Coronary MR Angiography

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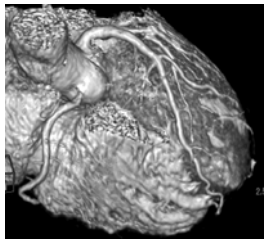
Advantages of coronary MRA

- **No ionizing radiation**
- **No contrast injection**
- **No interference by calcification**



Weakness of MRI

- **Substantially slower than 64-slice MDCT**
- **Acquisition time of 3D volume** (FOV 32x32x20cm, acquisition resolution 0.6x0.6x0.6mm, no ECG gating)
  - **64-slice MDCT < 2 sec.**
  - **MRI > 2 min.**

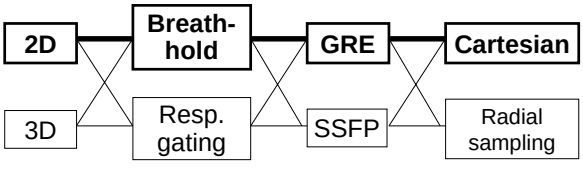
    40,960 phase encoding steps
    TR 3ms, SENSE factor 2, half scan

MR detection of coronary artery stenoses

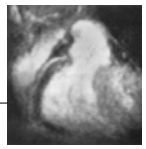
Investigator	Reference	Method	Sensitivity (%)	Specificity (%)
Manning WJ	NEJM 1993;328:828	2D breath-hold	90	92
Duerinckx AJ	Radiology 1994;193:731	↑	63	82
Van Geuns RJ	Radiology 2000;217:270	3D breath-hold	68	97
Regenfus M	JACC 2000;36:44	↑	94	57
Woodard PK	AJR 1998;170:883	3D navigator, retrospective	73	N/A
Sandstede JJ	AJR 1999;172:135	↑	81	89
Sardanelli F	Radiology 2000;214:808	↑	82	89
Kim WY	NEJM 2001;345:1863	3D navigator, prospective	93	42
Bogaert J	Radiology 2003;226:770	↑	50	90
Kefer J	JACC 2005;46:92	↑	75	77

1993-2005 Sensitivity 50-94%, Specificity 42-97%

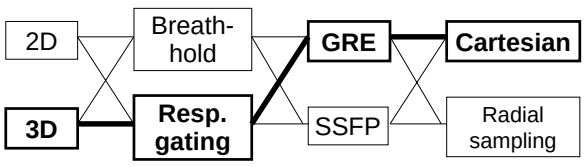
Breath-hold 2D coronary MRA



Edelman RR, Radiology 1991;181: 641-643
Manning WJ, N Eng J Med 1993;328: 828-832
Sakuma H. AJR 1994; 163:533-537

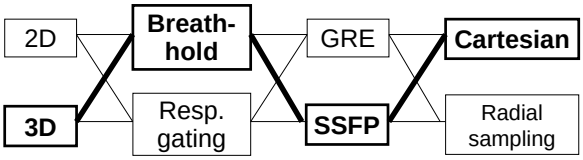


Respiratory gated 3D coronary MRA



Kim WJ, New Engl J Med 2001; 345:1863
Sardanelli F. Radiology 2000;214:808
Sakuma H. Invest Radiol. 1999;34:503

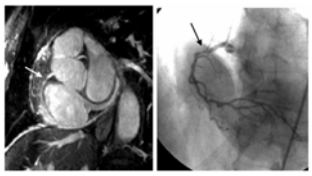
Breath-hold 3D coronary MRA



3D Breath-hold Coronary MRA - Multi-center study -

Foo TK, Ho V, Saranathan M, Cheng L, Sakuma H, et al.

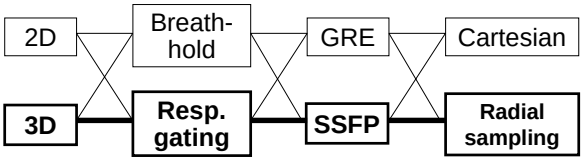
- **Breath-hold 3D FIESTA**
- **1.1x1.2x2 mm resolution**
- **77%(79/103) coronary arteries visualized**
- **In 79 arteries visualized, 82%showed diagnostic image quality（Grade 3-4）**

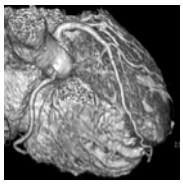


GE CV/I, Mie Univ.

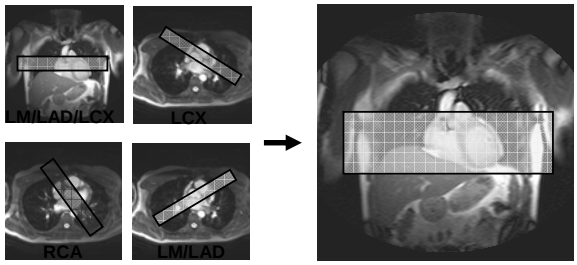
Radiology 2005;235:1025-1030

Whole Heart Coronary MRA





Whole heart coronary MR angiography using steady state free precession



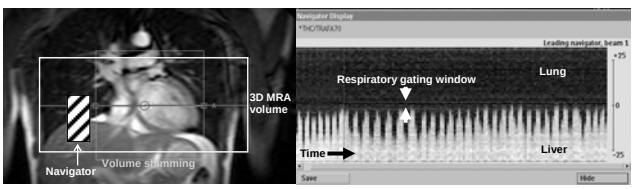
5:36 min/volume x 4 (Targeted volume)

13:48 min x 1 (Whole heart)

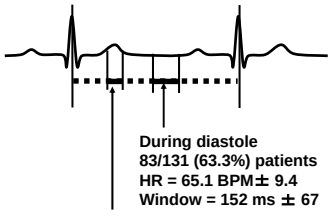
Weber OM. MRM 2003;50:1223
Sakuma H, Radiology 2005;237:316

Free-breathing 3D coronary MRA

- **Navigator echo**
  - **prospective real-time respiratory gating**
  - **gating window = +/- 2.5mm**
  - **adoptive motion correction**

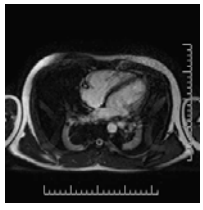


Whole heart coronary MRA in 131 patients using optimized acquisition window in the cardiac cycle



During diastole
83/131 (63.3%) patients
HR = 65.1 BPM± 9.4
Window = 152 ms ± 67

During systole
48/131 (36.7%) patients
HR= 83.2 BPM± 9.5
Window = 98 ms ± 26

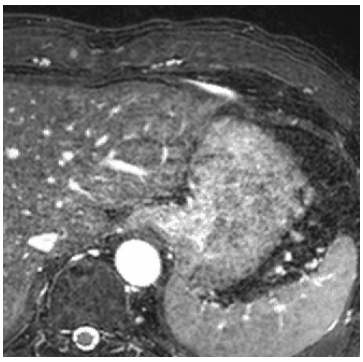


Axial cine MRI (50 phases)

Sakuma H. J Am Coll Cardiol 2006 (in press)

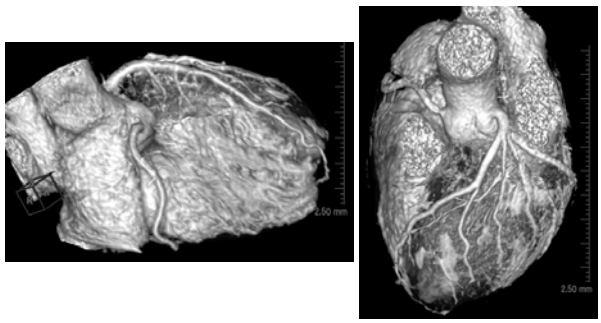
Whole heart coronary MRA

Sequence	3D B-TFE
FOV	28x28x12cm
Preparation	T2 prep SPIR
Acq. Mat.	256x256x80
TR	4.6ms
TE	2.3ms
Flip angle	90 deg
SENSE fact.	2
Imaging time	6-20 min



Whole heart coronary MRA

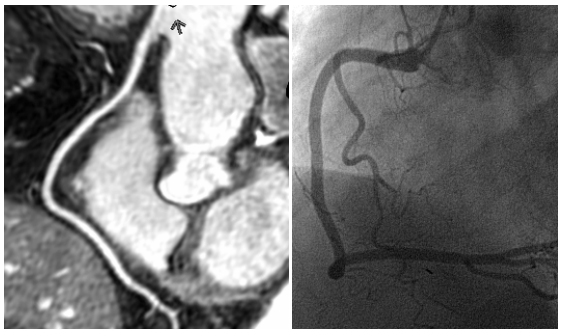
Normal coronary artery



Volume Rendering

Whole heart coronary MRA

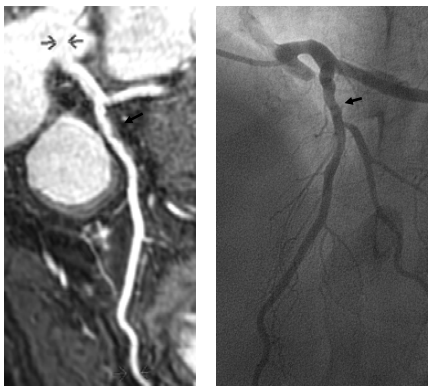
61M



Curved MPR of RCA **X-ray coronary angiography**

Whole heart coronary MRA

61M

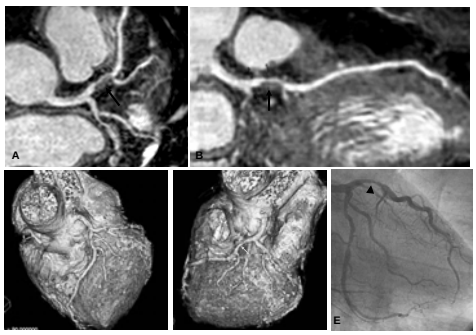


Initial results

- **Imaging time**
  13.8min ± 3.8 (range 6.8-23.8 min)
- **Imaging completed 34/39 (87.2%)**
- **Study success rate 32/39 (82.1%)**
  High quality (score ≥3 in 4 point-scale) images in all three major coronary arteries

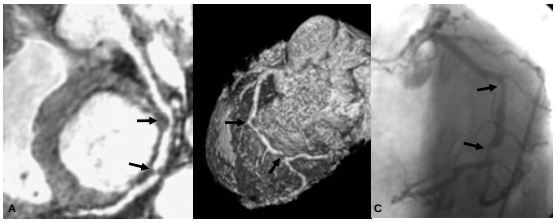
Sakuma H, Ichikawa Y, Radiology 2005;237:316

78-year-old man with LAD stenosis (HR = 64/min)



A and B, Curved multiplanar reconstruction of whole heart coronary MRA.
C and D, Volume rendering of whole heart coronary MRA.
E, Catheter X-ray coronary angiography

54-year-old man with LCX stenosis (HR = 78/min.)



A, Curved multiplanar reconstruction of whole heart coronary MRA.
B, Volume rendering of whole heart coronary MRA.
C, Catheter X-ray coronary angiography.

Detection of significant coronary artery stenoses with whole heart coronary MRA using optimal acquisition window in the cardiac cycle in 113 patients

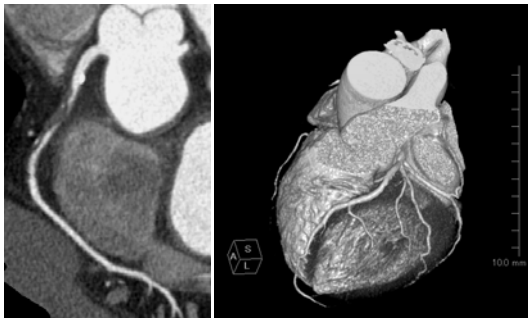
	n	Sensitivity, %	Specificity, %	PPV, %	NPV, %	Accuracy, %
Per patient	113	82(69-91)	90(79-96)	88(74-95)	86(75-93)	87(79-92)
Per vessel	452	78(66-86)	96(93-97)	79(67-87)	95(93-97)	93(90-95)
RCA	113	85(65-95)	95(88-98)	85(65-95)	95(88-98)	93(86-97)
LM	113	NA	98(93-100)	NA	100(96-100)	98(93-100)
LAD	113	77(56-90)	95(88-99)	83(62-95)	93(85-97)	91(84-95)
LCX	113	70(47-86)	93(86-97)	73(50-88)	92(84-97)	89(81-94)
Per segment	1000	78(68-85)	96(95-97)	69(60-77)	98(96-98)	94(93-96)

Study success rate = 86% (113/131)
All arteries with diameter of ≥2mm on coronary angiography were evaluated.

Sakuma H, Ichikawa Y, et al. J Am Coll Cardiol 2006 (in press)

How we use coronary MRA in the era of 64-slice MDCT.

64-slice MDCT angiography



76M RCA occlusion

Light Speed VCT64, Virtual Place
Matsusaka Central Hospital, Mie, Japan

Coronary MRA vs. CTA

- Kefer J, JACC 2005;46:92
- Coronary MRA - free breathing, 3D balanced TFE on targeted double oblique slices

	Sensitivity	Specificity
Coronary MRA	75%	77%
16-slice CTA	82%*	79%*

* p=N.S.

Diagnostic accuracy of CTA and MRA in detecting patients with significant CAD

Whole heart coronary MRA

	Sensitivity	Specificity
Jahnke C, Eur Heart J 2005 ;26:2313	78%	91%
Sakuma H , JACC 2006 (in press)	82%	90%

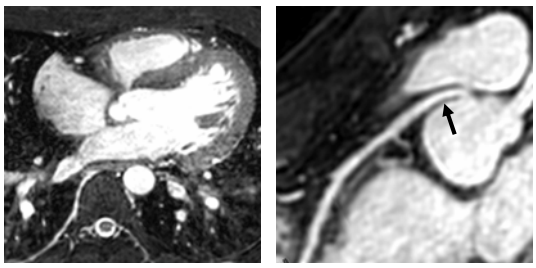
64-slice MDCT

	Sensitivity	Specificity
Mollet NR. Circulation 2005;112:2318	100%	92%
Pugliese S. Eur Radiol 2005;16:1	100%	90%
Leber AW. JACC 2005;46:155	90%	95%

How we use coronary MRA in the era of 64-slice MDCT.

1. Anomalous coronary artery
2. Coronary aneurysm in Kawasaki disease.
3. Patients with renal failure.
4. Patients with heavy coronary calcification.
5. As a part of one-stop-shop CMR study
6. Screening CAD in asymptomatic subjects

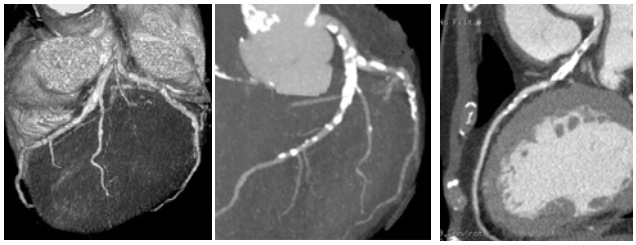
31-year-old man, VT after exercise



Anomalous origin of RCA

Whole heart coronary MRA

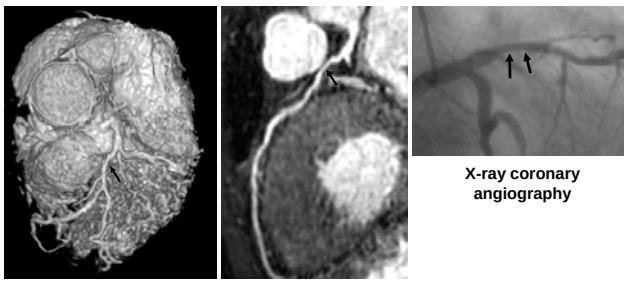
- 71-year-old man, chest pain on effort
- Coronary CT angiography was performed using 64-slice MDCT



Volume rendering | Angiographic view | Curved MPR

Coronary CT Angiography (GE VCT64)

- 71-year-old man, chest pain on effort
- Whole heart coronary MR angiography was subsequently performed.

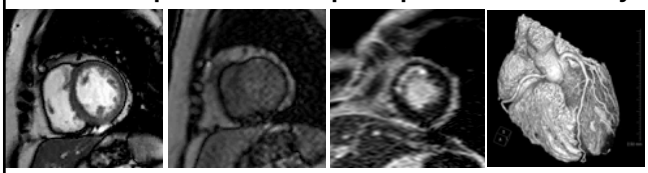


Volume rendering | Curved MPR

X-ray coronary angiography

Whole heart coronary MR angiography

MRA as a part of one-stop-shop cardiac MR study

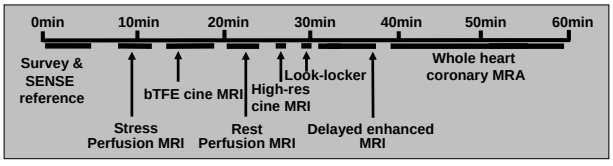


Cine MRI — LV function

Stress-rest perfusion MRI — Perfusion

Delayed enhanced MRI — Viability

Whole heart 3D coronary MRA — Morphology



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