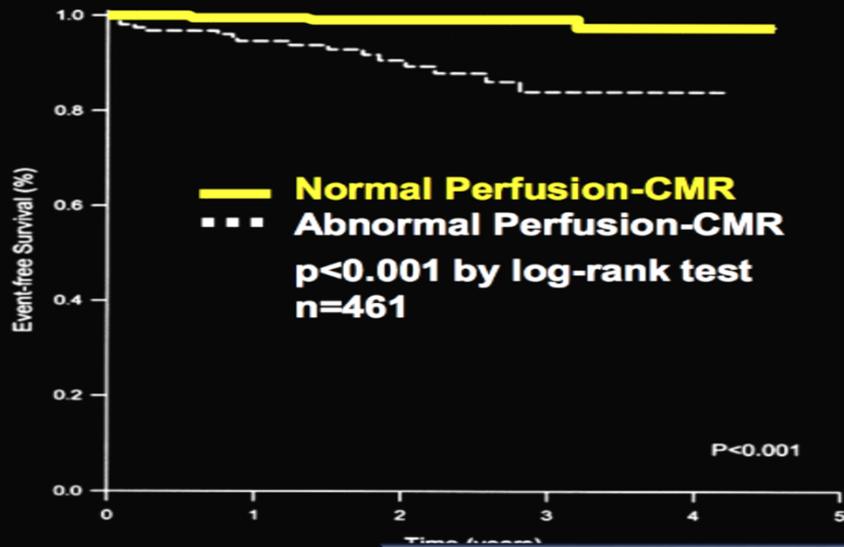
**P = 0.95**



# Ressonância e Perfusão Miocárdica





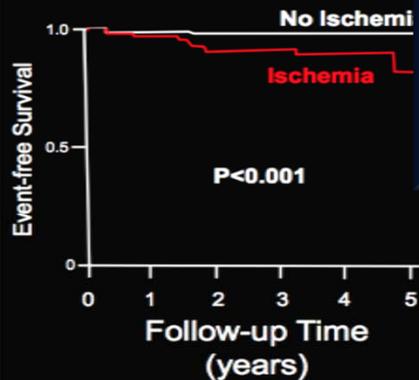


**Perfusion-CMR  
Excellent for E**

Perfusão por ressonância:

**Dobutamine-CMR  
Best for Exclusion of CAD**

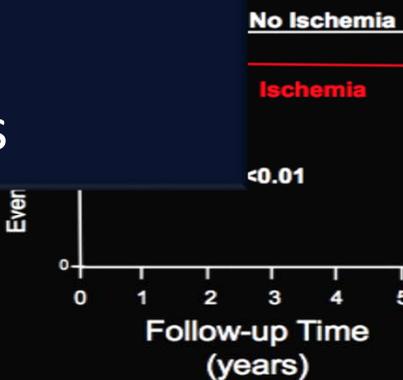
**Men:  
Cardiac Death**



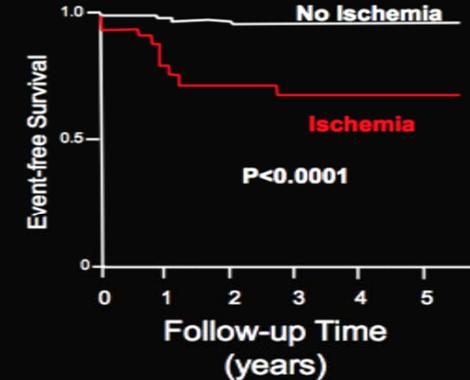
- Identifica isquemia
- Prevê eventos



**Death**

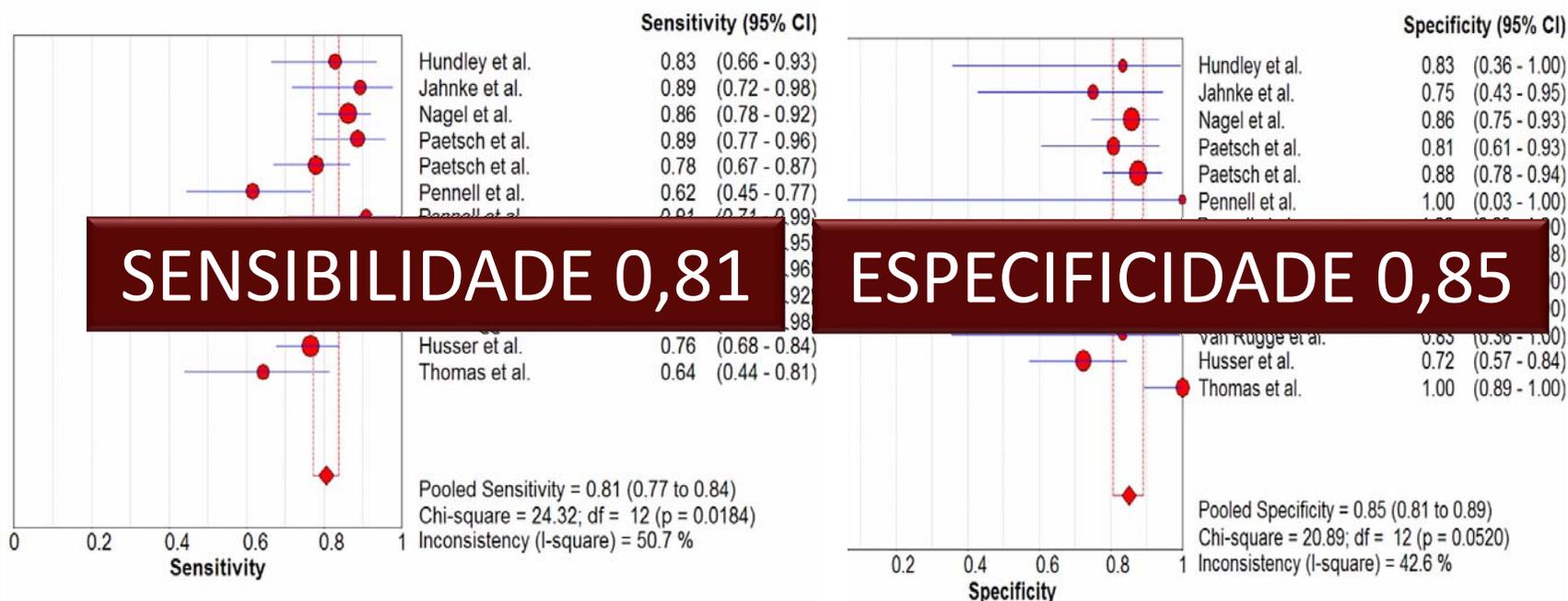


**Women:  
Cardiac Death/MI**



AHA-Meeting 2009: O. R. Coelho-Filho et al. Brigham and Women, Boston, USA  
 424 patients, 177 women, 57+13 years  
 Median Follow-up: 30 mos, 9% MACE, 27 cardiac deaths, 11 MI  
 Ischemia was the strongest multivariable predictor for MACE

# Acurácia da Ressonância por Estresse



Group	AUC	DOR	Lower CI	Upper CI
<b>All Perfusion Studies</b>	<b>0.930</b>	<b>37.91</b>	<b>24.36</b>	<b>51.45</b>
<b>Subgroups</b>				
1.5T	0.928	37.09	22.44	51.73
3T	0.932	44.41	4.02	84.81
Stable	0.930	39.98	25.23	54.73

AUC refers to area under the curve; CI, confidence interval; DOR, diagnostic odds ratio; NA, not applicable; T, Tesla.



# Effective Health Care Program

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Comparative Effectiveness Review  
Number 58

## **Noninvasive Technologies for the Diagnosis of Coronary Artery Disease in Women**

Junho 2012

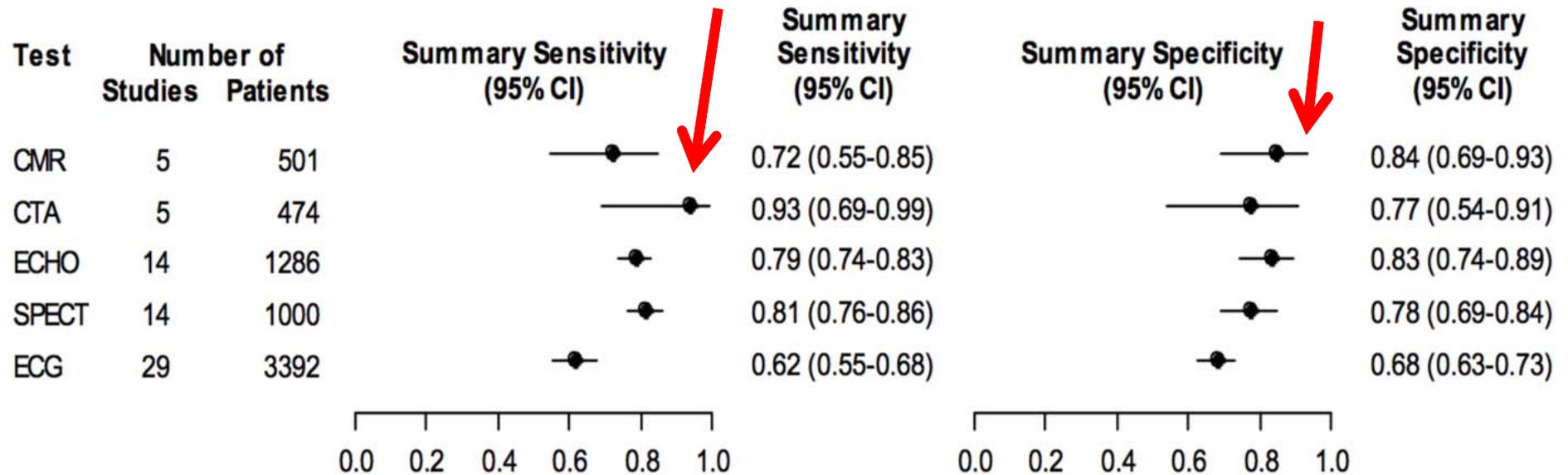
**Table B. Summary of accuracy of NITs compared with coronary angiography for diagnosing CAD in women**

Modality	Population	Quality of Included Studies	Number of Studies	Number of Women	Summary Sensitivity (95% CI)	Summary Specificity (95% CI)
ECG	No known CAD	All	29	3,392	62% (55%–68%)	68% (63%–73%)
		Good	10	1,410	70% (58%–79%)	62% (53%–69%)
	Mixed population	All	41	4,879	61% (54%–67%)	65% (58%–72%)
		Good	13	1,679	65% (52%–76%)	60% (52%–68%)
ECHO	No known CAD	All	14	1,286	79% (74%–83%)	83% (74%–89%)
		Good	5	561	79% (69%–87%)	85% (68%–94%)
	Mixed population	All	22	1,873	78% (73%–83%)	86% (79%–91%)
		Good	8	807	77% (65%–85%)	89% (76%–95%)
SPECT	No known CAD	All	14	1,000	81% (76%–86%)	78% (69%–84%)
		Good	4	394	83% (52%–95%)	72% (37%–92%)
	Mixed population	All	30	2,146	82% (77%–87%)	81% (74%–86%)
		Good	10	982	82% (72%–88%)	79% (66%–87%)
CMR	No known CAD	All	5	501	72% (55%–85%)	84% (69%–93%)
		Good	5	501	72% (55%–85%)	84% (69%–93%)
	Mixed population	All	6	778	78% (61%–89%)	84% (74%–90%)
		Good	5	610	76% (55%–89%)	84% (72%–91%)
Coronary CTA	No known CAD	All	5	474	93% (69%–99%)	77% (54%–91%)
		Good	3	124	85% (26%–99%)	73% (17%–97%)
	Mixed population	All	8	690	94% (81%–98%)	87% (68%–96%)
		Good	4	201	83% (58%–94%)	77%% (40%–94%)

**Table B. Summary of accuracy of NITs compared with coronary angiography for diagnosing CAD in women**

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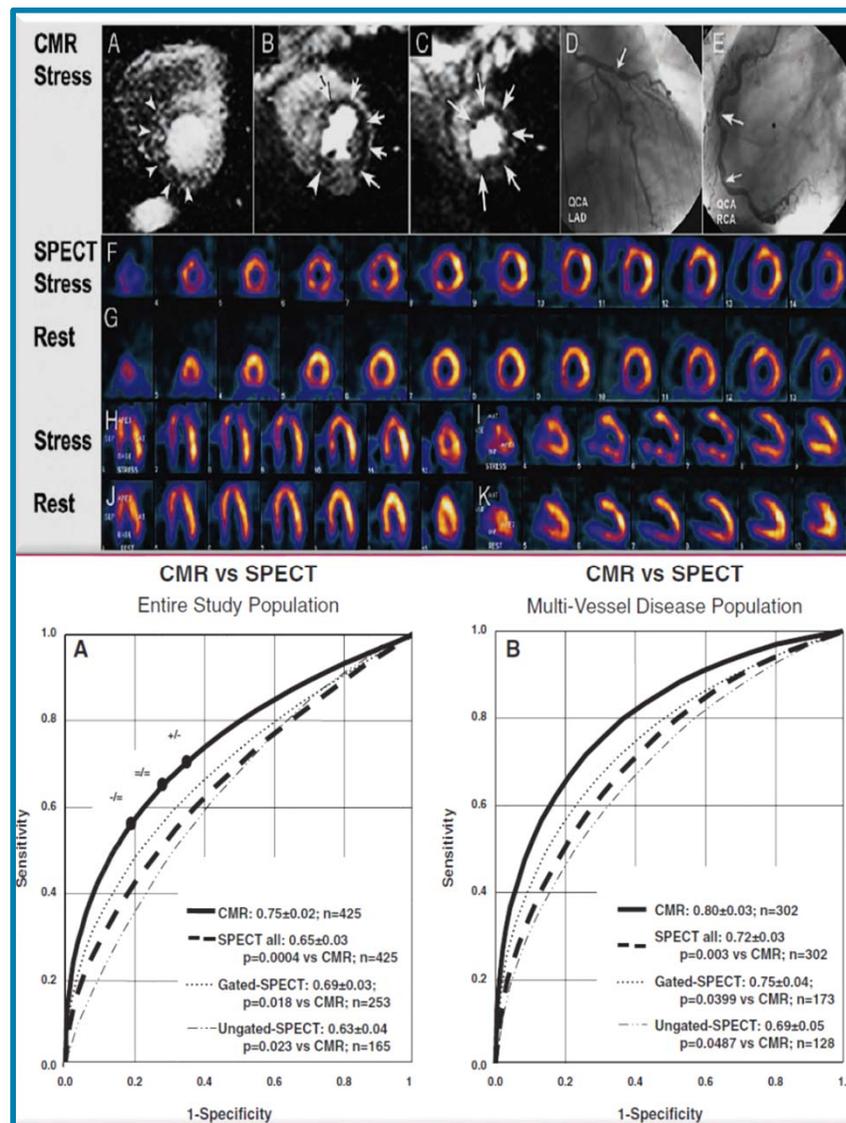
**Figure C. Summary of accuracy of NITs compared with coronary angiography for diagnosing CAD in women with no known CAD (all studies)**



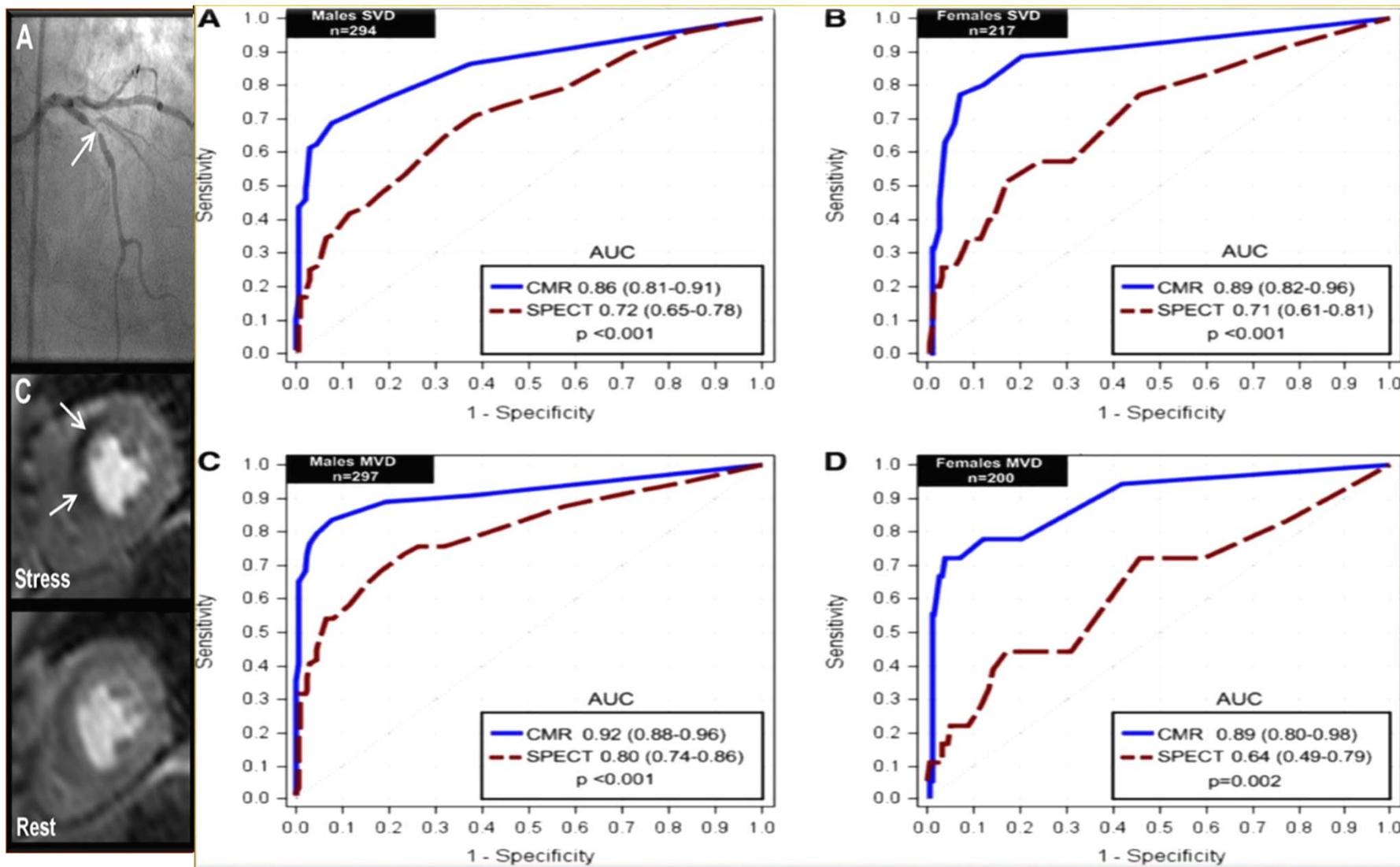
Modality	Population	Quality of Included Studies	Number of Studies	Number of Women	Summary Sensitivity (95% CI)	Summary Specificity (95% CI)
Coronary CTA	No known CAD	All	5	474	93% (69%–99%)	77% (54%–91%)
		Good	3	124	85% (26%–99%)	73% (17%–97%)
	Mixed population	All	8	690	94% (81%–98%)	87% (68%–96%)
		Good	4	201	83% (58%–94%)	77% (40%–94%)

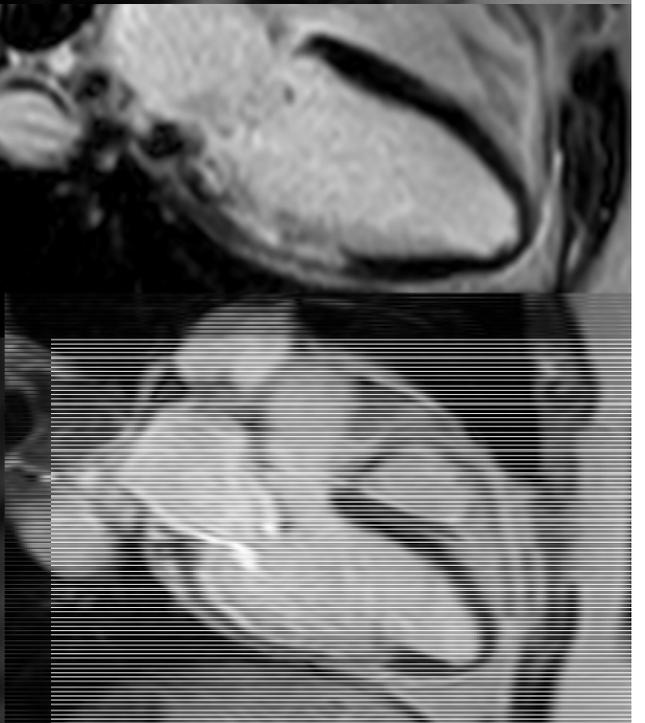
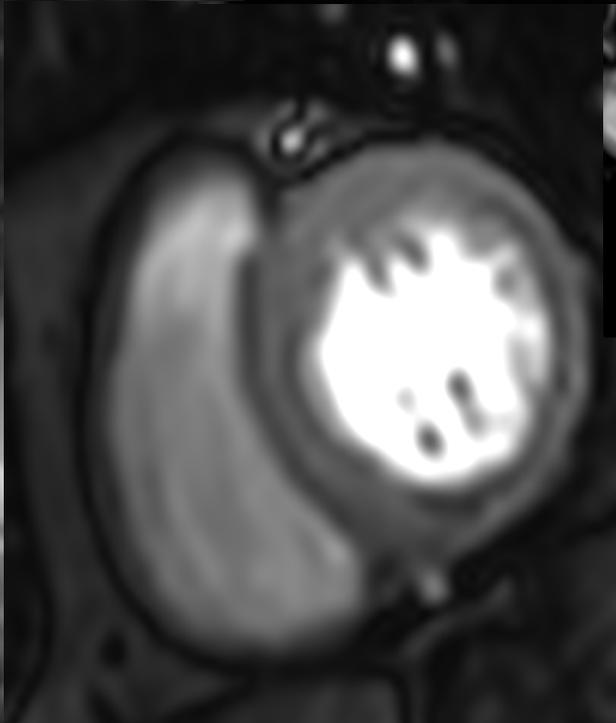
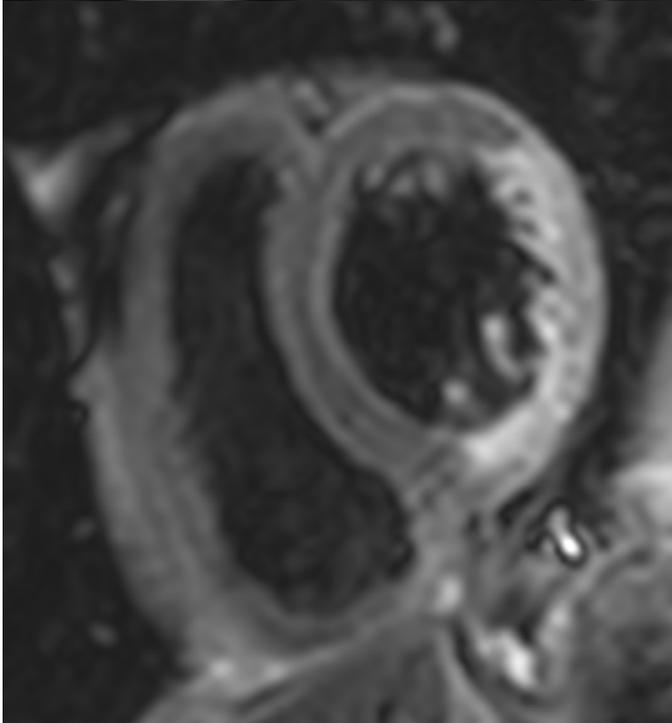
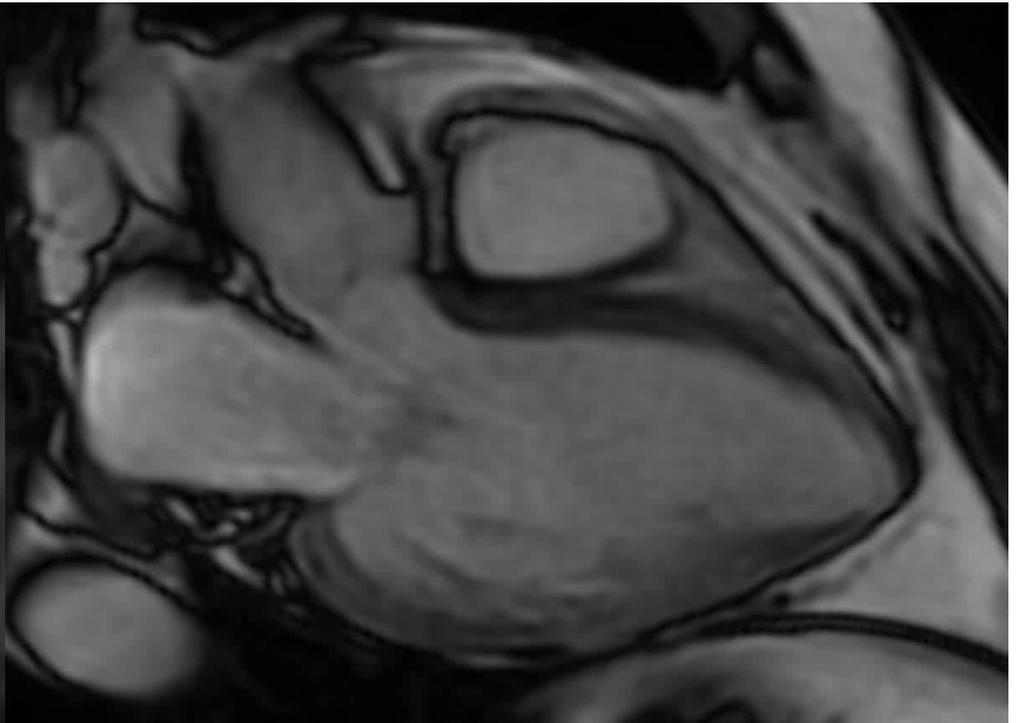
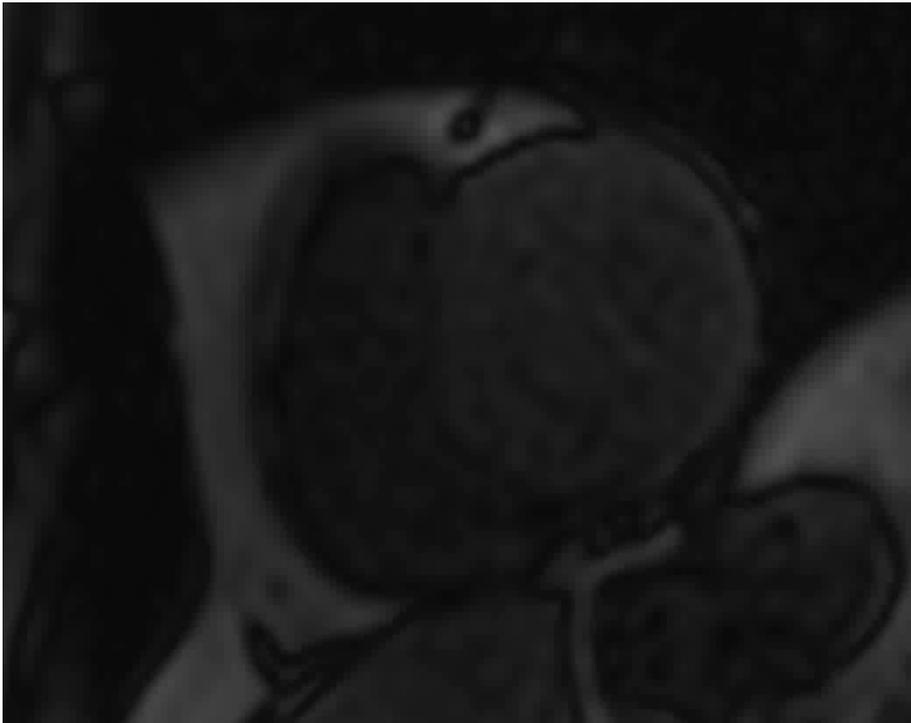
# Perfusão Miocárdica Por Ressonância Magnética

- MR IMPACT II
- 531 pacientes / 33 centros
- RM (adenosina)
- SPECT (adenosina)
- Cine
- 465 completaram o estudo, com 26 (5,5%) casos na RMC e 17 (3,65%) na MN



# MR Impact: Subanálise em mulheres

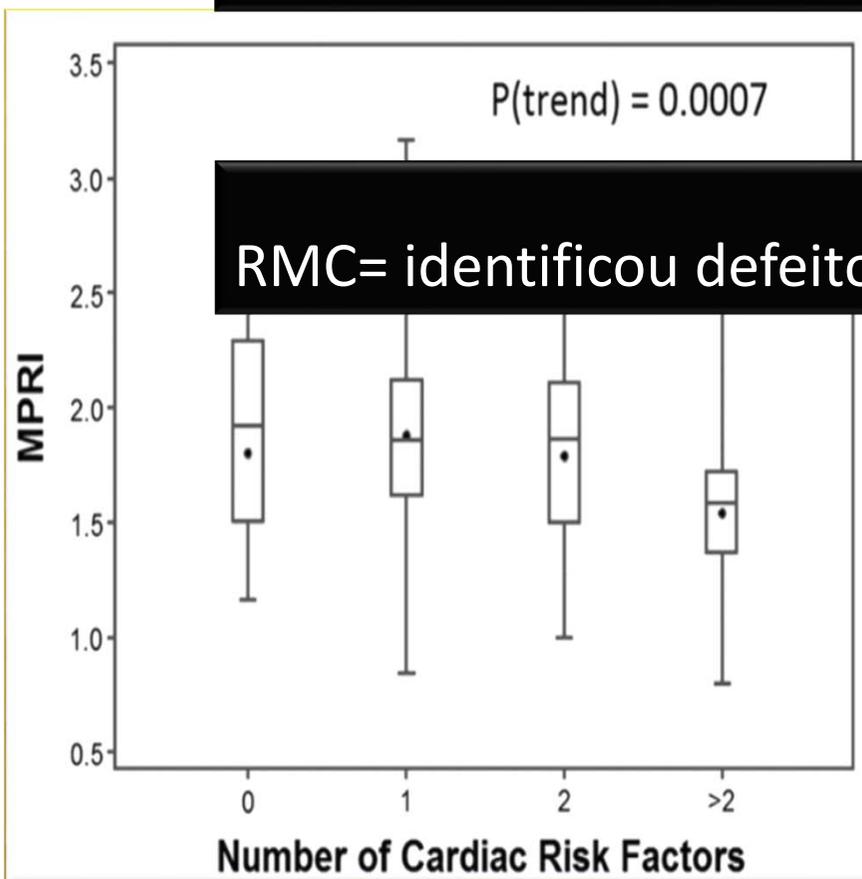




# Cardiac Magnetic Resonance Myocardial Perfusion Reserve Index Is Reduced in Women With Coronary Microvascular Dysfunction

A National Heart, Lung, and Blood Institute-Sponsored Study From the

Mulheres com síndromes isquêmicas e sem DAC

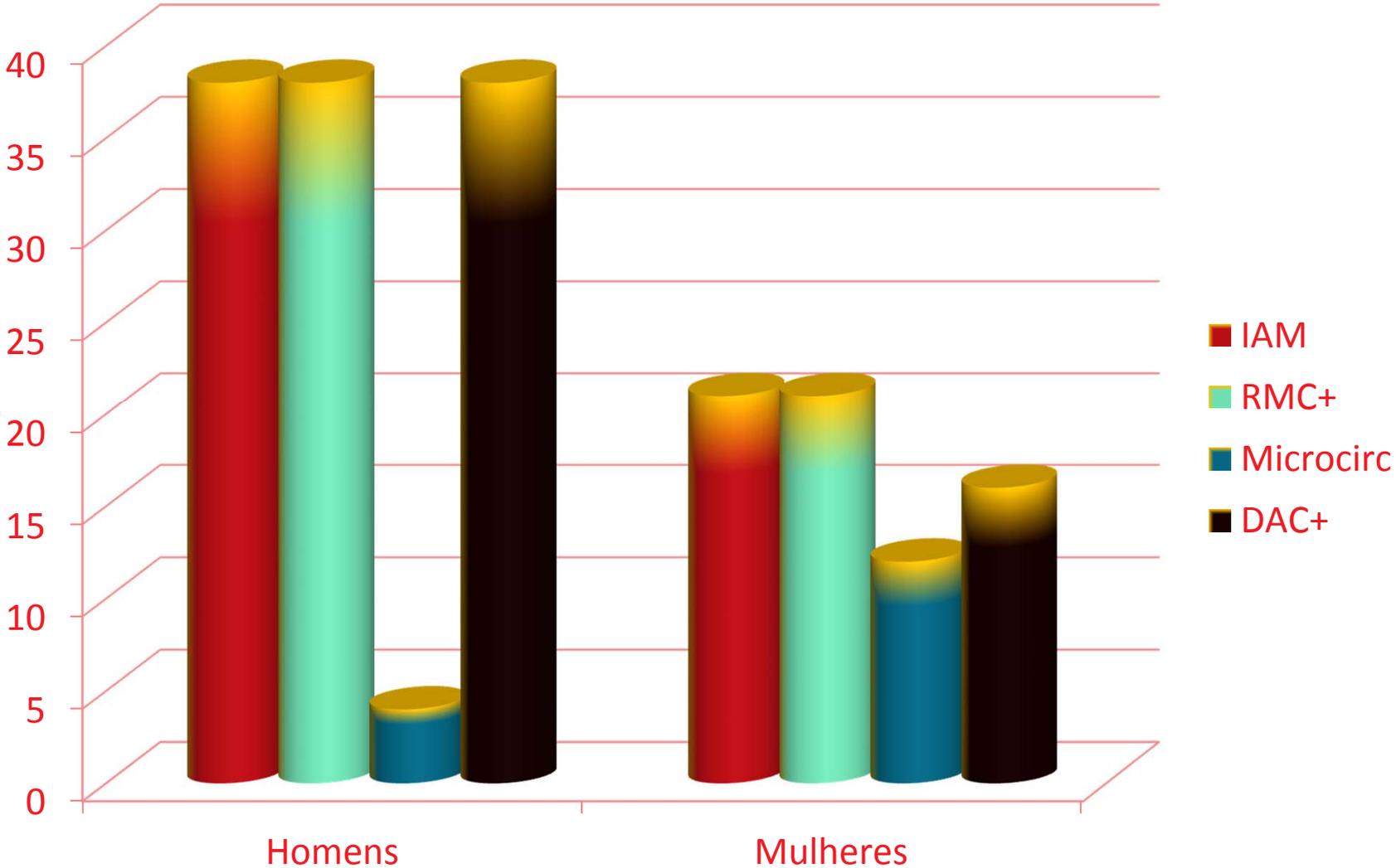


RMC= identificou defeito de microcirculação

Table 4. CMRI Measures

			P Value
Whole MPRI	1.71±0.43	2.23±0.37	<0.0001
Subendocardial MPRI	1.55±0.39	2.01±0.35	<0.0001
Subepicardial MPRI	1.79±0.45	2.38±0.41	<0.0001
Summed stress score	6.66±5.62	4.45±4.97	0.09
Ejection fraction, %	67.19±7.05	69.4±4.26	0.17
LV EDV, mL	121.96±25.54	131.71±28.16	0.11
LV mass, g	91.94±17.07	85.69±12.04	0.11
Mass/volume, g/mL	0.77±0.14	0.68±0.12	0.0064

# RMC em Mulheres



# Ressonância de Stress: Aspectos Positivos

## Vantagens

- Não utiliza radiação ionizante
- Elevada resolução espacial
- Quantifica a área de isquemia
- Detecta pequenas áreas de isquemia
- Identifica pequenas zonas de necrose
- Mostra lesão de microcirculação

## Perfusão e Realce por Ressonância: Indicações

- Pacientes sintomáticas, com risco pré teste intermediário para alto.
- Alterações segmento ST no ECG de repouso
- Alterações ao ECG de repouso ou mulheres com incapacidade funcional (indivíduos que não sejam capazes de realizar atividades físicas corriqueiras).
- Pacientes sintomáticas com risco pré teste indeterminado
- Mulheres pré menopausa com incapacidade funcional
- Suspeita de necrose / fibrose miocárdica
- Mulheres jovens como alternativa aos exames com radiação (Eco)

***Consenso AHA. Circulation 2014;***

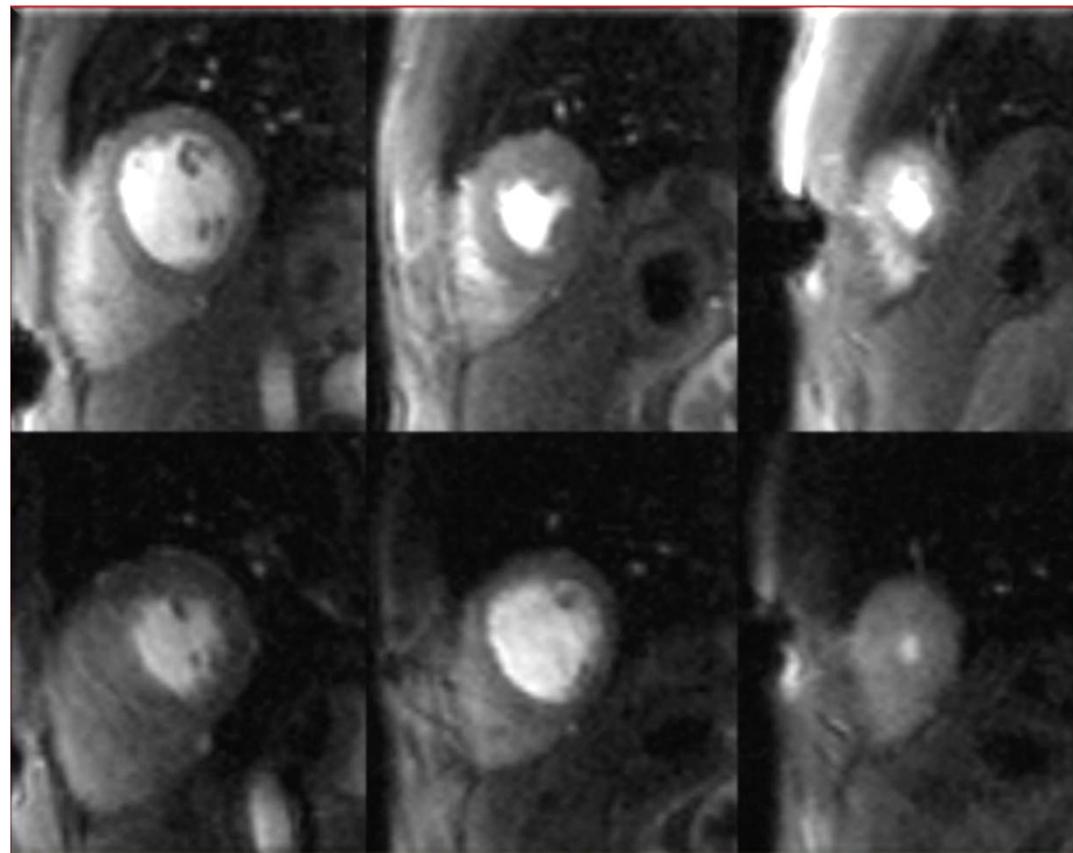
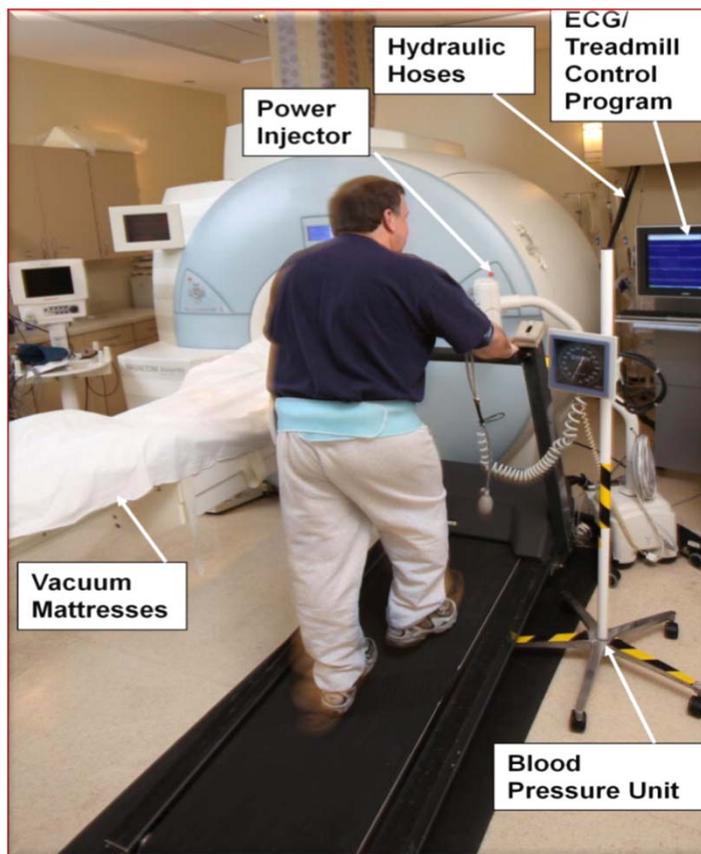
***130: 350 – 379***

***Arq Bras Cardiol 2014; 103, Nº 6,***

***Suplemento 3***

# An MR-Compatible Treadmill for Exercise Stress Cardiac Magnetic Resonance Imaging

Eric L. Foster<sup>1</sup>, John W. Arnold<sup>3</sup>, Mihaela Jekic<sup>1,2</sup>, Jacob Bender<sup>1,2</sup>, Vijay Balasubramanian<sup>1</sup>, Paaladinesh Thavendiranathan<sup>4</sup>, Jennifer A. Dickerson<sup>4</sup>, Subha V. Raman<sup>1,4,5</sup>, and Orlando P. Simonetti<sup>1,2,4,5</sup>



*Magn Reson Med. 2012 March ; 67(3): 880–889*

## Tomografia, Ressonância e mulheres

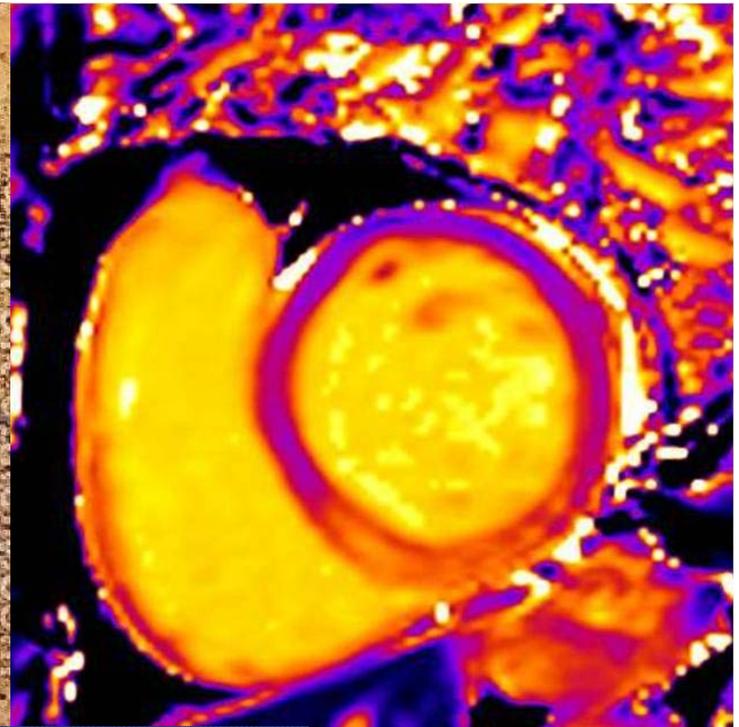
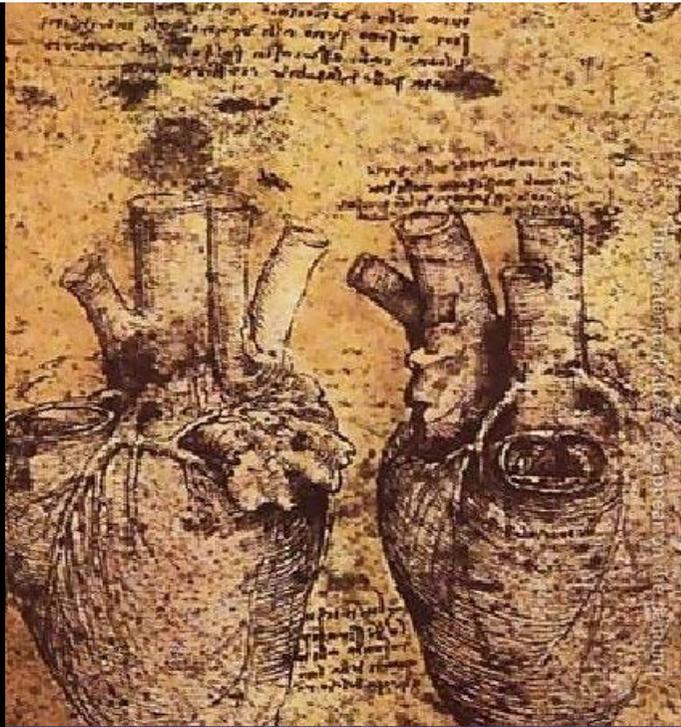
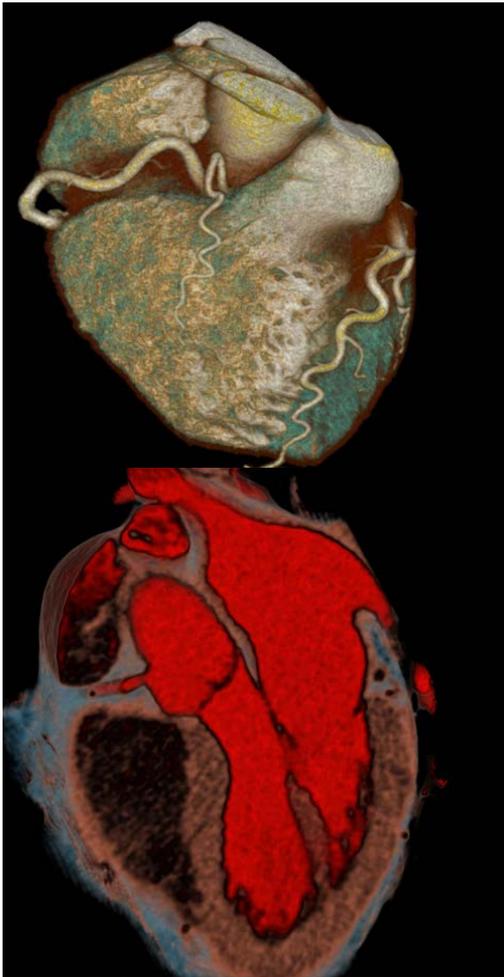
- Tomografia:
  - Risco baixo intermediário
  - Exclusão de DAC
  - Equipamento – radiação
- Ressonância
  - Risco intermediário – alto, alto
  - Diagnóstico de defeito de perfusão – isquemia
  - Resultados comparáveis a outras tecnologias
  - Não utiliza radiação
  - Excelente definição de necrose.

## DAC em Mulheres, Ressonância e Tomografia

- Avaliação clínica (apresentações atípicas)
- Estratificação de risco + idade
- Assintomática risco intermediário > 45 anos : considerar CAC
- Assintomática risco intermediário <45 anos : considerar IMT
- Sintomas ou alterações em testes funcionais > 45 anos: considerar Tomo

## DAC em Mulheres, Ressonância e Tomografia

- Sintomas ou alterações em testes funcionais > 45 anos:  
considerar Tomo
- Sintomas ou alterações em testes funcionais < 45 anos:  
considerar exames sem radiação (eco ou RMC)
- Risco intermediário-alto ou Duke Forrester alto (70%):  
exames de perfusão
  - > 50 anos- Cintilografia
  - <50 anos- Eco,RMC
- Conflito exames não invasivos: considerar tomografia



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