CTO With Good Collaterals

Conservative Strategy

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Coronary CTO lesion

- Unmet Clinical Challenge
- Definition
  - 100% blockage of coronary artery
    (TIMI 0-1 Flow)
  - Greater than 3 months old
- Current treatment alternatives
  - PCI
  - CABG
  - Medical

Benefits of successful CTO recanalization

✓ Relief of angina on exertion

- TOAST (N=376): Olivari Z, et al, *J Am Coll Cardiol* 2003;41:1672–8
- FACTOR Trial: J. Aaron Grantham, MD and John A. Spertus, MD, MPH

✓ Improvement of ventricular function

- J Hug et al., *AHA* 2000
- Serruys et al. JACC 2006
- Kirschbaum et al, *Am J Cardiol* 2008;101:179-185

✓ Reduced incidence of late CABG

- Hoye et al. *EHJ* 2005
- B. Meier et al J Invas Cardiol 2001
- Milan CTO Registry

✓ Improvement in event free survival

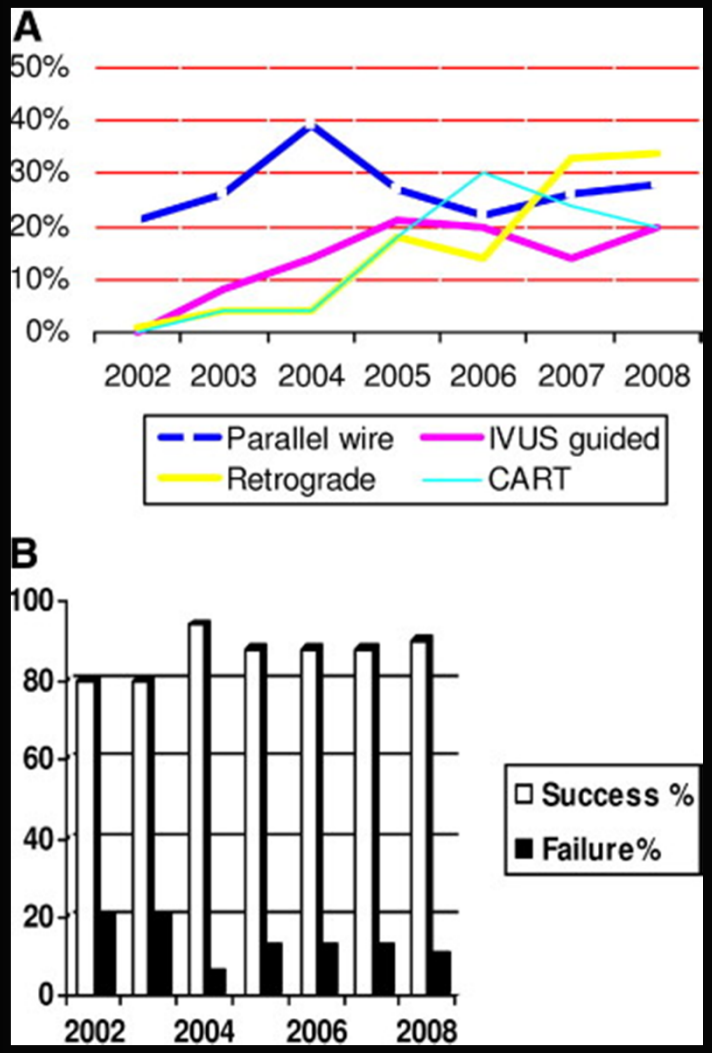
- TOAST, JACC 2003
- Suero et al. *JACC* 2001
- Hoye, *EHJ* 2005
- Aziz, *CCI* 2007
- Hannan EL: *Circ* 2006
- Kitano, *Circ* 2001
- Prasad, *JACC* 2007
- Butler TCT 2003

CTO guidewires and support catheters

Guidewires	Tip Load (g)	Utility
Fielder, FC, XT	1	Excellent for antegrade microchannel and retrograde collateral trac king
Miracle Bros	3, 4.5, 6, 9, 12	Variable penetrating power with excellent tactile feedback
Confianza	9, 12	Excellent penetrating force with great tip steering against resistance
Confianza Pro	9, 12	Improved torqueability associated with hydrophilic coating
Pilot 50, 150, 200	1, 5, 3, 4.5	Hydrophilic with a nitinol shaping wire
Choice PT,PT Graphix	3.2, 3.0	Hydrophilic and good support for device tracking
Runthrough	1	Soft tip with nitinol core and hydrophilic coating
Persuader	3, 6, 9	Variable power for penetration
Whisper LS, MS	1, 3	Excellent tracking in tortuous vessels
Support Catheters	**Crossing Profile (F)**	**Length (cm)**
Finecross	Tapered 1.8–2.6	130, 150
Progreat	Tapered 2.4–2.9	110, 130
Tracker	Tapered 1.9–2.4	150
Transit	Tapered 2.5–2.8	100–170
Tornus	2.1, 2.6	135
Corsair	Tapered 1.3–2.8	135–150

Toyohashi Heart Center Experience

2002-2008, TIMI 0-1, >3mo, n=904, 86.2% success



Variables	CTO Success (n = 791)	CTO Failure (n = 113)	p Value
Death	2 (0.25)	3 (2.6)	NS
Q-wave MI	4 (0.50)	1 (0.88)	NS
Non–Q-wave MI	20 (2.5)	2 (1.76)	NS
Urgent CABG	1 (0.10)	1 (0.88)	NS
MACE	12 (1.5)	5 (4.4)	0.027
Aortic dissection	1 (0.10)	1 (0.88)	NS
Arrhythmias	3 (0.40)	1 (0.88)	NS
Delayed tamponade	5 (0.6)	1 (0.88)	NS
Acute vessel occlusion	5 (0.6)	0 (0)	0.058
Subacute occlusion	2 (0.23)	0 (0)	1.00
Distal embolization	24 (3.0)	0 (0)	0.008
Spasm	2 (0.23)	0 (0)	1.00
Side branch compromise	35 (4.4)	1 (0.88)	0.008
Any dissection	110 (13.9)	25 (22)	0.006
Type 1 perforation	59 (7.0)	39 (19.2)	<0.01
Type 2 perforation	3 (0.4)	2 (1.0)	0.240

Rathore S. JACC Cardiovasc Interv. 2009;2:489-97.

Toyohashi Heart Center Experience

Predictors of unsuccessful CTO procedure

Variables	Odds Ratio	95% CI	p Value
Female	0.93	0.57–1.52	0.787
Age	0.98	0.97–1.0	0.164
Diabetes mellitus	1.08	0.78–1.51	0.628
Hypertension	0.88	0.63–1.24	0.499
Hyperlipidemia	0.93	0.67–1.30	0.695
Family history	0.89	0.57–1.40	0.637
Smoking	0.87	0.60–1.25	0.463
Previous MI	0.81	0.50–1.34	0.427
Previous CABG	0.74	0.43–1.05	0.195
Unstable angina	0.61	0.36–1.06	0.084
BSA	0.50	0.20–1.24	0.137
Previous PCI	1.17	0.75–1.83	0.472
In-stent restenosis	1.27	0.65–2.49	0.478
Absence of side branch	1.96	1.18–3.26	0.009
Severe tortuosity	2.30	1.26–4.18	0.006
Moderate calcification	1.95	1.19–3.21	0.008
Severe calcification	1.60	0.97–2.65	0.064
Nonaorto-ostial	0.70	0.44–1.11	0.132
Multivessel disease	1.20	0.85–1.69	0.283

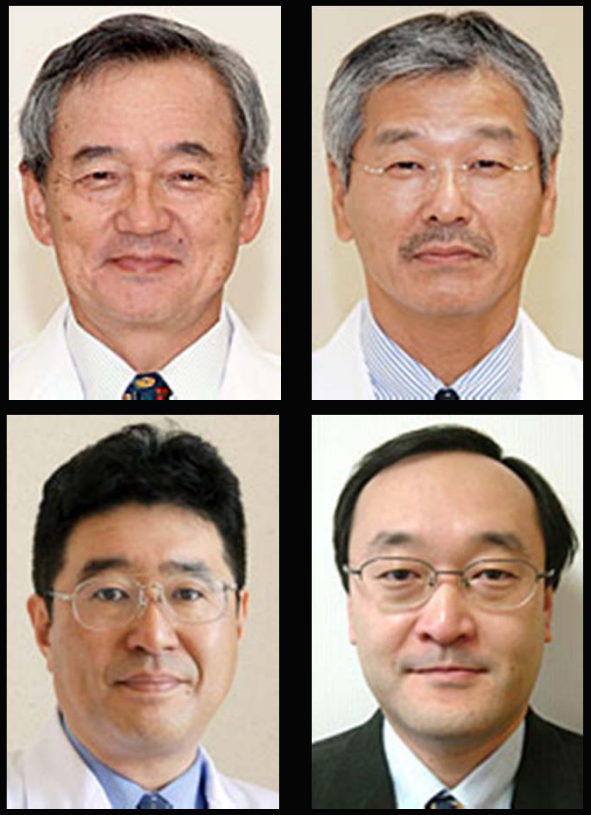
Rathore S. JACC Cardiovasc Interv. 2009;2:489-97.

Toyohashi Heart Center Experience

2002-2008, TIMI 0-1, >3mo, n=904, 86.2% success

Low in-hospital complications

MACE	1.8%
Q-wave MI	0.5%
Non-Q-wave MI	2.4%
Cardiac tamponade	0.66%
Aortic dissection	0.33%
Major SB compromise	3.9%



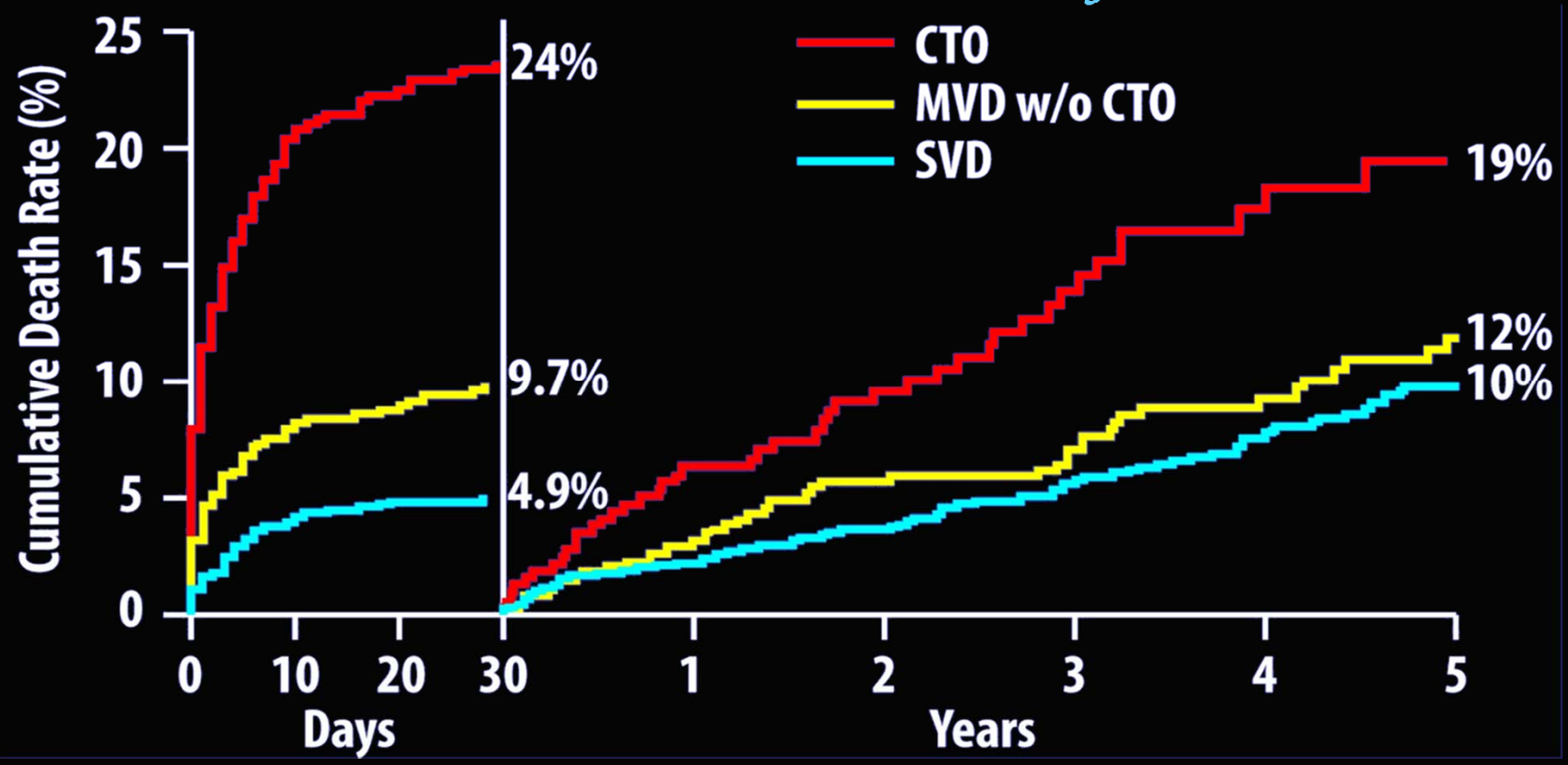
Rathore S. JACC Cardiovasc Interv. 2009;2:489-97.

Evaluation of the Effect of a Concurrent CTO on Long-Term Mortality and LVEF in Pts After Primary PCI in AMI

3277 STEMI pts 1997-05. SVD 65%, MVD 23%, MVD + CTO 13%

Endpoint: Survival at 5 yrs, LVEF at 12 mths (median F/U 3.1 yrs)

Landmark Survival Analysis



Claessen et al. JACC Int 2009;2:1128.

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Endpoint: Survival at 5 yrs, LVEF at 12 mths (median F/U 3.1 yrs)

Independent Predictors of Death

	First 30 Days		30 days to 5 years	
	H.R.	p-value	H.R.	p-value
Shock	7.4	<0.01	1.6	0.04
CTO	**3.6**	**<0.01**	**1.9**	**<0.01**
MVD w/o CTO	1.6	0.01	1.1	0.51
LAD related AMI	1.4	0.01	1.7	<0.01
Hypertension	0.7	<0.01	1.1	0.52
TIMI 3 Flow	0.4	<0.01	0.6	<0.01
Age > 60 years	1.3	0.13	3.3	<0.01

Claessen et al. JACC Int 2009;2:1128.

Concurrent CTO on Long-Term Mortality in Pts After Primary PCI in AMI

- In patients presenting with STEMI and multiple vessel disease, the presence of a CTO in a non-infarct related artery is associated with an adverse prognosis

Claessen et al. JACC Int 2009;2:1128.

Incomplete Revascularization in the Era of DES

- 11,294 stented pts with MVD, NY State PCI Reporting System. 88% had DES
- Oct 2003-Dec 2004, F/U through Dec 2005

Pt. Group	Adjusted HR for 18-month Mortality			
	No. of Cases	Mortality	HR	p-value
CR	3499 (31%)	5.1%	Ref	-
IR	7795 (69%)	6.2%	1.23	0.01
1 IR vessel no CTO	3815	6.2%	1.23	0.03
1 IR vessel CTO	1725	5.6%	1.11	0.39
≥ 2 IR vessel, no CTO	1233	5.9%	1.18	0.26
≥ 2 IR with CTO	1022	7.1%	1.44	0.002

Hannan EL. JACC Int. 2009;2:17

CTO Intervention

Do we have evidence that successfully opening a CTO improves long-term prognosis?

Long Term Survival in Successful vs. Unsuccessful PCI for CTO

Study	Year	n	Follow-up, yrs	Mortality difference	P-value
Suero et al	2001	2007	Cum 10	27 vs. 35%	0.001
Hoye et al	2003	874	5	6.5 vs. 12.0%	0.02
Kandzari et al*	2003	1458	1	1.1 vs. 7.2 %	0.02
Olivari et al	2003	376	1	2.5 vs. 7.3%	0.005
Aziz et al	2007	543	1.7	22 vs. 28%	0.004
Prasad et al	2008	1267	Cum 10	8.4 vs 12.6%	0.025
Valenti et al	2008	486	2	5.6 vs. 8.7%	0.025
Mehran et al	2008	1326	3	13 vs 26%	0.012
Thompson et al	2008	487	Cum 7	4.9 vs. 5.3%	0.09

* Abstracts

8986 patients

Absolute Risk reduction 3.1-9.0%

Late outcomes of PCI for CTO

True CTO ?

Study	Year	n	Duration (d)	Flow	Benefit
Bell et al	1992	354	≤1	No anterograde flow	0
Ivanhoe et al	1992	480	>10	TIMI flow grade 0 or 1	+
Noguchi et al	2000	226	>90	No anterograde flow	+
Suero et al	2001	2,007	>7	TIMI flow grade 0 or 1	+
Olivari et al	2003	419	>30	TIMI flow grade 0 or 1	+
Hoye et al	2005	874	>30	No anterograde flow	+
Aziz et al	2007	543	>90	TIMI flow grade 0 or 1	+
Prasad et al	2007	1,262	>90	Not stated	0
Hochman et al	2006	2,166	>7 and <30	TIMI flow grade 0 or 1, 2, 3	0

No anterograde flow = TIMI flow grade 0 and 1.

Labriolle A. AJC 2008;102:1175-81

‘Chronic’ and ‘Total’ Occlusion
True CTO ?

Chronic ≥ 3 months

- A patient has survived with a CTO for 3 months without intervention may indicate that he or she has little to gain from opening it.

Total occlusion (TIMI 0)

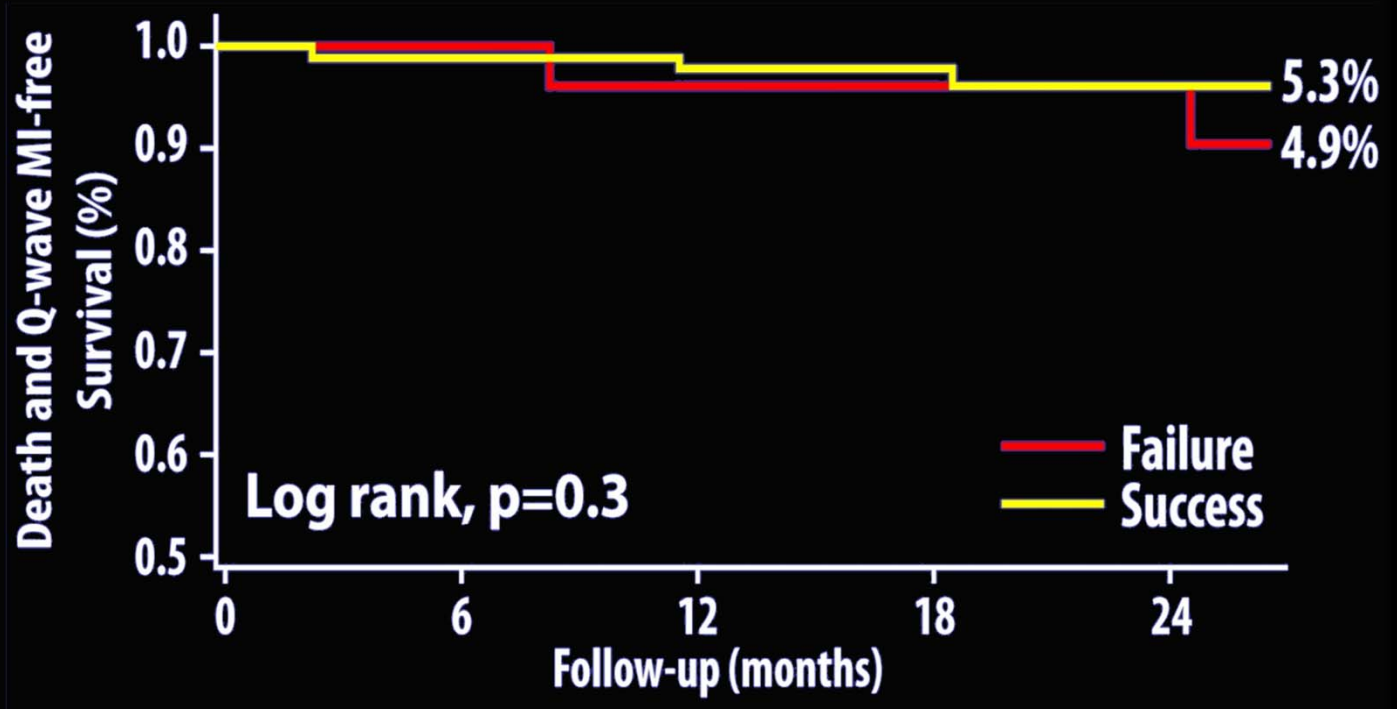
- Crossing the occlusion should be safer and more effective in patients with TIMI flow grade 1.

Unsuccessful CTO intervention might be a marker of disease severity

Late outcomes of PCI for CTO
in true CTO

- 172 pts, **TIMI 0 Flow, duration ≥ 3 months**
- Technical success 73.8%, In-hospital death/MI 0%; Perf 6.7%

Long-term Outcomes
Limited to pts w/o in-hospital complications



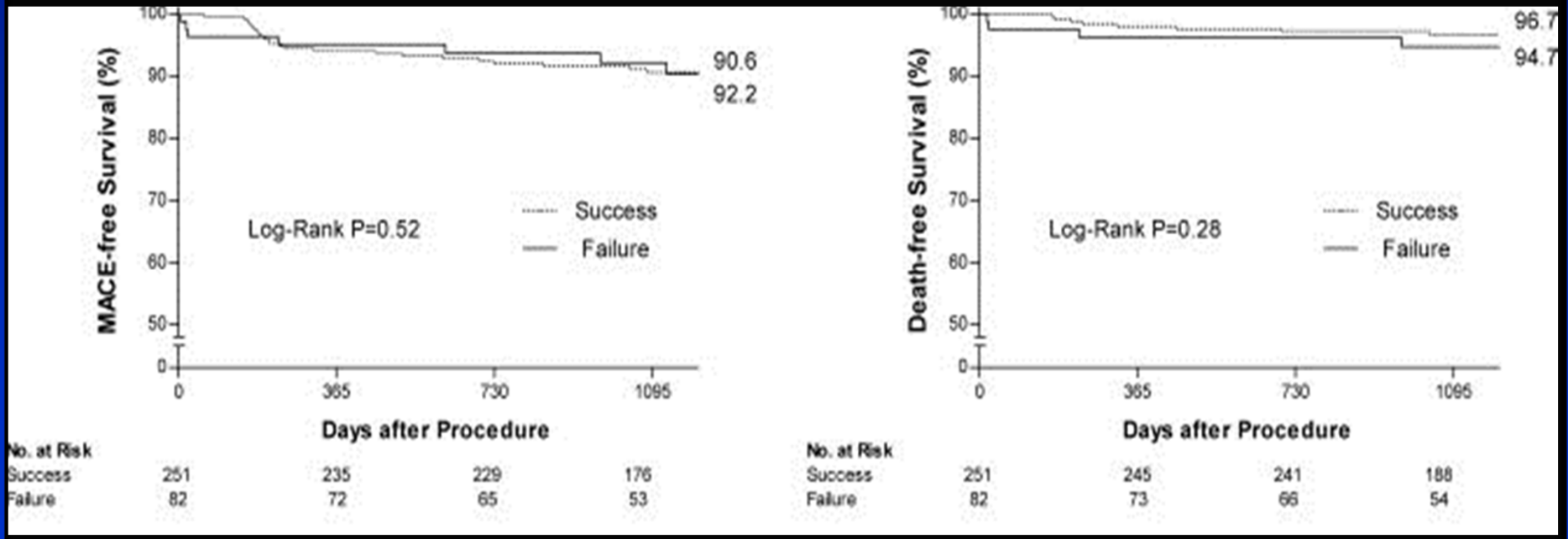
- **Conclusion:** Successful recanalization did not translate into long-term benefit

Labriolle A. AJC 2008;102:1175-81

AMC Experience in true CTO

2003-2006, TIMI 0, >3mo, n=333, 73.8% success

Similar long-term clinical outcomes (median 1,317 days F/U)



Lee SW. CCI 2011 Mar; Epub ahead of print

AMC Experience

2003-2006, TIMI 0, >3mo, n=333, 73.8% success

Similar long-term clinical outcomes (median 1,317 days F/U)

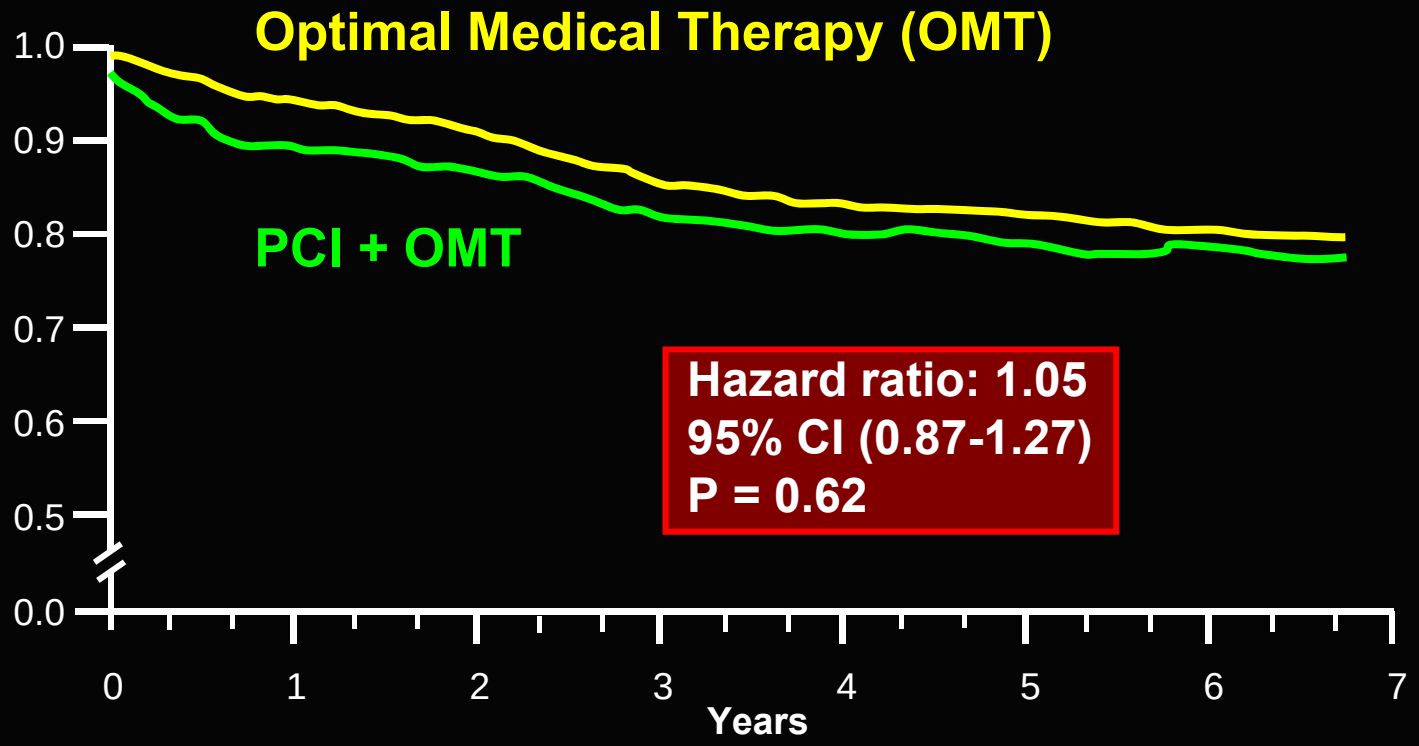
Variable	PCI success (N = 251)	PCI failure (N = 82)	P
CTO lesion length (mm)	20.3 ± 9.1	23.7 ± 11.2	0.012
Non-CTO lesion intervention	106 (42.2)	32 (39.0)	0.61
Complete revascularization (overall)	228 (90.8)	0 (0)	<0.001
Complete revascularization (except CTO)	228 (90.8)	69 (84.1)	0.09
Complete revascularization (except CTO and ≥2.5mm vessel)	228 (93.8)	69 (94.5)	0.89

High rate of complete revascularization

Lee SW. CCI 2011 Mar; Epub ahead of print

COURAGE Trial

Death and MI-free Survival



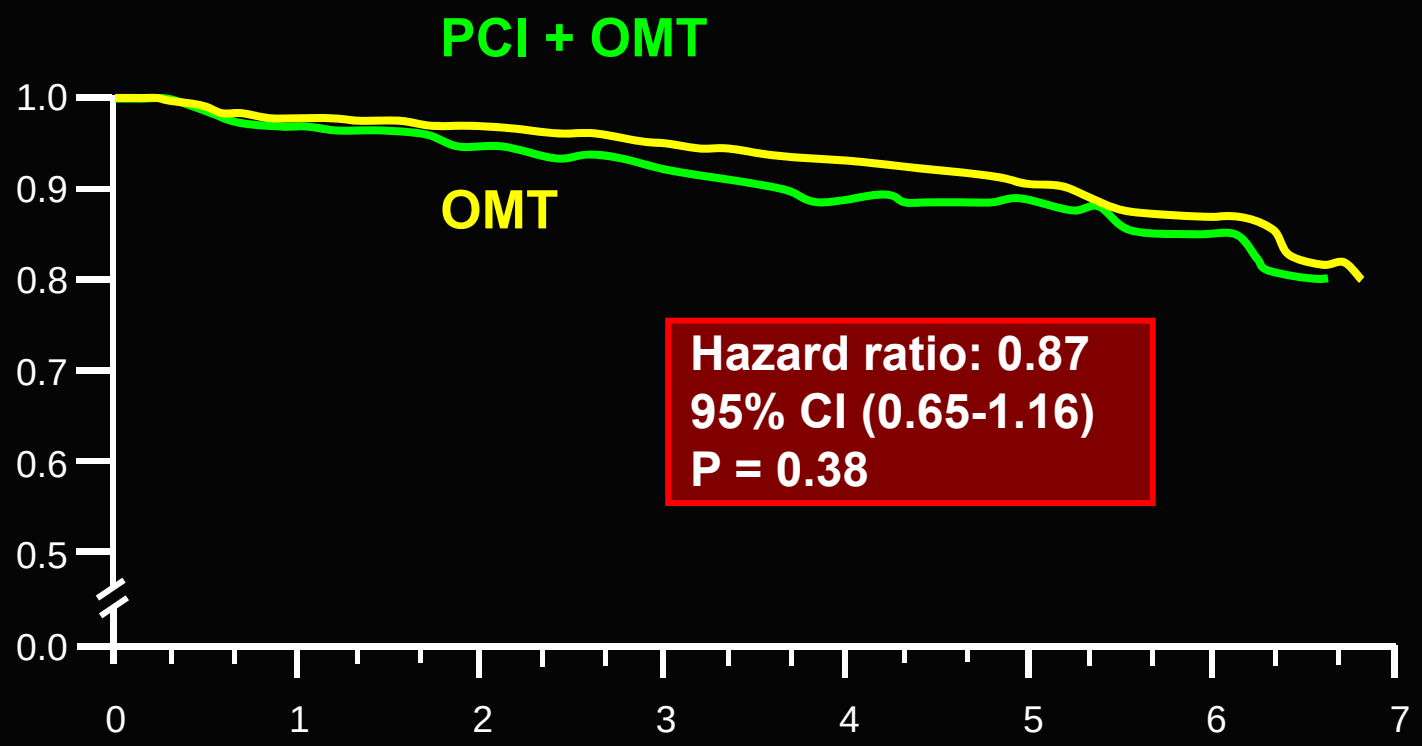
Number at Risk

Medical Therapy	1138	1017	959	834	638	408	192	30
PCI	1149	1013	952	833	637	417	200	35

Boden WE. NEJM 2007;356:1503-16

COURAGE Trial

Overall Survival



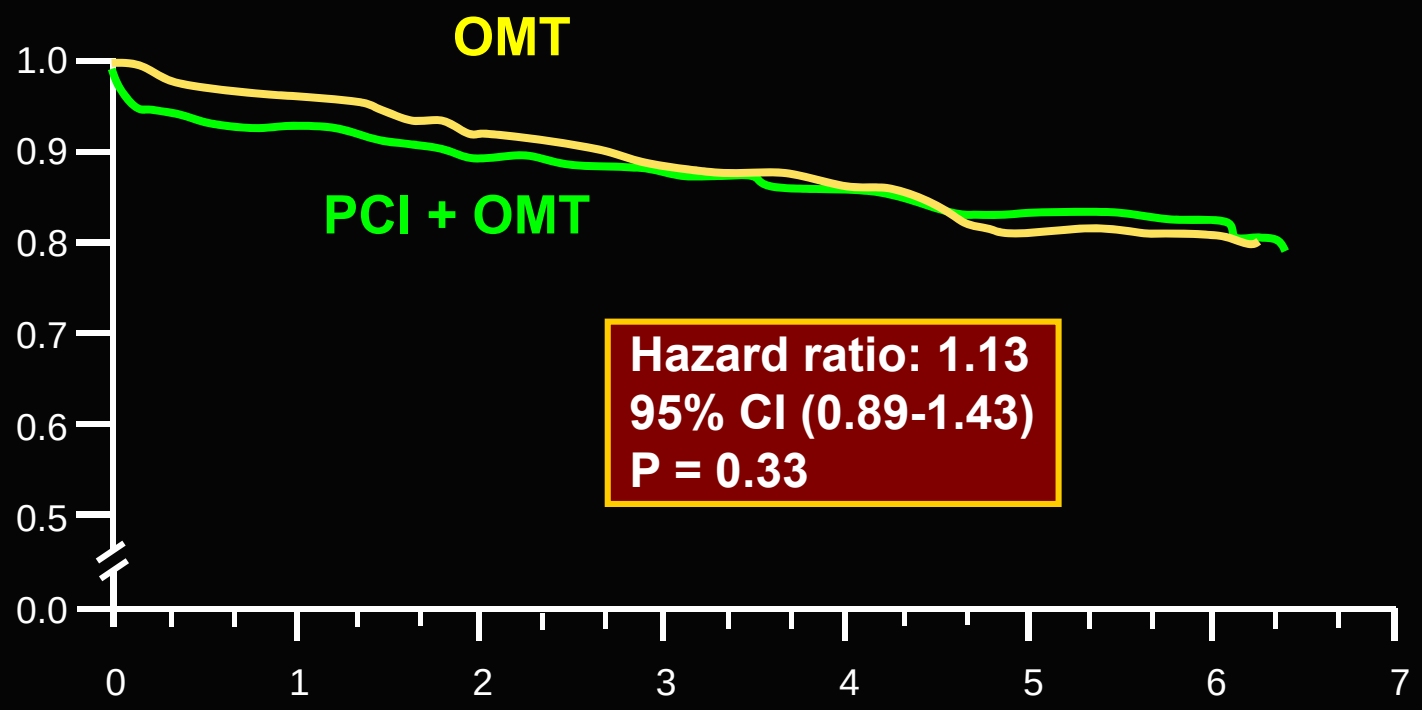
Number at Risk

Medical Therapy	1138	1073	1029	917	717	468	302	38
PCI	1149	1094	1051	929	733	488	312	44

Boden WE. NEJM 2007;356:1503-16

COURAGE Trial

MI-free Survival



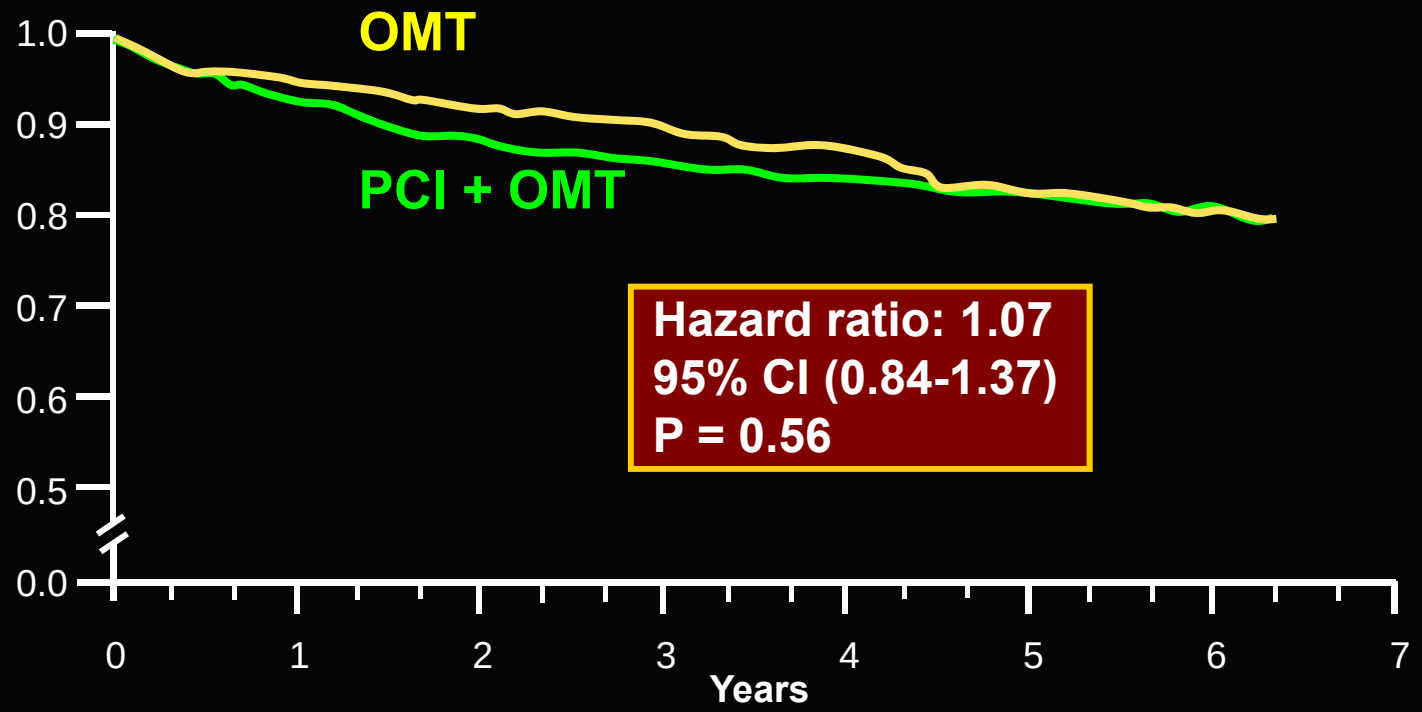
Number at Risk

Medical Therapy	1138	1019	962	834	638	409	192	120
PCI	1149	1015	954	833	637	418	200	134

Boden WE. NEJM 2007;356:1503-16

COURAGE Trial

Freedom from Hospitalization for ACS



Number at Risk

Medical Therapy	1138	1025	956	833	662	418	236	127
PCI	1149	1027	957	835	667	431	246	134

Boden WE. NEJM 2007;356:1503-16

COURAGE enrolled low risk patients?

DM 34%

Dyslipidemia 71 %

HTN 67%

Smoker 29%

Prior MI 39%

Prior Revasc 26%

Angina 88%

Prox LAD 34%

MVD 70%

Multiple defects 67%

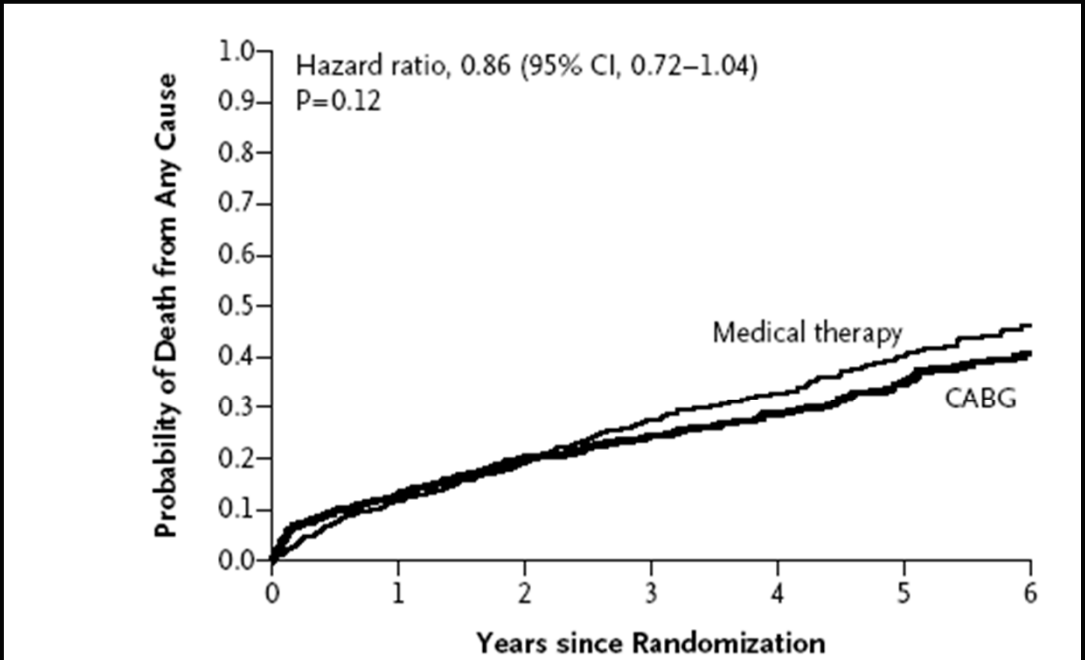
Event rate/yr 4%

Boden WE. NEJM 2007;356:1503-16

STICH – CABG vs. OMT

1,212 CABG candidates with LVEF<35%

Similar all-cause mortality (median 56 months FU)

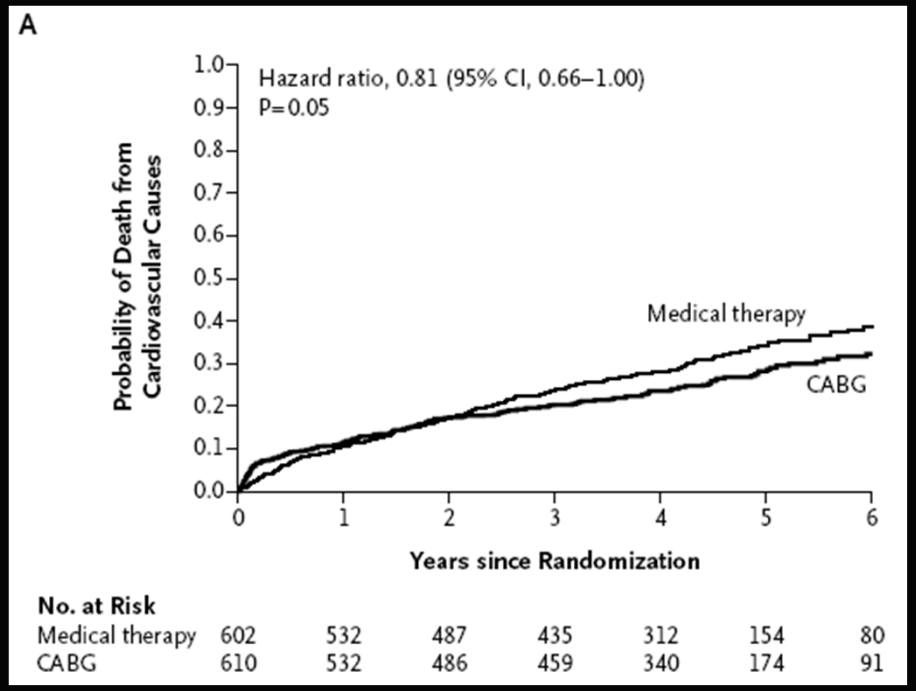


Velazquez EJ, NEJM 2011 Apr; Epub ahead of print

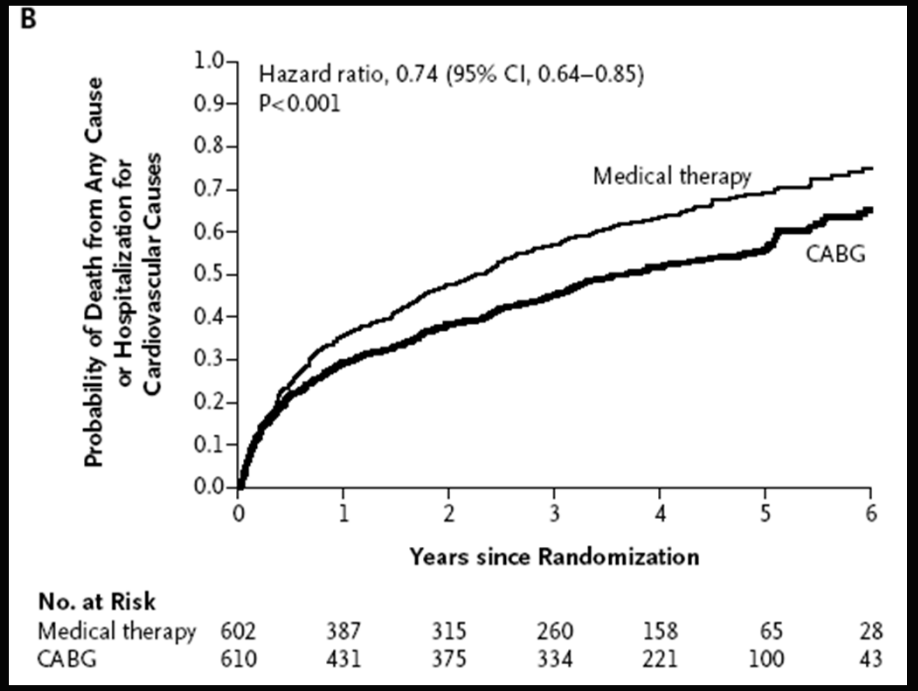
STICH – CABG vs. OMT

1,212 CABG candidates with LVEF<35%

Reduced cardiac death (median 56 months FU)



Reduced all-cause death or admission (median 56 months FU)

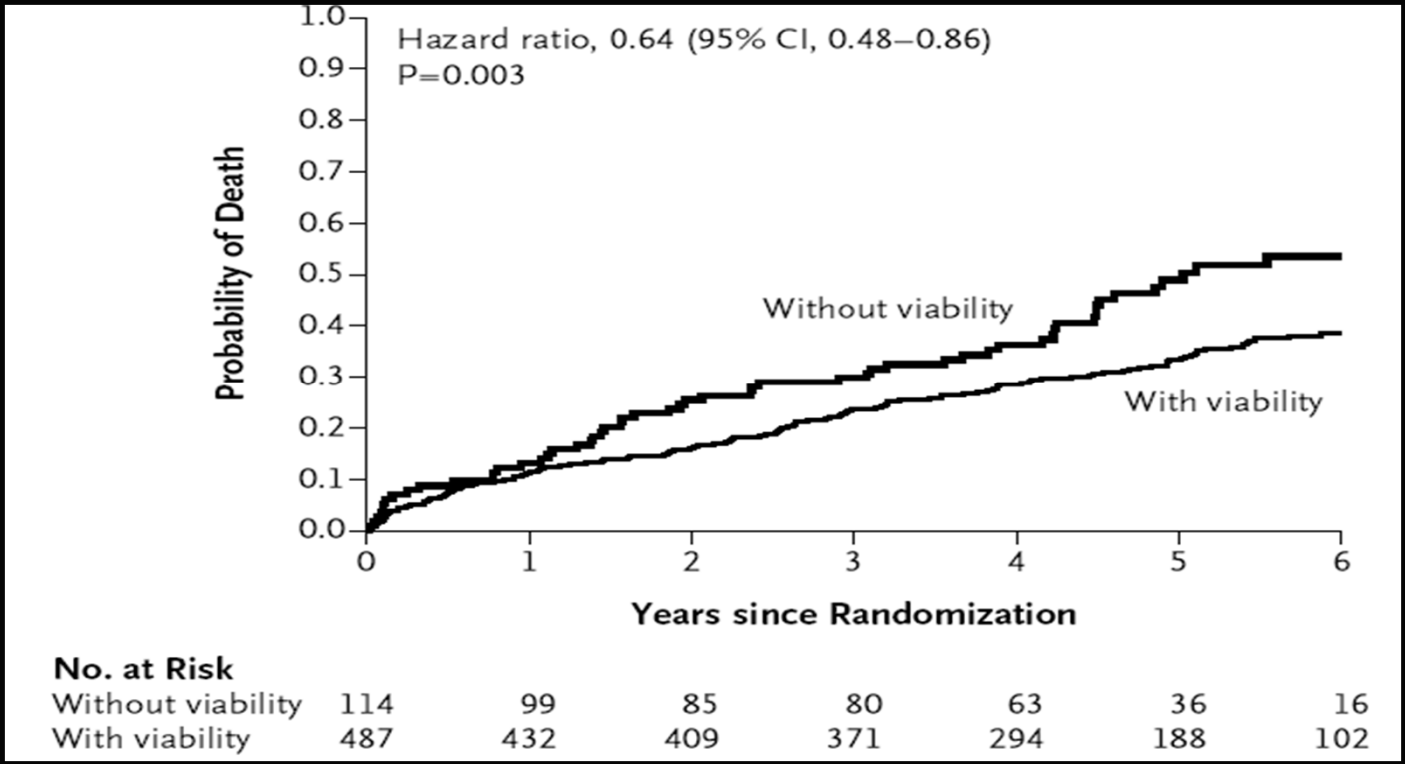


Velazquez EJ, NEJM 2011 Apr; Epub ahead of print

STICH – Viable vs. Nonviable

601 CABG candidates, EF<35%, median 5.1yrs FU

Lower mortality in patients with viable myocardium?



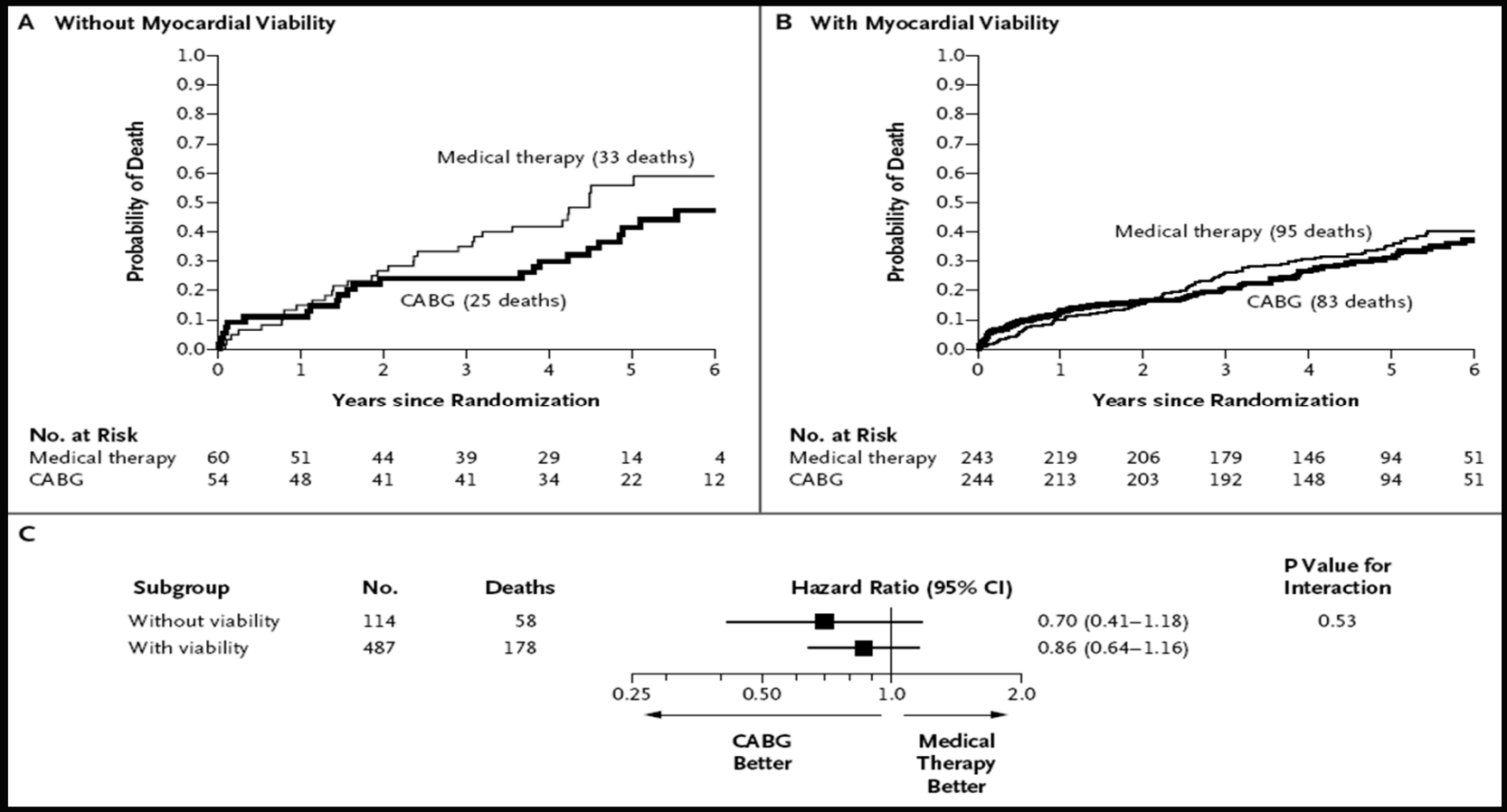
No between-group difference on multivariate analysis (p=0.21) !!

Bonow RO, NEJM 2011 Apr; Epub ahead of print

STICH – Viable vs. Nonviable

601 CABG candidates, EF<35%, median 5.1yrs FU

No mortality difference btw viability status and Tx assignment



Bonow RO, NEJM 2011 Apr; Epub ahead of print

DISCOURAGE

STICCH OUT

One Question for Aggressive Interventionist

Have you given the patient your best shot?

- We have to more aggressive for doing OMT -

Pharmacologic treatment

- Anti-platelet: aspirin; clopidogrel in accordance with established practice standards
- Statin: simvastatin ± ezetimibe or ER niacin
- ACE Inhibitor or ARB: lisinopril or losartan
- Beta-blocker: long-acting metoprolol
- Calcium channel blocker: amlodipine
- Nitrate: isosorbide 5-mononitrate

Lifestyle modification

- Smoking cessation
- Exercise program
- Nutrition counseling
- Weight control

CTO intervention

- Higher procedural complications
  - Perforation
  - Coronary dissection d/t
    guiding manipulation and subintimal GW tracking
  - Aortic dissection
  - Thrombosis
  - Collateral vessel occlusion
- Longer procedural time → Radiation injury, CIN
- More periprocedural MI (6-13%)
- More devices and cost needed
- Higher chance of restenosis
- Worse QOL of cath lab staffs

Predictors of perforation during PCI

57 perforations in 9,568 PCI cases (0.59%)

Variable	OR	95% CI	p-value
Chronic total occlusion	14.7	5.5–38.8	<0.0001
Calcified lesion	4.8	1.99–11.5	0.0005
Previous CABG surgery	3.78	1.38–10.3	0.009
UA/NSTEMI	2.93	1.26–6.8	0.012
Culprit lesion in RCA	2.77	1.23–6.28	0.014
Femoral approach for PCI	2.63	1.14–6.0	0.023

Classification

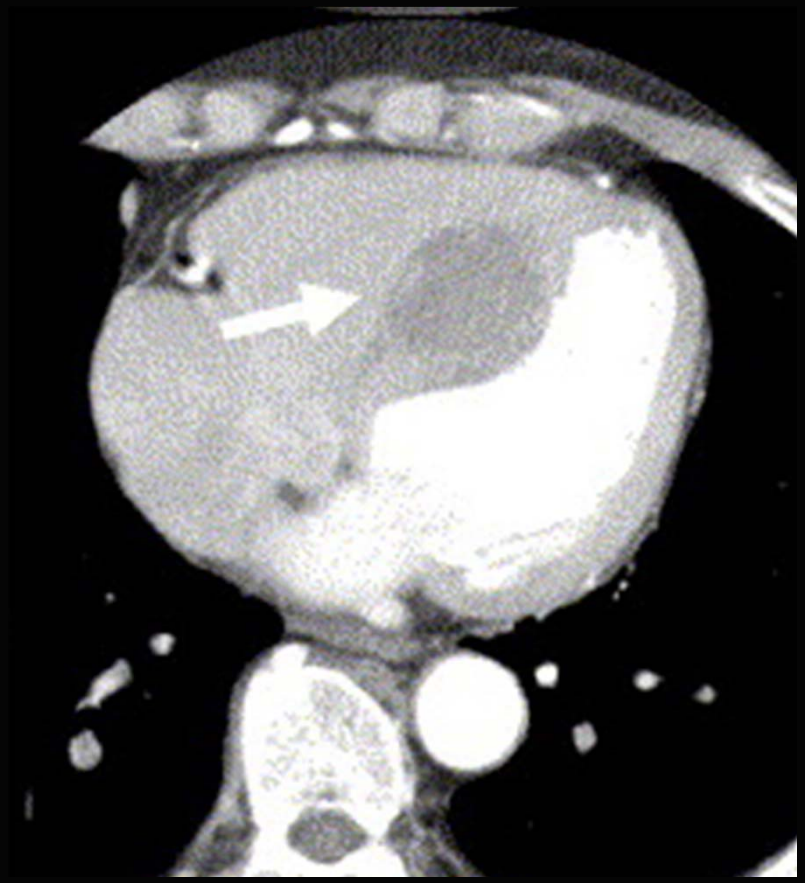
Type I (extraluminal crater without extravasation),

Type II (pericardial and myocardial blush without contrast jet extravasation)

Type III (extravasation through a frank [1 mm] perforation)

Shimony A. AJC 2009;104:1674-7.

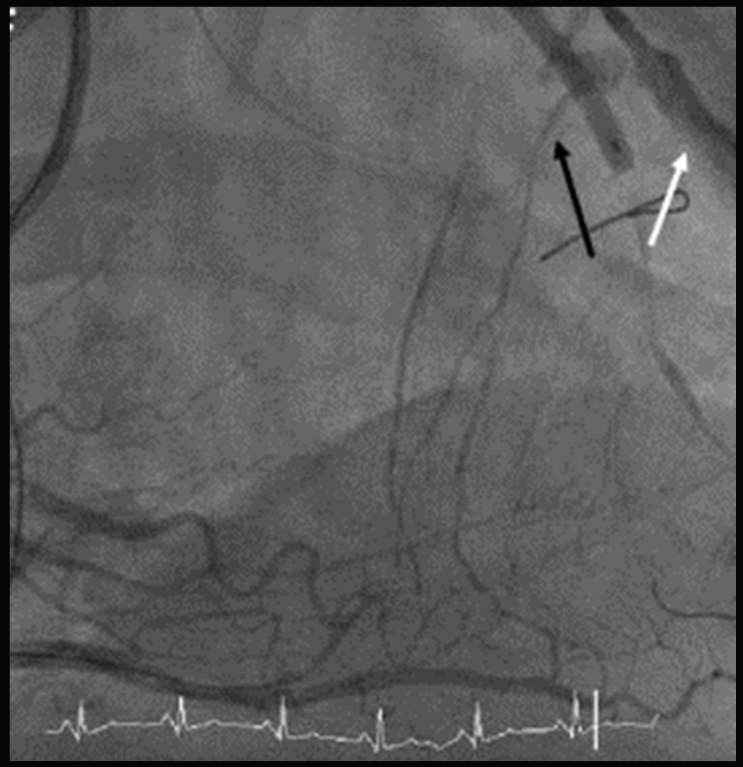
GW-induced septal hematoma

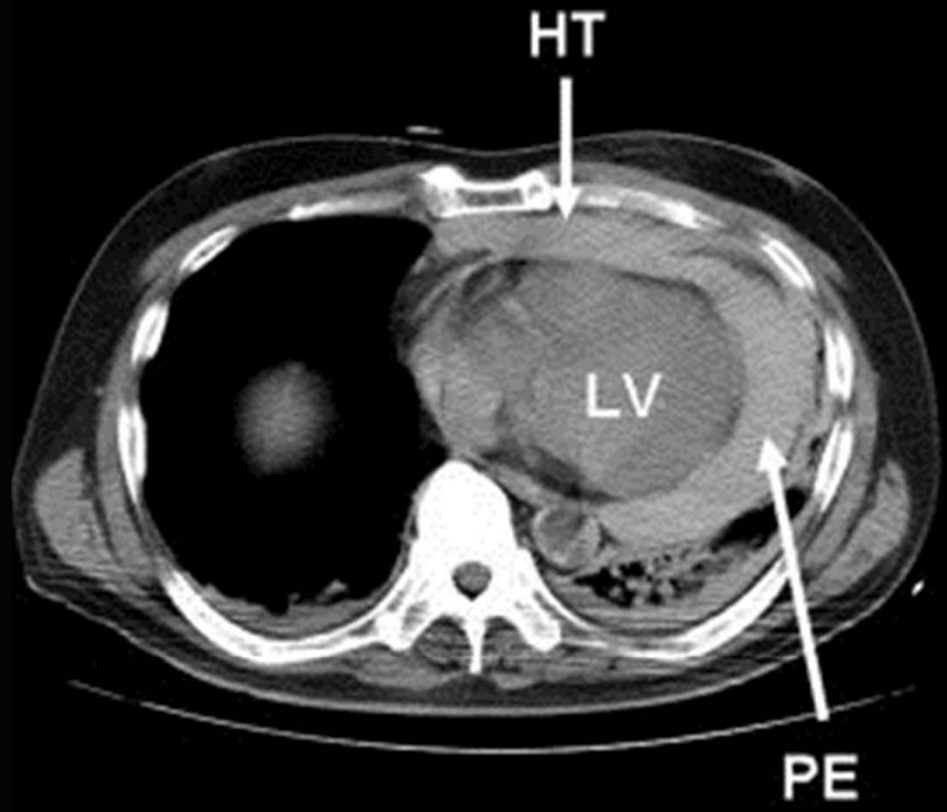


Managed conservatively

Lin TH. IJC 2006:113;E64-E66

GW-induced perforation of the septal branch resulted in cardiac tamponade

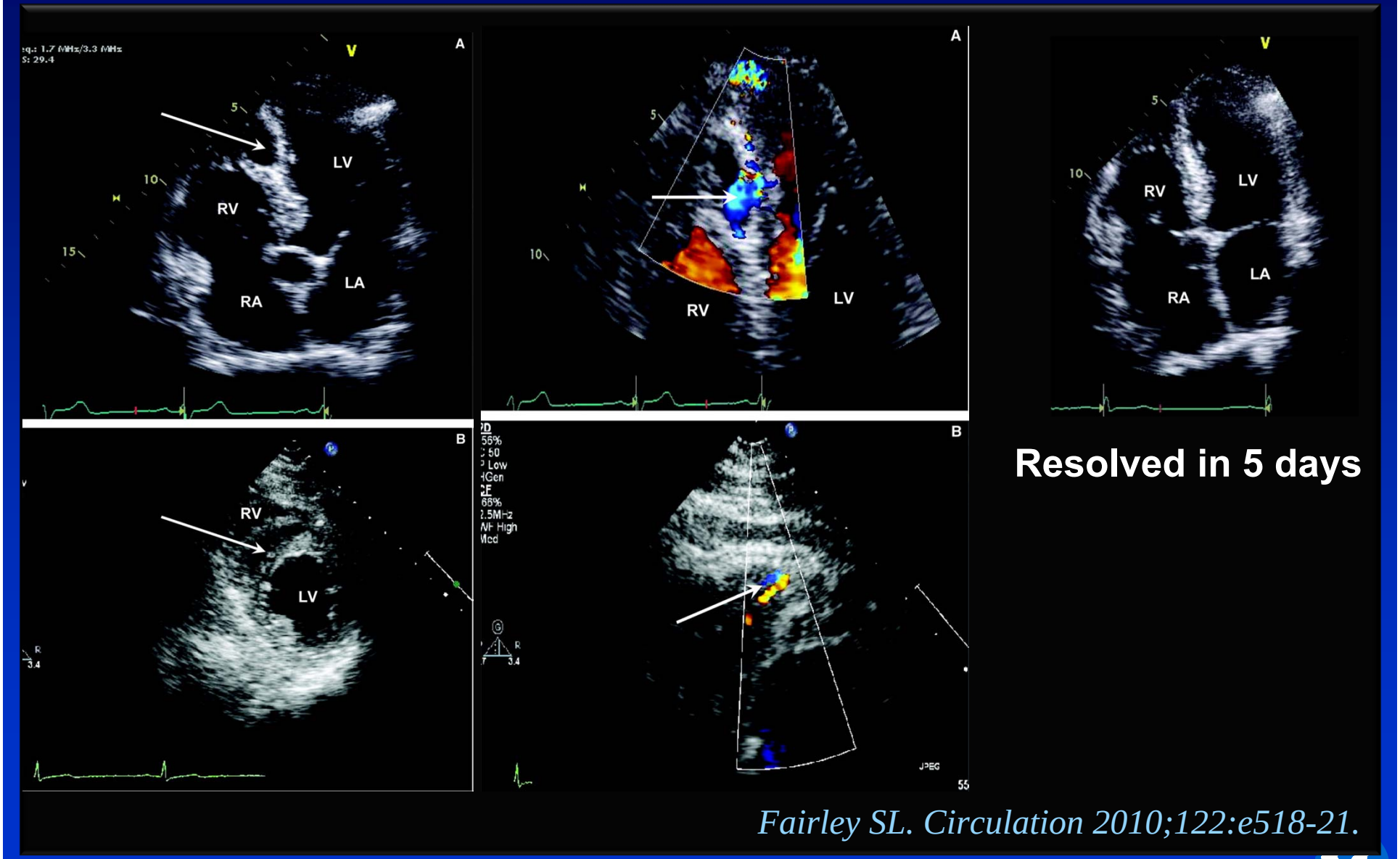




Needs septal embolization and surgical drainage

Matsumi J. CCI 2008;72(3):379-80.

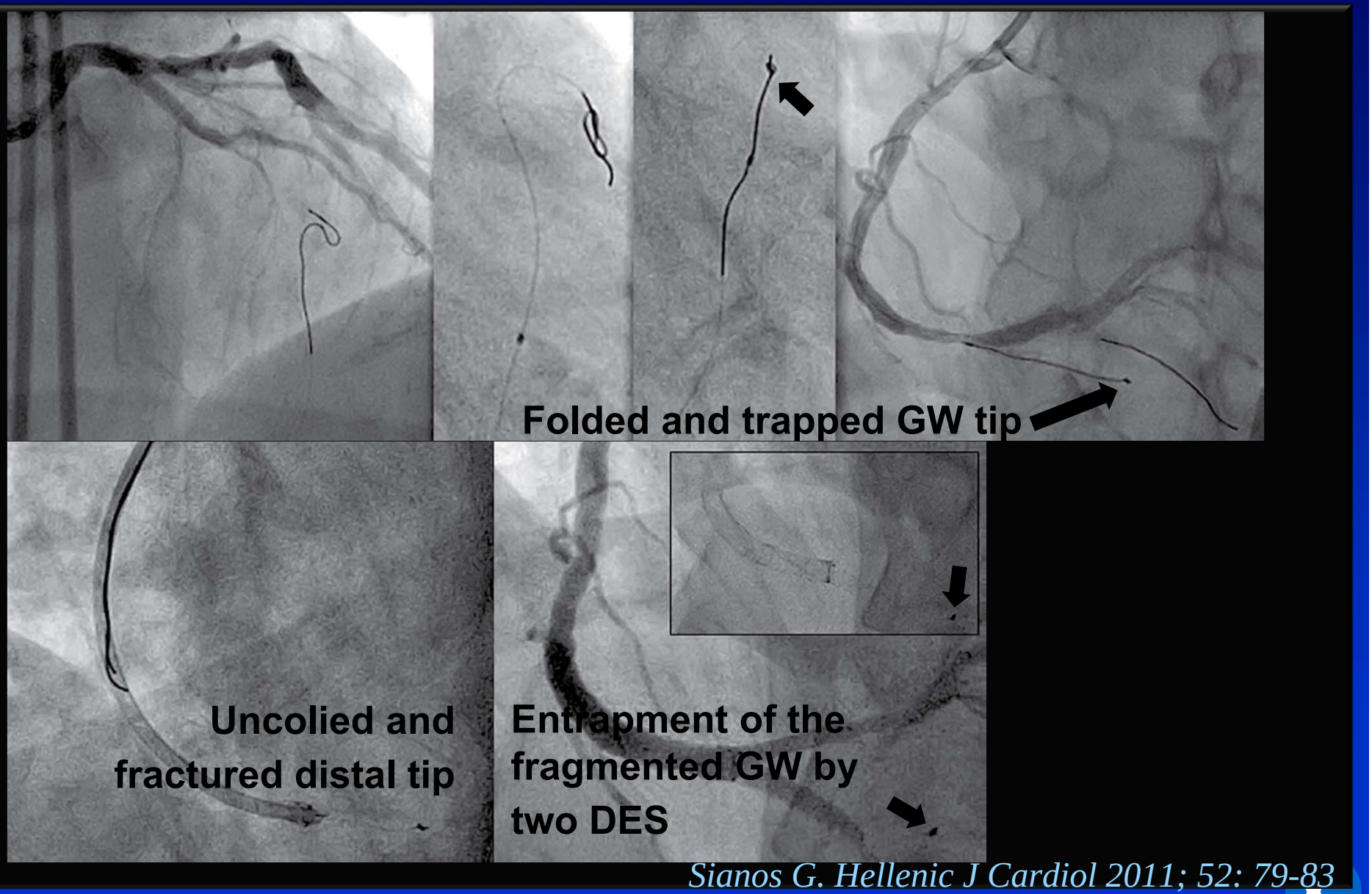
Interventricular septal hematoma & VSD



Resolved in 5 days

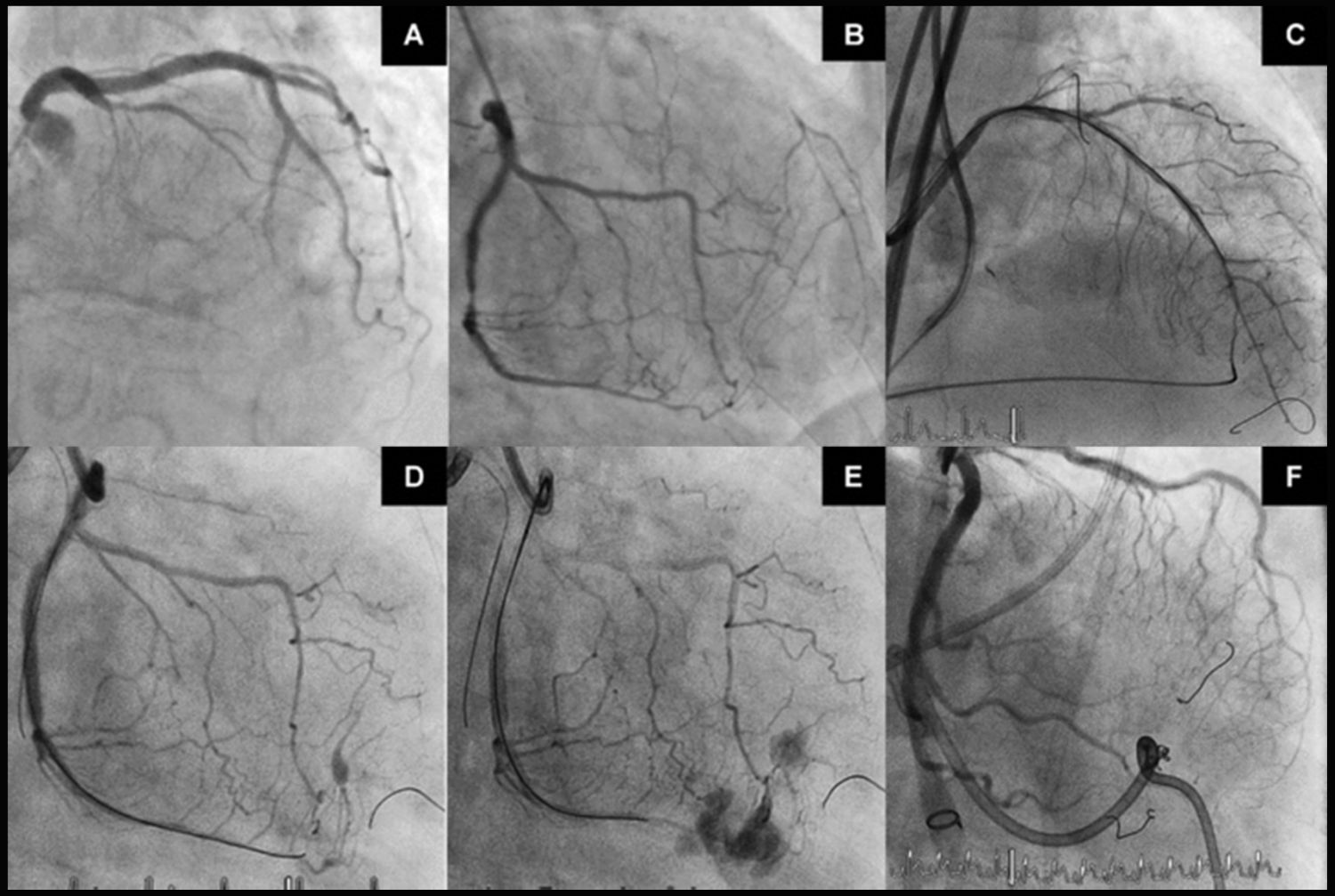
Fairley SL. Circulation 2010;122:e518-21.

Entrapped GW at the septal channel



Sianos G. Hellenic J Cardiol 2011; 52: 79-83

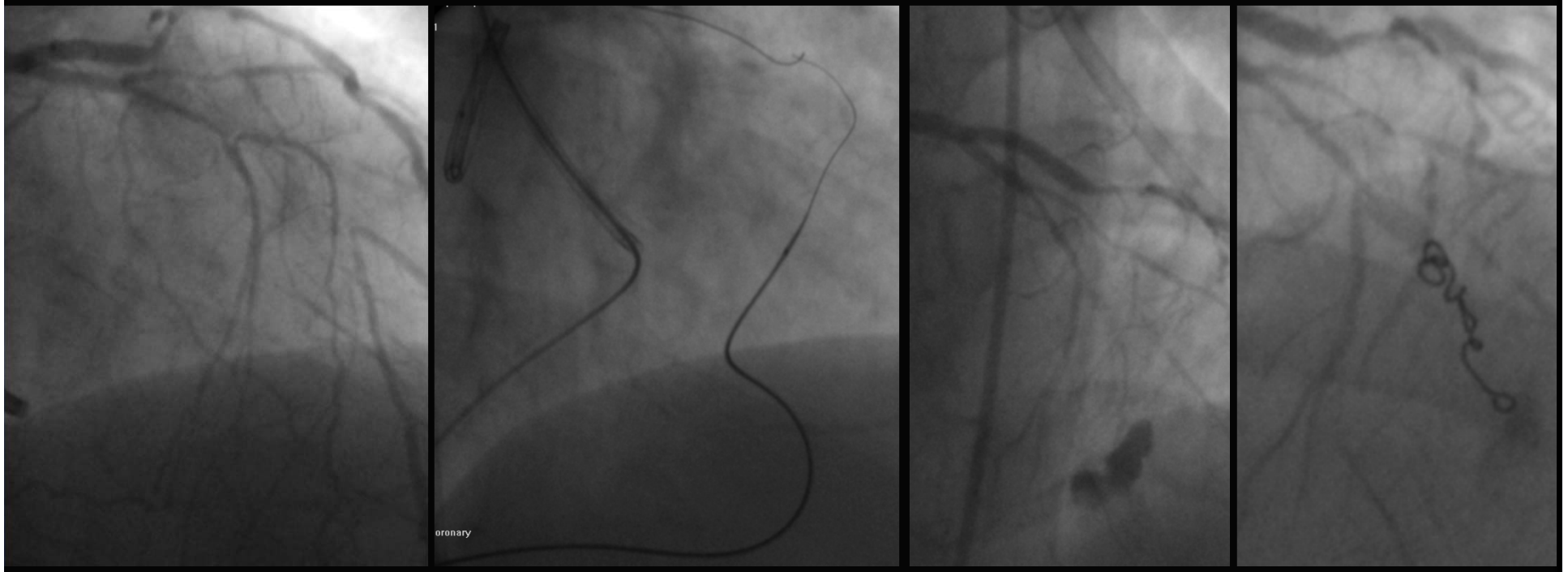
Septal perforation and tamponade after Corsair removal



Hashidomi H. JIC 2011;24:73-6

LAD CTO intervention

mLAD perforation and tamponade



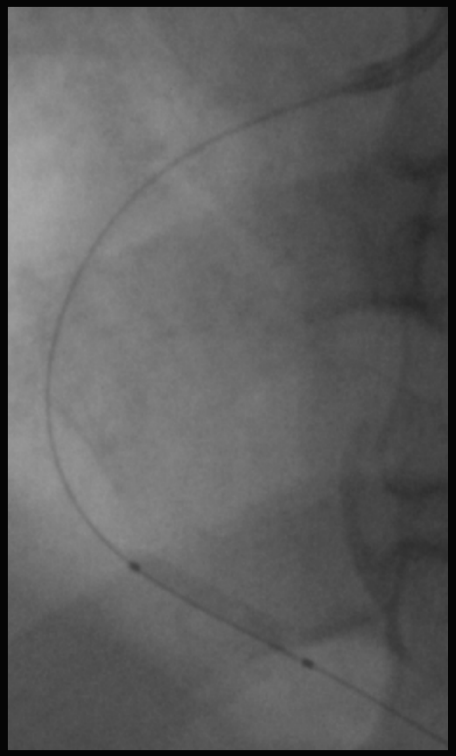
mLAD CTO
Good collateral
from RCA

Retrograde approach
with Corsair

Perforation with tamponade
→ Pericardiocentesis
& coil embolization

Unexpected perforation
mRCA STEMI lesion

mRCA occlusion



2.5 mm balloon

Perforated dRCA

RV br. perforation

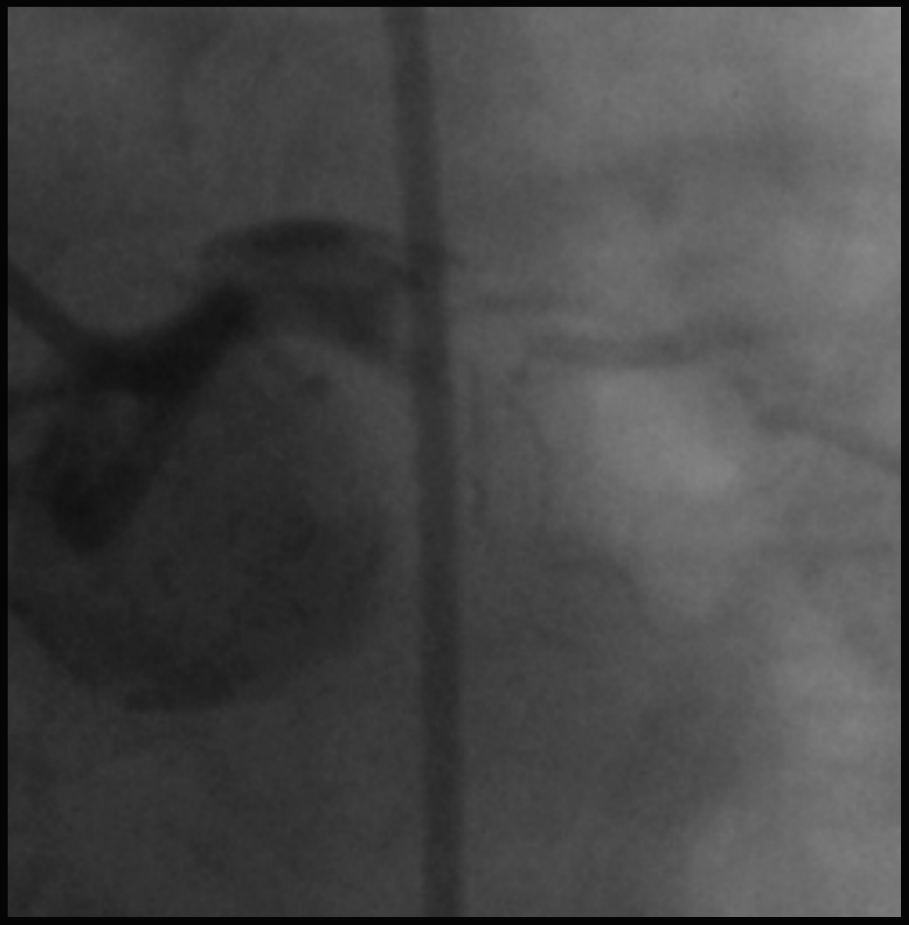
Intracatheter thrombi
During CART for dRCA CTO

dRCA occlusion Almost successful CART mLAD occlusion

LMCA dissection

During pLCx CTO wiring

pLCx occlusion



LMCA dissection

CTO PCI may kill the patient's back

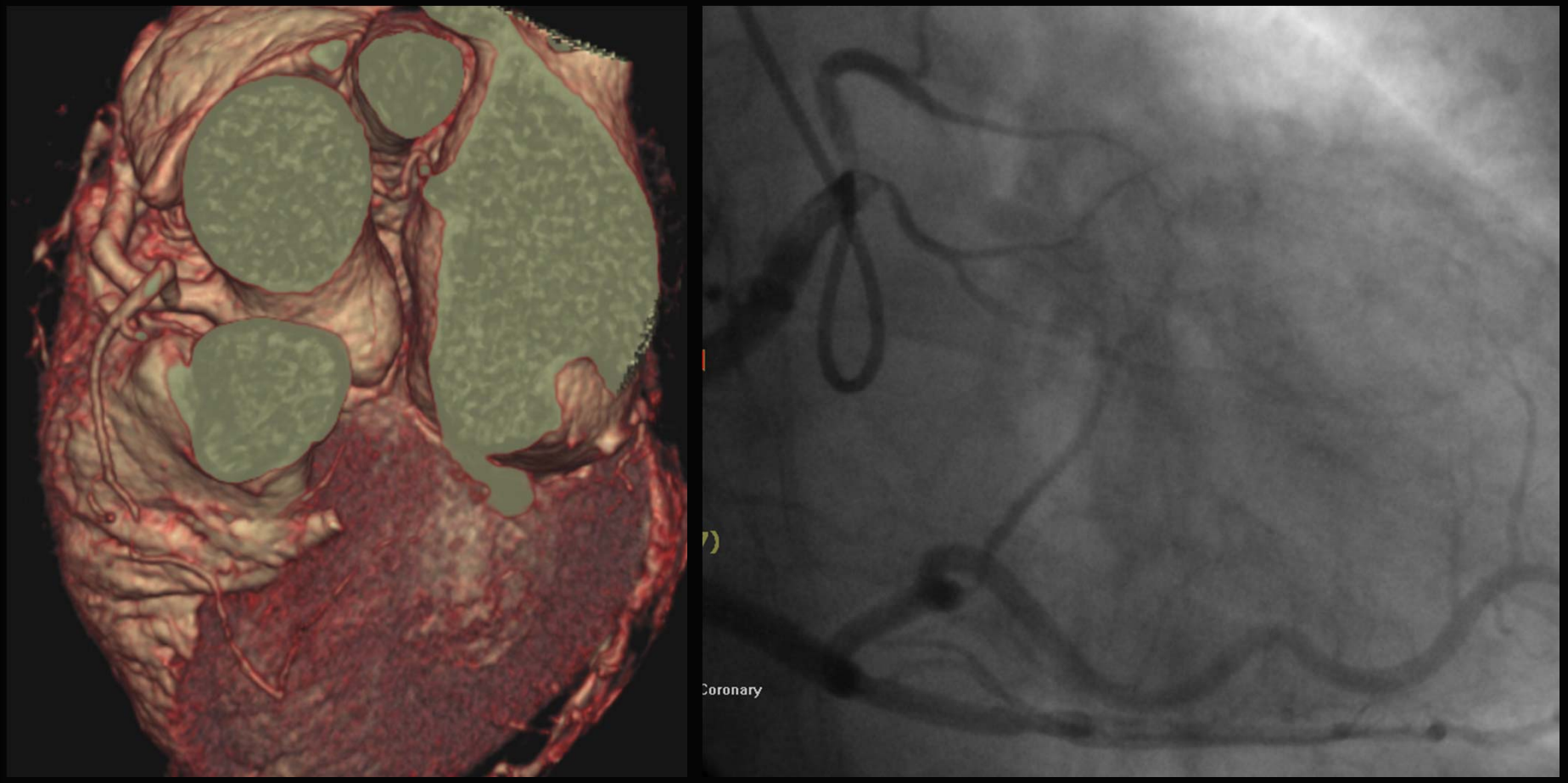
Radiation dermatitis in a 64 YO woman

4 years after repeated PCI

At 6 years

Ukisu R. AJR. 2009;193:S59-S69

Single RCA



CTO intervention may people asleep

CTO intervention makes people K.O.

Rah SW & Dying people. J Kor Guro Cath Lab. Jan 26th 2011; 03:48 am

Medical therapy makes people happy

Lee JH & happy people. J Chungnam Cath Lab. Apr 14th 2011; 12:30 pm