

# CHRONIC TOTAL OCCLUSION

*20-Year Follow-Up*

*Barry D. Rutherford, MD*

*Angioplasty Summit  
Seoul, Korea 2004*



# Chronic Total Coronary Occlusion

- ♥ Occurs in 30% of the 1.5 million diagnostic angiograms per year
- ♥ NHLBI Registry and BARI Trials show only 8% of interventions are aimed at CTO's
- ♥ CTO remains one of the major reasons for surgical referral
- ♥ Significant number of CTO's are left untreated
- ♥ Success rates 60-85% (lack of unified definition)

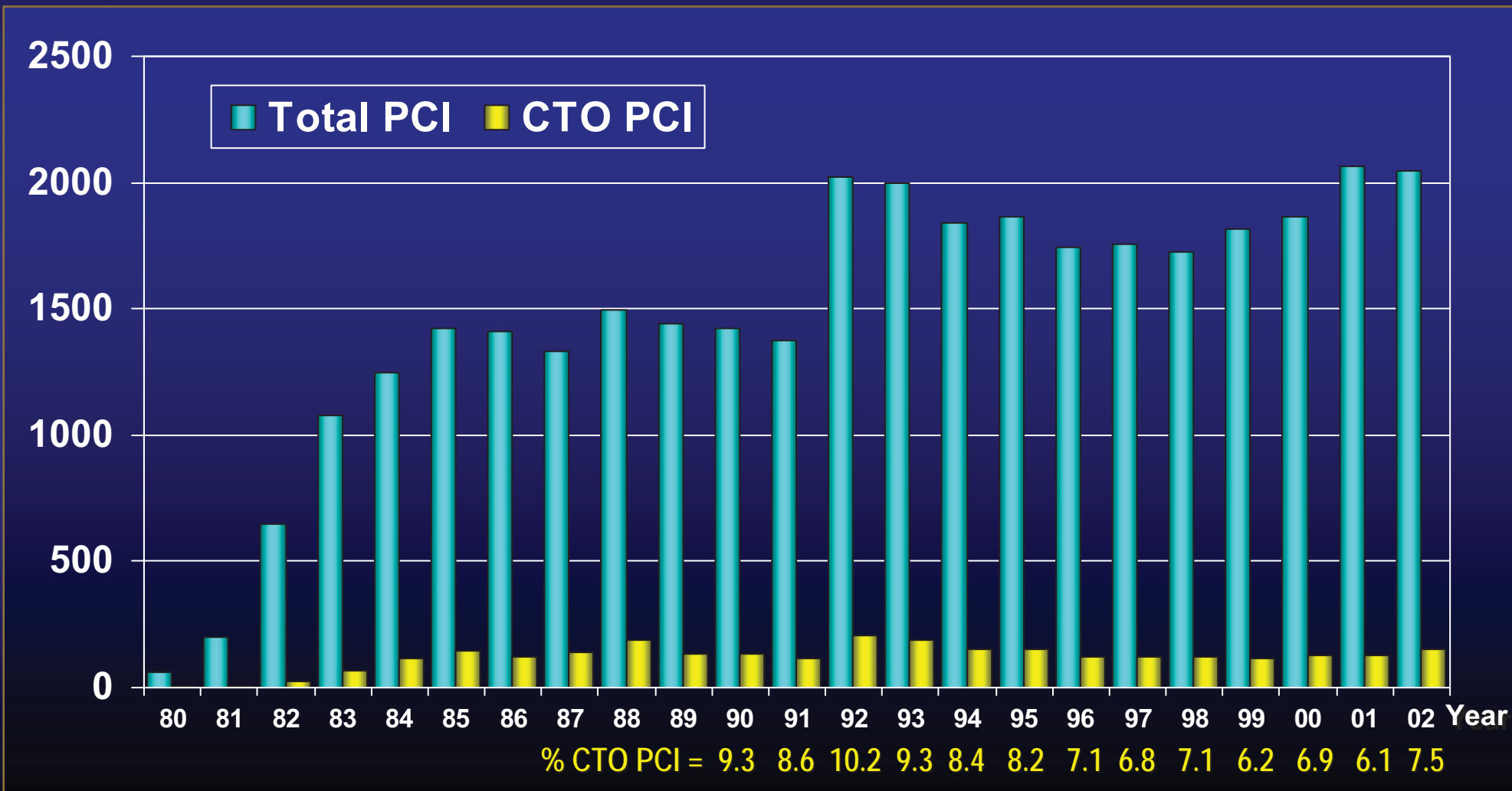
# Temporal Trends in the Treatment of Total Coronary Occlusions

*1985-86 NHLBI Registry and current NHLBI Dynamic Registry (1997-2001)*

	Registry	Dynamic Registry			p-value
	1985-86	1	2	3	
<b>Attempts at TO</b>					
AMI pts	40%	3%	25%	21%	< 0.0001
Non AMI pts	14%	8%	6%	4%	< 0.0001
<b>Success</b>					
AMI pts	65%	90%	92%	88%	< 0.0001
Non AMI pts	63%	81%	77%	78%	< 0.0001



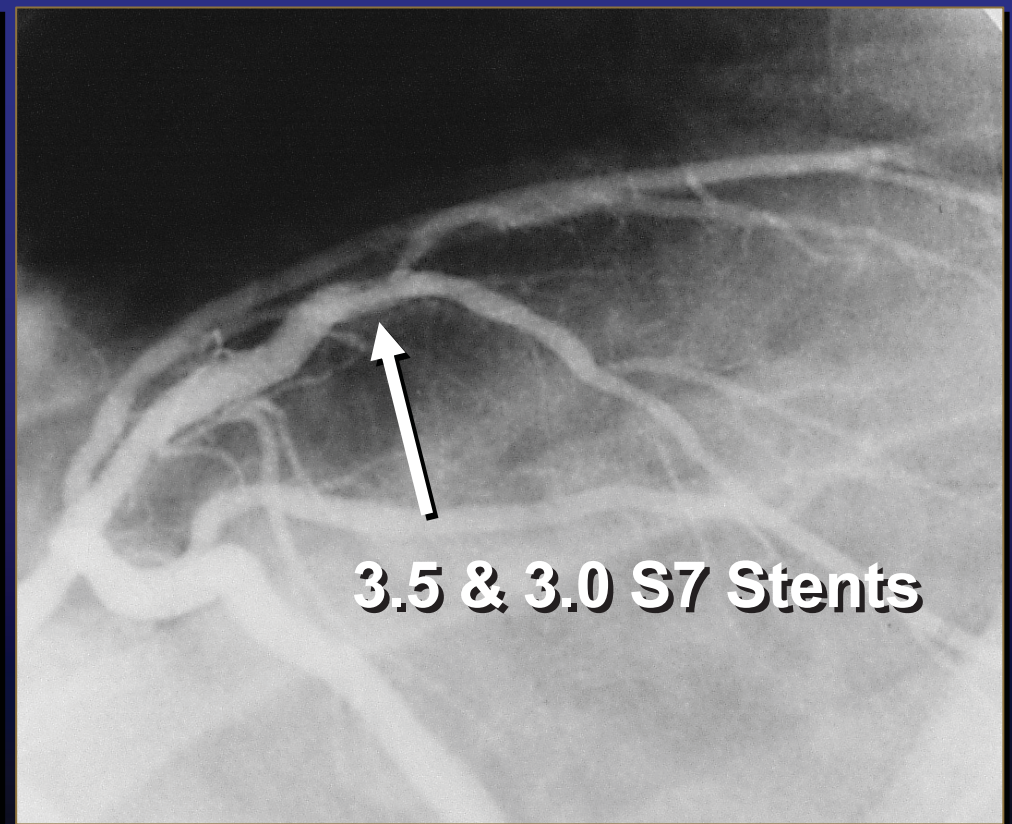
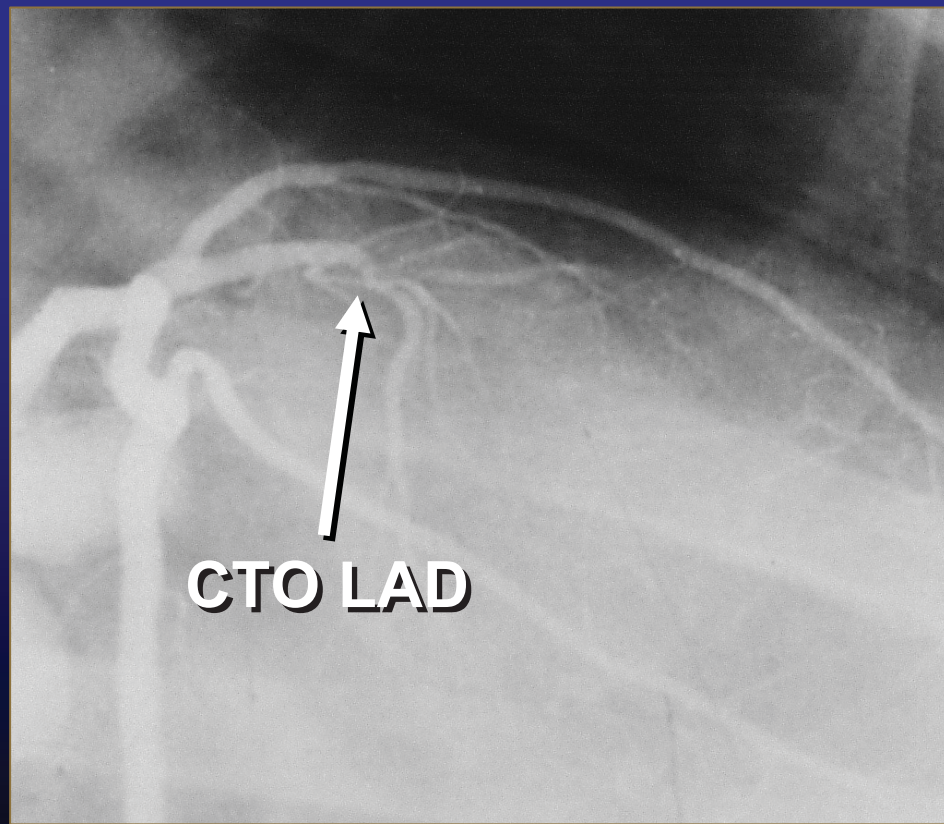
# Chronic Total Coronary Occlusion MAHI Experience







# J.S. 48-Year-Old Male 6-Month Post Anterior MI



Short Axis

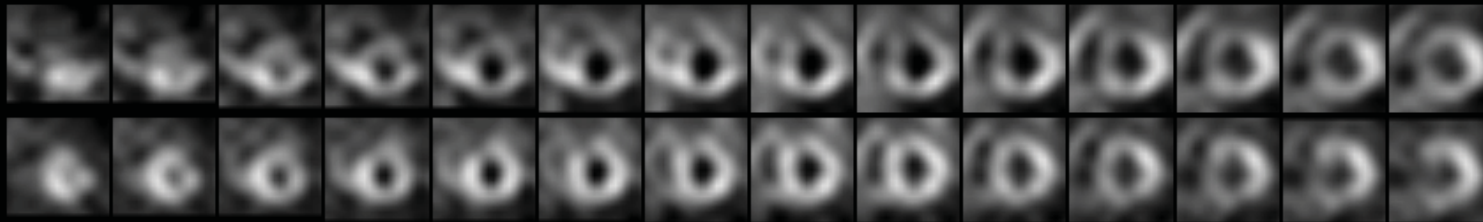
apex to base

ACQ: KF

PR: MJS

DSP: MJS

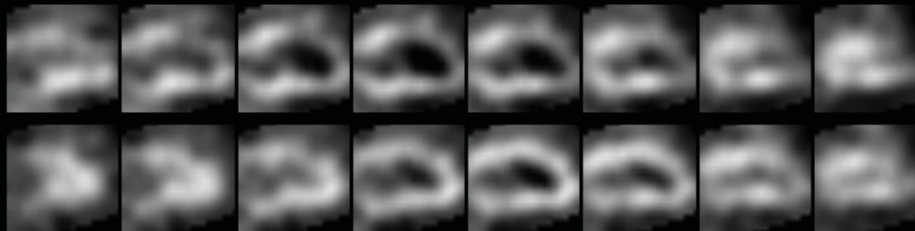
ant  
sep lat  
inf



Vertical Long Axis

sep to lat

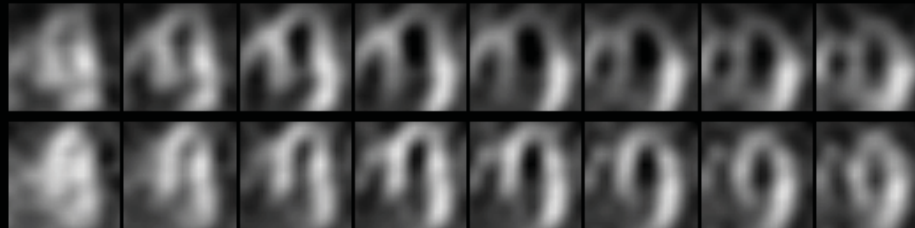
ant  
base apex  
inf



Horizontal Long Axis

inf to ant

apex  
sep lat  
base



PERFUSION

STRESS

REST



63	LAD%	23
0	RCA%	0
0	LCX%	0
38	TOTAL%	15

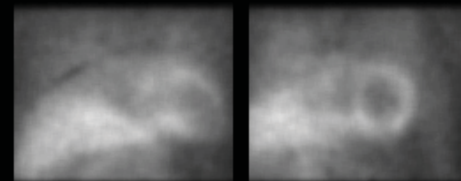
MOCO/TID= 1.13

FUNCTION

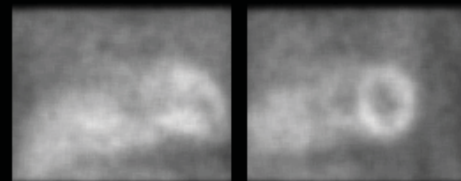
0.60 LUNG/HEART RATIO

33% LVEF 32%

STRESS



REST



CCL124317

20 Jun 00

JS

Short Axis

apex to base

ACQ: WS

PR: MJS

DSP: MJS

ant  
sep lat  
inf



Vertical Long Axis

sep to lat

ant  
base apex  
inf



Horizontal Long Axis

inf to ant

apex  
sep lat  
base



PERFUSION

STRESS

REST



0	LAD%	0
0	RCA%	0
0	LCX%	0
3	TOTAL%	0

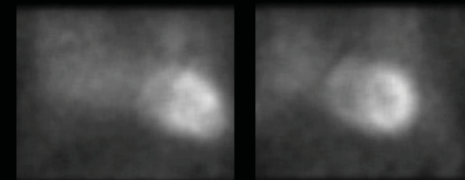
MOCO TID= 1.01

FUNCTION

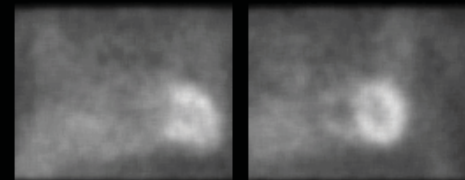
0.50 LUNG/HEART RATIO

LVEF 52%

STRESS



REST



CCL124317

30 Aug 01

JS

Cardiovascular Consultants, P.C.





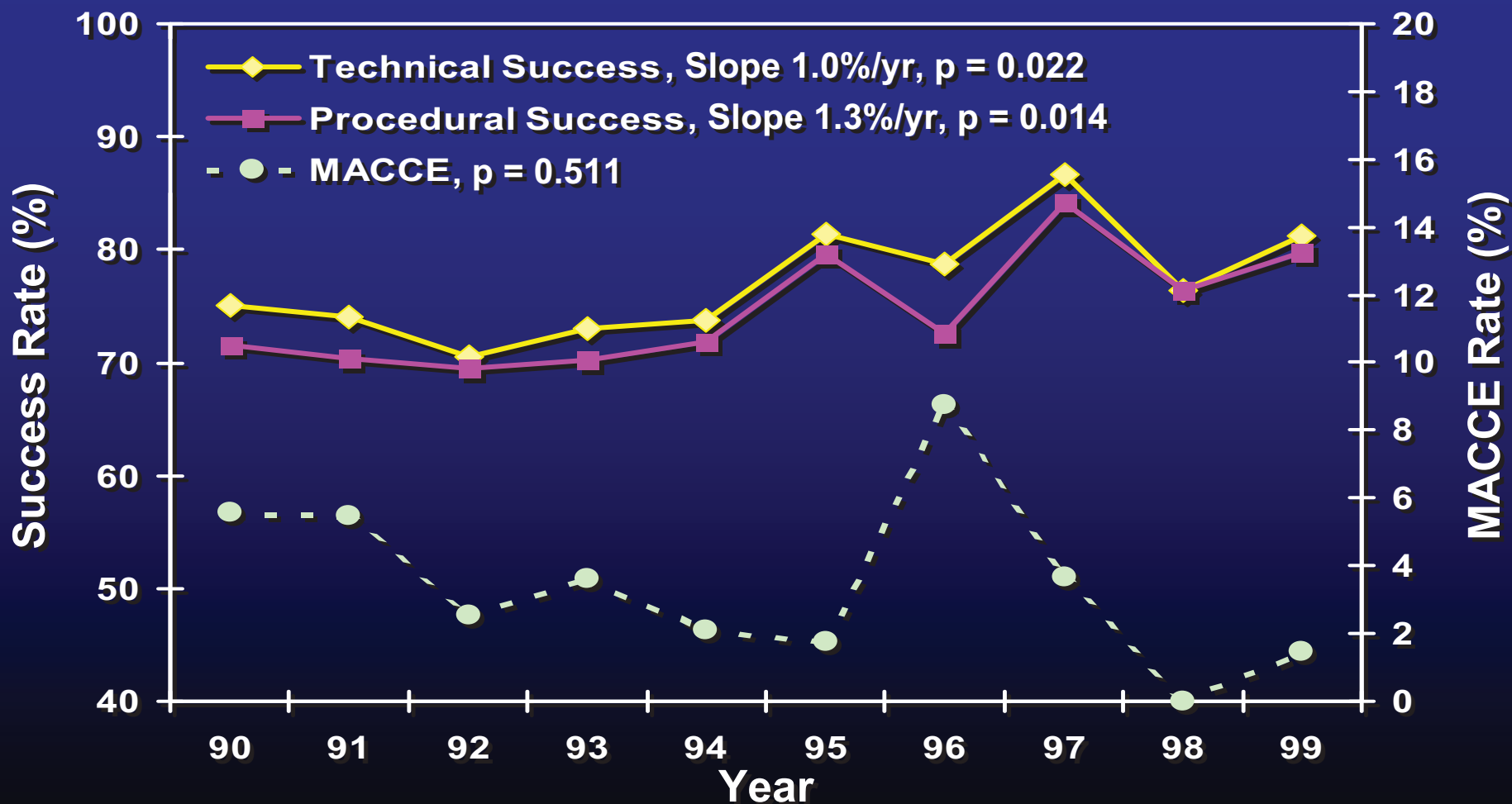
## **Procedural Outcomes and Long-Term Survival Among Patients Undergoing PCI of a CTO: *A 20-Year Experience***

- ♥ June 1980 – December 1999, 2007 consecutive patients underwent PCI of a CTO
- ♥ Utilizing propensity scoring, a matched cohort of 2007 non-CTO patients undergoing elective PCI was identified from the MAHI PTCA database
- ♥ Long-term follow-up was available for 93.6%  
Mean follow-up time:  $91.4 \pm 55.4$  months





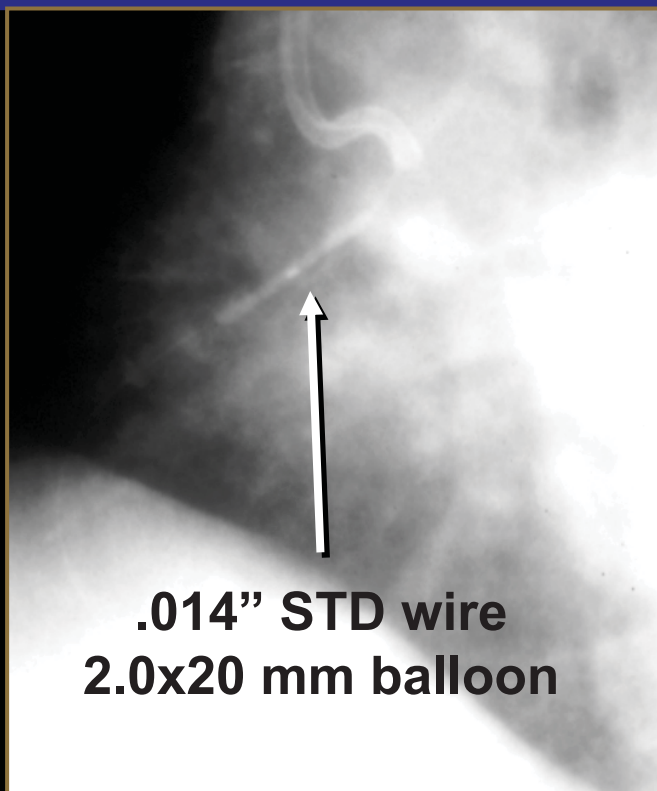
# Procedural Outcomes and Long-Term Survival for PCI of Chronic Total Occlusion



*Mid America Heart Institute Experience*



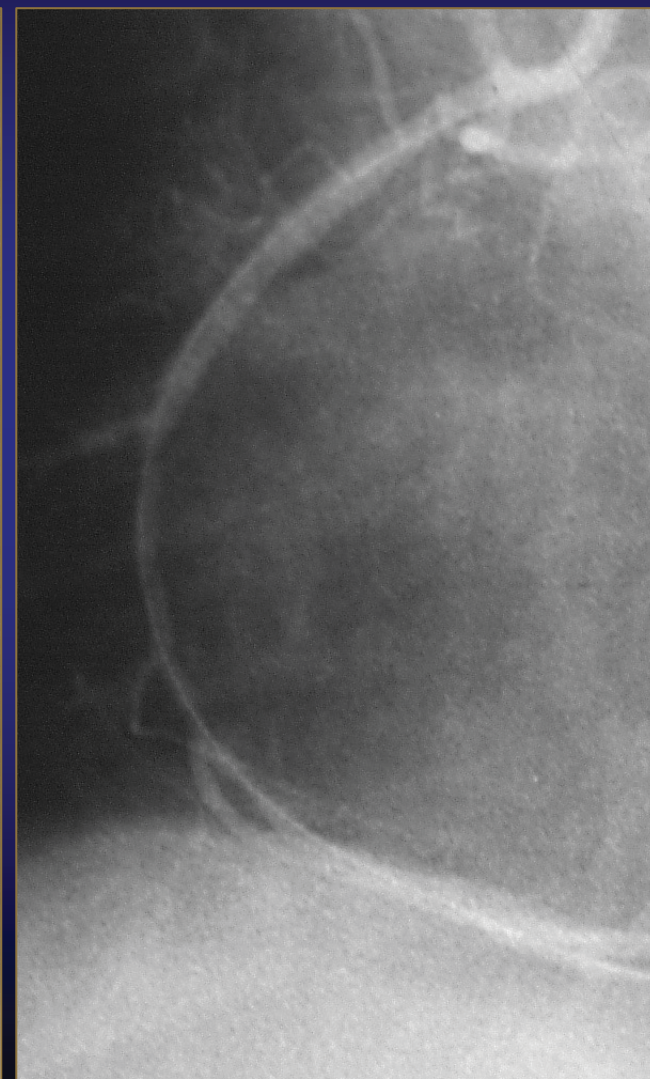
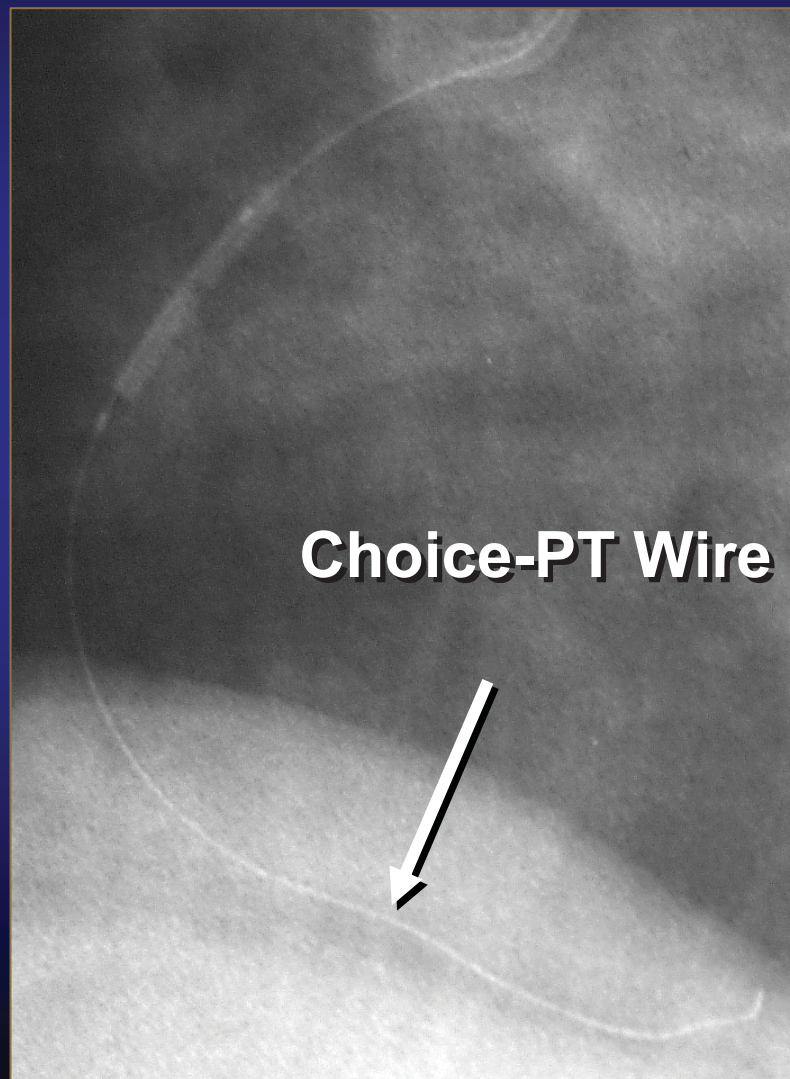
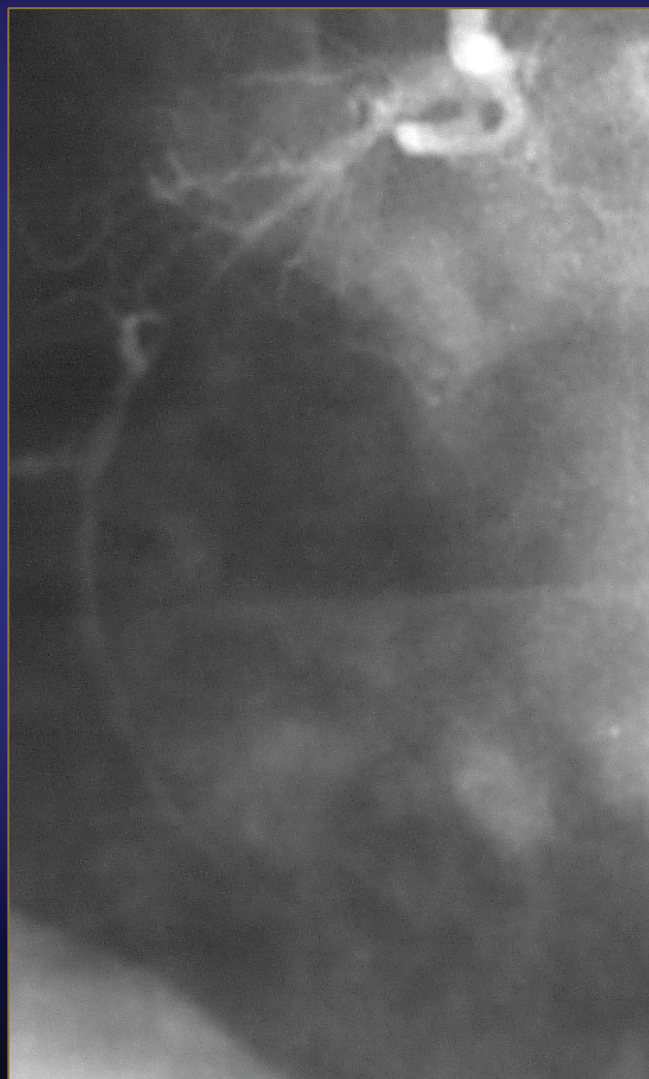
# Documented 13-Year-Old CTO





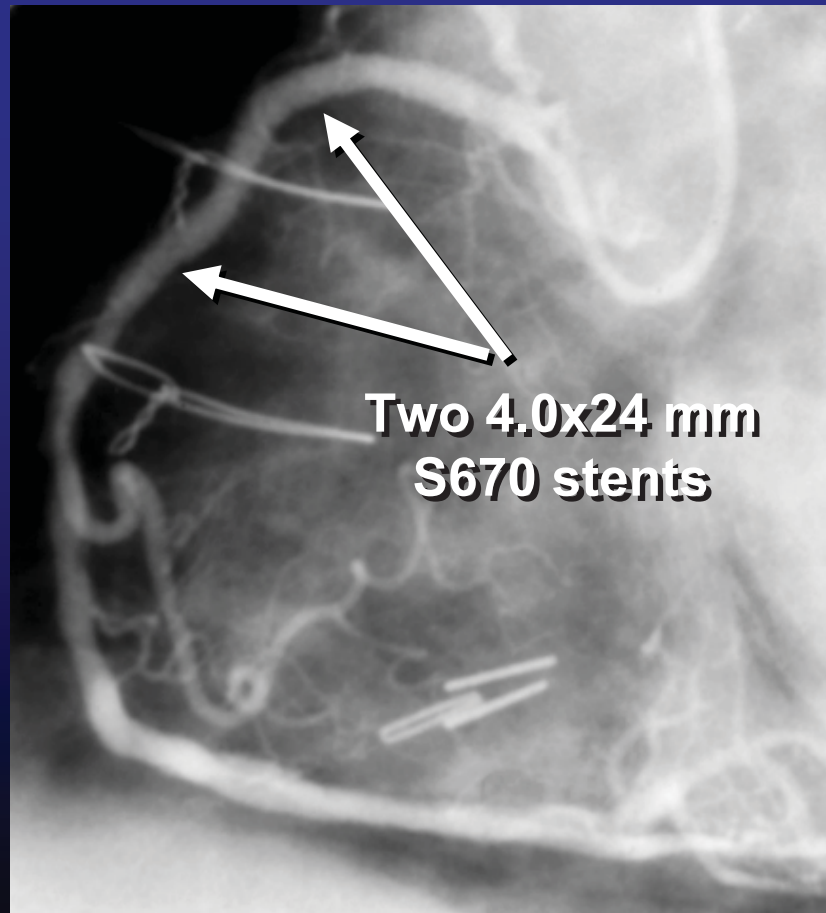
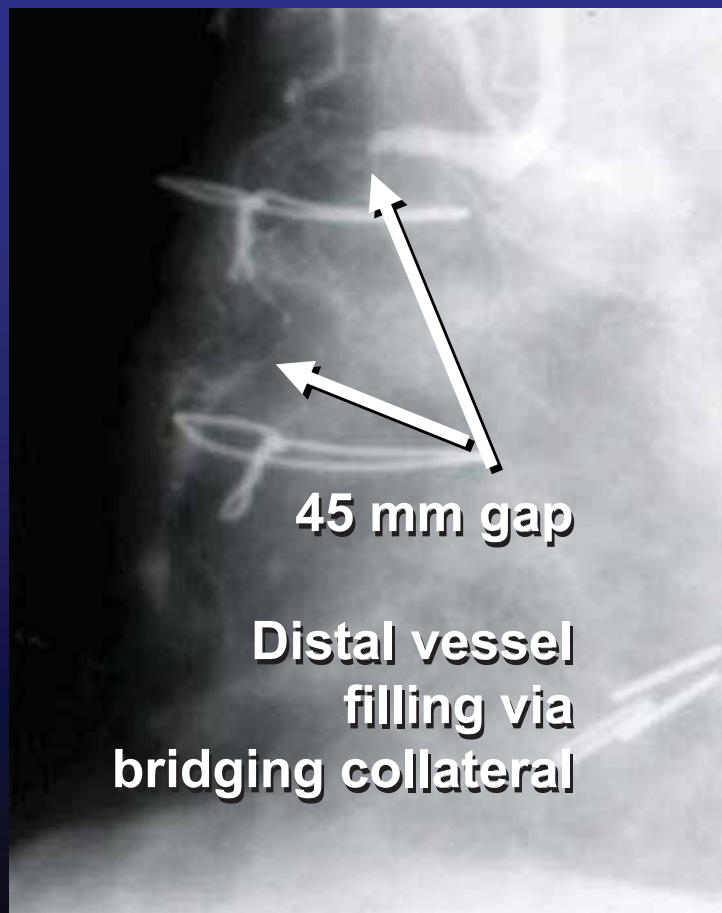


# C.F. 62-Year-Old Female CTO of RCA with Microchannels





# L.H. 61-Year-Old Male CTO of the RCA 24 Months Duration Opened with Shinobi Wire







## Chronic Total Occlusion: In-Hospital Complications

	CTO (n = 2007)	Non-CTO (n = 2007)	P-value
Death	27 (1.3%)	17 (0.8%)	0.13
Q-wave MI	10 (0.5%)	12 (0.6%)	0.67
Non Q-wave MI	38 (1.9%)	48 (2.4%)	0.27
Urgent Re-PCI	15 (0.7%)	22 (1.1%)	0.25
Urgent CABG	30 (1.5%)	40 (2.0%)	0.23
Any dissection	357 (17.8%)	267 (13.3%)	< 0.001
CVA	1 (0.01%)	3 (0.1%)	0.63
Vascular complications	34 (1.7%)	50 (2.5%)	0.08
MACE	76 (3.8%)	75 (3.7%)	0.9

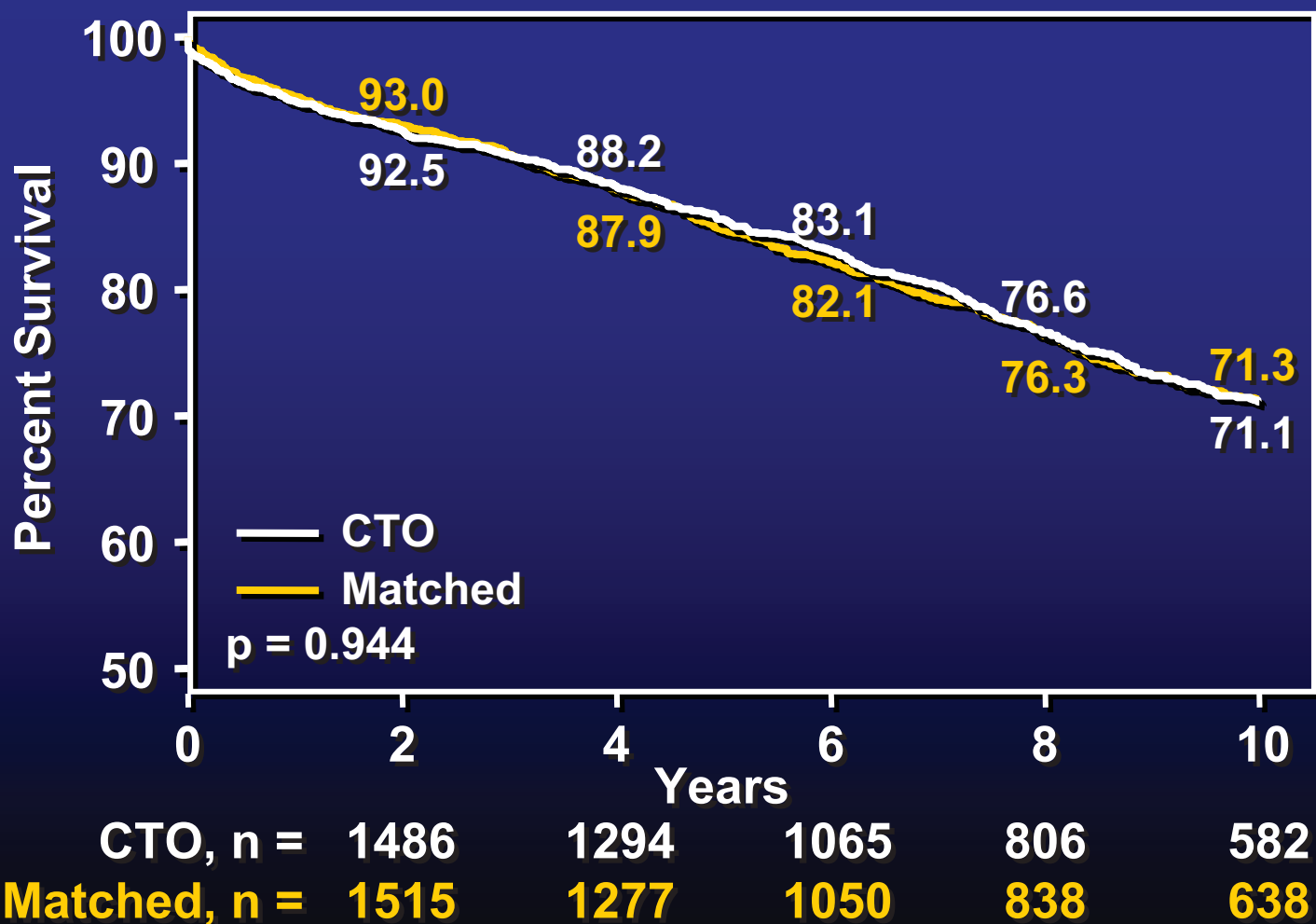


## Chronic Total Occlusion: *In-Hospital Complications*

	CTO Success (n = 1491)	CTO Failure (n = 514)	P-value
Death	15 (1.0%)	12 (2.3%)	0.024
Q-wave MI	6 (0.4%)	4 (0.8%)	0.3
Non Q-wave MI	22 (1.5%)	16 (3.1%)	0.02
Urgent Re-PCI	29 (1.9%)	1 (0.2%)	0.005
Any dissection	255 (17.1%)	102 (19.8%)	0.16
CVA	0 (0%)	1 (0.2%)	0.3
Vascular complications	29 (1.9%)	5 (1.0%)	0.1
MACE	48 (3.2%)	28 (5.4%)	0.023

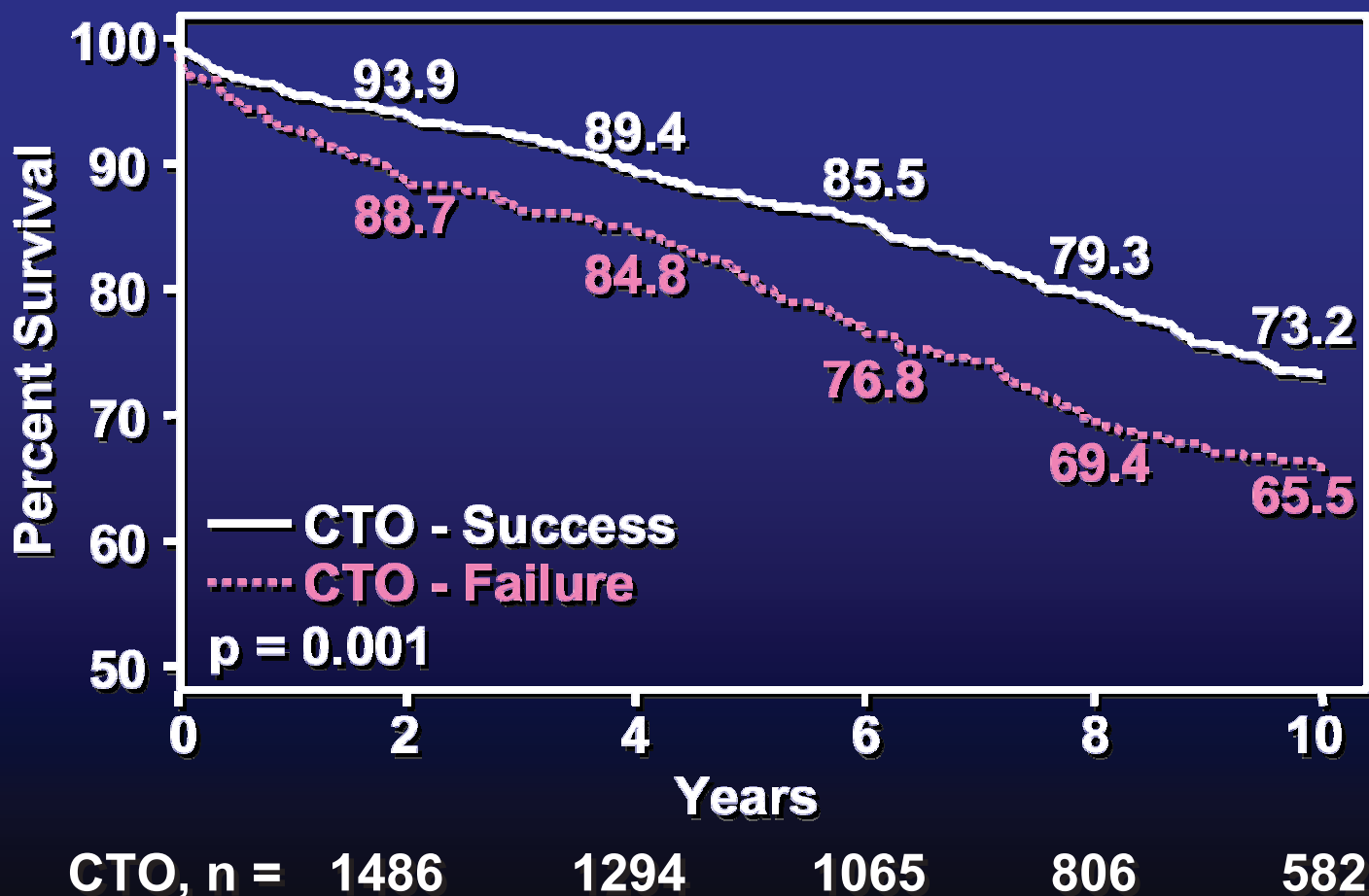


# Procedural Outcomes and Long-Term Survival for PCI of Chronic Total Occlusion





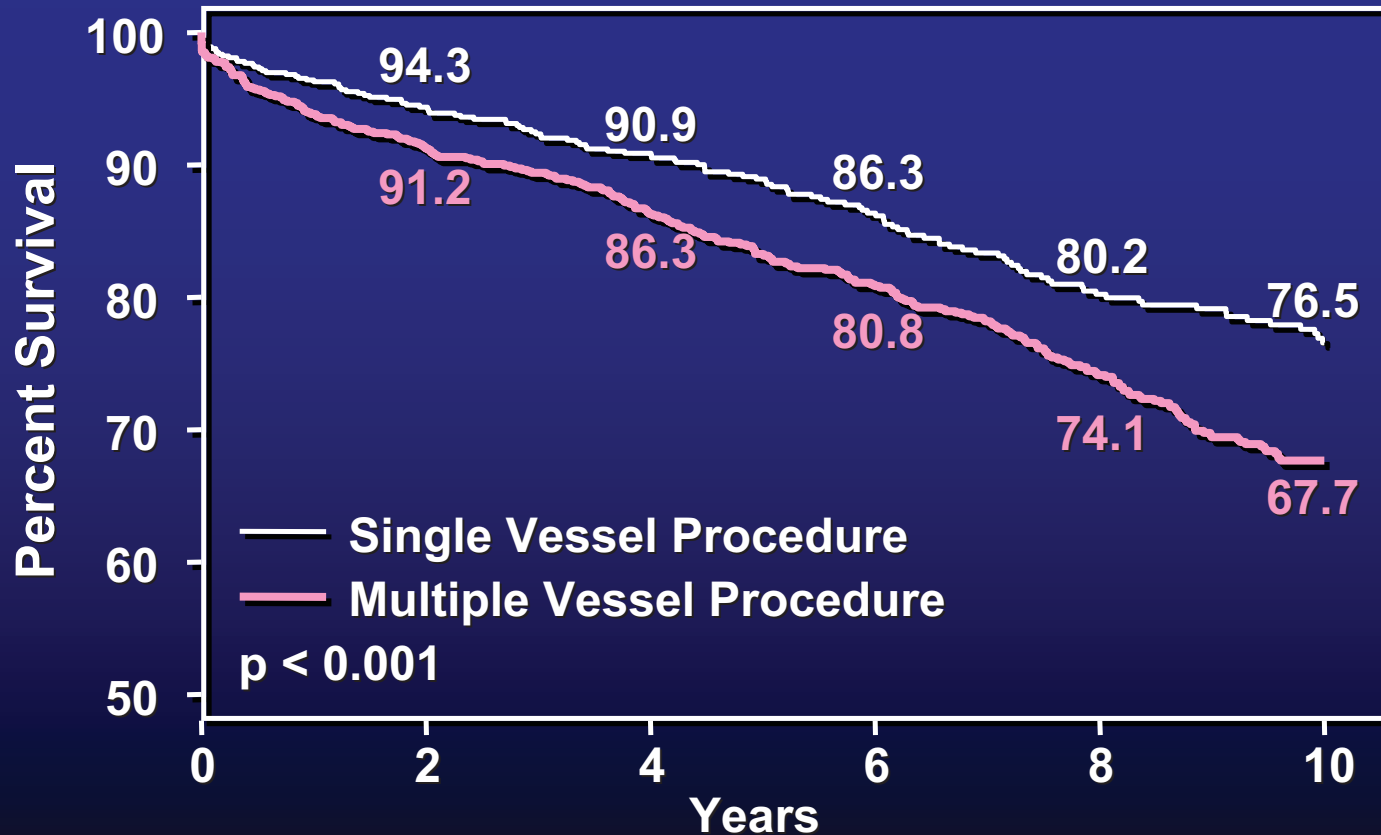
## Procedural Outcomes and Long-Term Survival for PCI of Chronic Total Occlusion







# Procedural Outcomes and Long-Term Survival for PCI of Chronic Total Occlusion

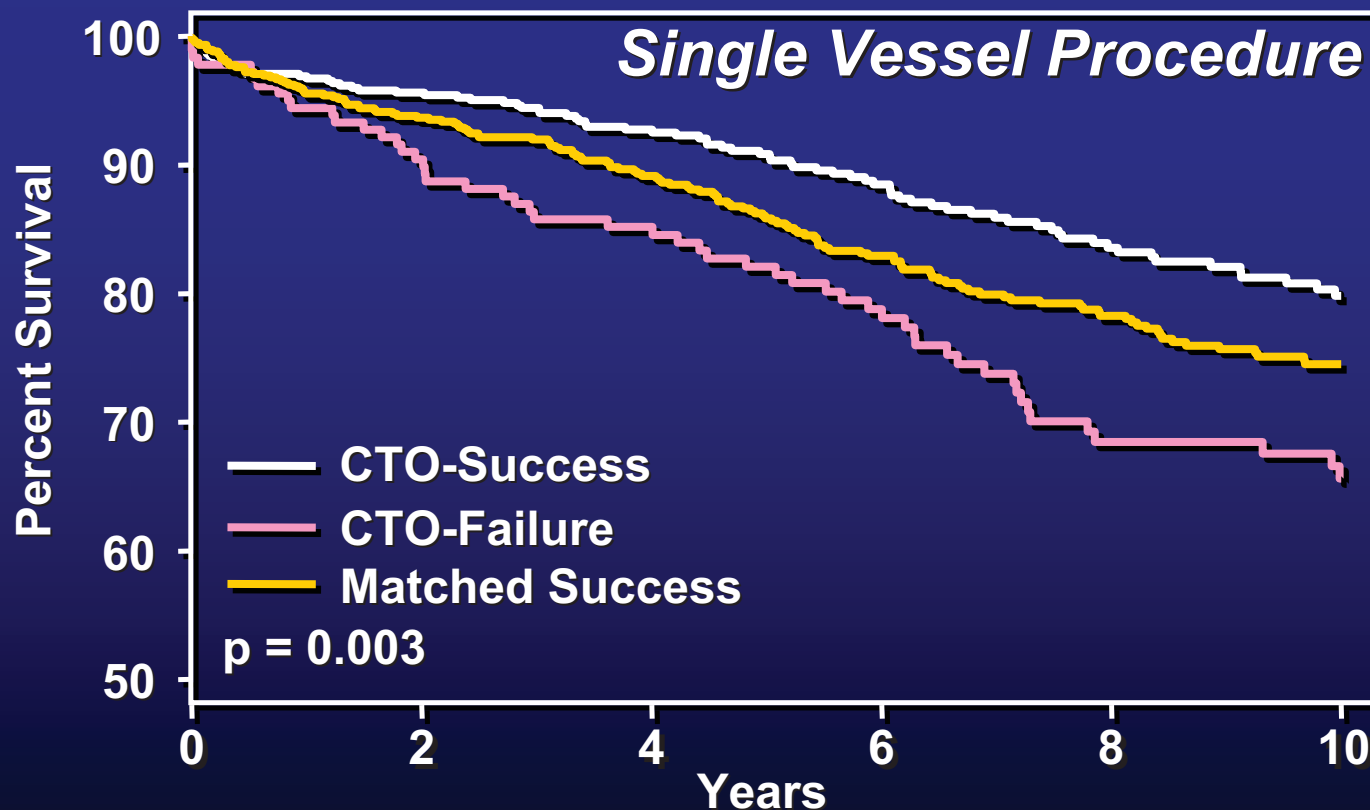


Single Vessel Procedure, n = 628      531      414      307      221

Multiple Vessel Procedure, n = 858      763      651      499      361



# Procedural Outcomes and Long-Term Survival for PCI of Chronic Total Occlusion



CTO-Success %	95.6	92.7	88.5	83.6	80.2
CTO-Failure %	90.4	85.2	78.8	68.5	65.6
Matched Success %	93.7	89.1	82.9	78.3	74.5



## Multivariate Predictors of Survival After PCI of CTO

	Hazard Ratio	95% CI	P-value
CTO Success	0.7	0.5-0.8	< 0.0003
Age > 70 yrs	1.9	1.5-2.4	< 0.001
EF < 40%	2.1	1.7-2.7	< 0.001
Diabetes mellitus	1.4	1.1-1.8	0.004
2-vessel disease	1.5	1.1-2.2	0.02
3-vessel disease	1.9	1.4-2.7	< 0.001
Creatinine > 2.0 mg/dl	2.2	1.3-3.9	0.005
Unstable angina	1.3	1.0-1.6	0.03

# Immediate Results and One-Year Clinical Outcome After PCI in Chronic Total Occlusions

*Data from Multicenter, Prospective Study (TOAST-GISE)*

*June 1999-Jan 2000. 29 Italian centers*

*CTO prevalence in overall PCI population 7.1 ± 2.9%*

*376 pts, 390 CTO's targeted. 89.7% stented*

Technical Success	301 (77.3%)
Procedural Success	286 (73.3%)
Death	1 (0.26%)
Q-Wave MI	1 (0.26%)
Non-Q MI	16 (4.3%)
Urgent CABG	2 (0.53%)
Perforation	8 (2.1%)
In-Hospital MACE	19 (5.1%)



# Immediate Results and One-Year Clinical Outcome After PCI in Chronic Total Occlusions

*Data from Multicenter, Prospective Study (TOAST-GISE)*

## 12-Month Clinical Outcome

	CTO Success N = 286	CTO Failure N = 83	p-value
All deaths	3 (1.05%)	3 (3.6%)	0.13
Cardiac death	1 (0.3%)	3 (3.6%)	0.03
Non fatal Q MI	1 (0.3%)	-	
Non fatal Non Q MI	1 (0.3%)	3 (3.6%)	0.3
Cardiac death/MI	3 (1.0%)	6 (7.2%)	0.005
CABG	7 (2.4%)	13 (15.7%)	< 0.0001
Any TLR	33 (11.5%)	19 (22.9%)	0.01
Any MACE	35 (12.2%)	21 (25.3%)	0.005

*Only MV predictor of MACE free survival was successful opening of CTO*

# One Year Clinical Outcomes After Successful PCI on Chronic Total Occlusions: Results from a Multicenter, Prospective Study (TOAST)

432 pts, 458 CTO's attempted  
Success achieved 77.3%, MACE 2.5%

1-Yr F/U	Single VD		Multiple VD	
	Success N = 167	Failure N = 38	Success N = 149	Failure N = 49
Death	2 (1.2%)	1 (2.6%)	2 (1.3%)	2 (4.1%)
MI (Q/non Q)	2 (1.2%)	-	1 (0.7%)	4 (8.2%)*
Death/QMI	3 (1.8%)	1 (2.6%)	3 (2%)	5 (10.2%)*
TLR	16 (9.6%)	4 (10.5%)	18 (12.1%)	3 (6.1%)
CABG	3 (1.8%)	6 (15.6%)*	7 (4.7%)	11 (22.4%)*
Event Free Survival	143 (85.6%)	27 (71.1%)*	120 (80.5%)	29 (59.2%)*

\*p = 0.01-0.001

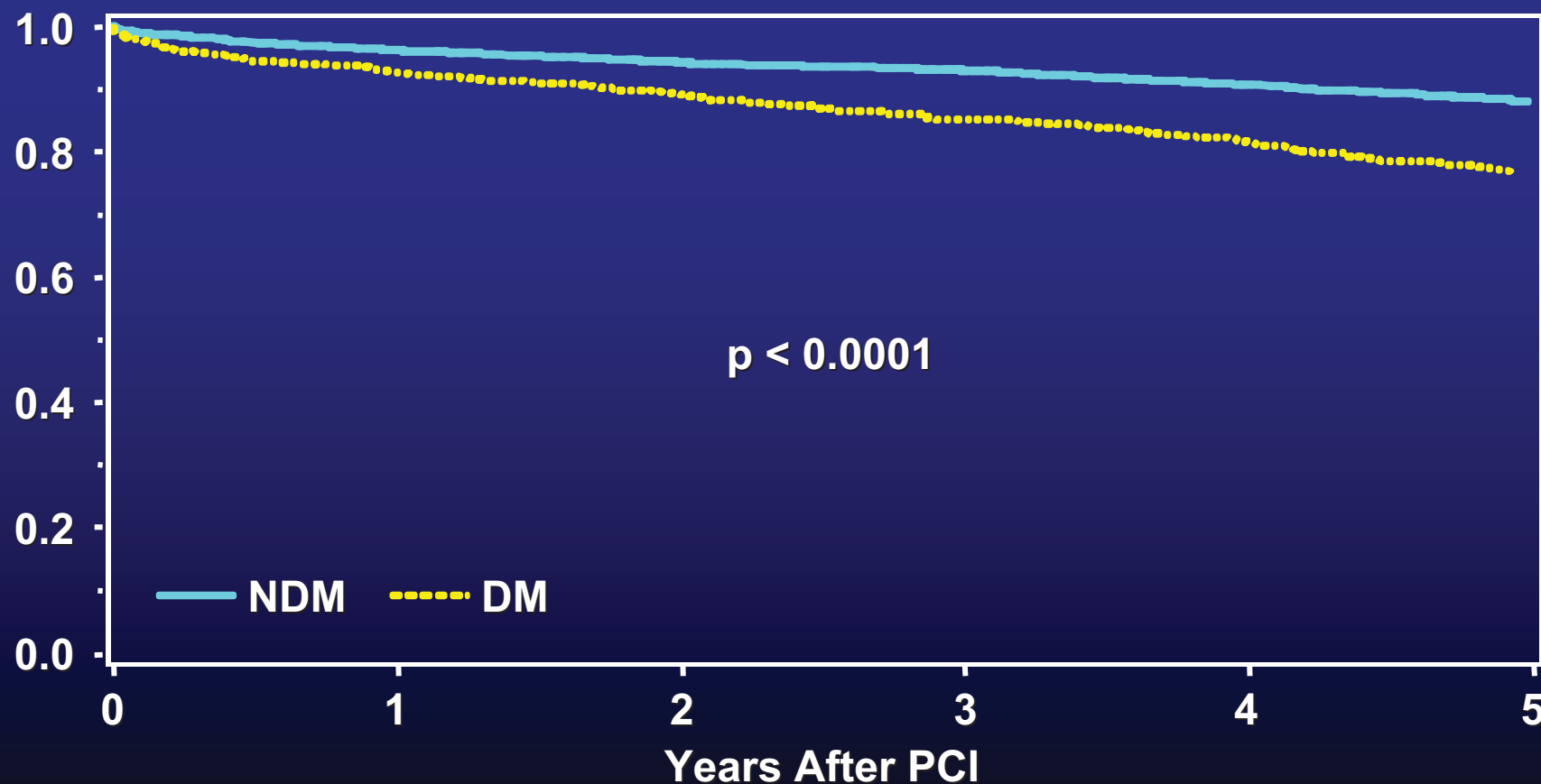
# Successful PCI of CTO is Associated With Significant Survival Benefit in Nondiabetics

*899 pts with CTO, 10-year experience, Cleveland Clinic  
Mean F/U of 4.3 years, SS Death Index*

	Non-Diabetic N = 622	Non-Insulin Diabetic N = 165	Insulin Diabetic N = 112
Successful procedure	316 (51%)	86 (52%)	63 (56%)
Death at F/U	28 (8.9%)	13 (15.1%)	19 (30.2%)
Unsuccessful procedure	306 (49%)	79 (48%)	49 (44%)
Death at F/U	49 (16%)	17 (21.5%)	12 (24.5%)
P-value	0.007	0.32	0.53



# Survival of CTO Patients with Diabetes vs. No Diabetes



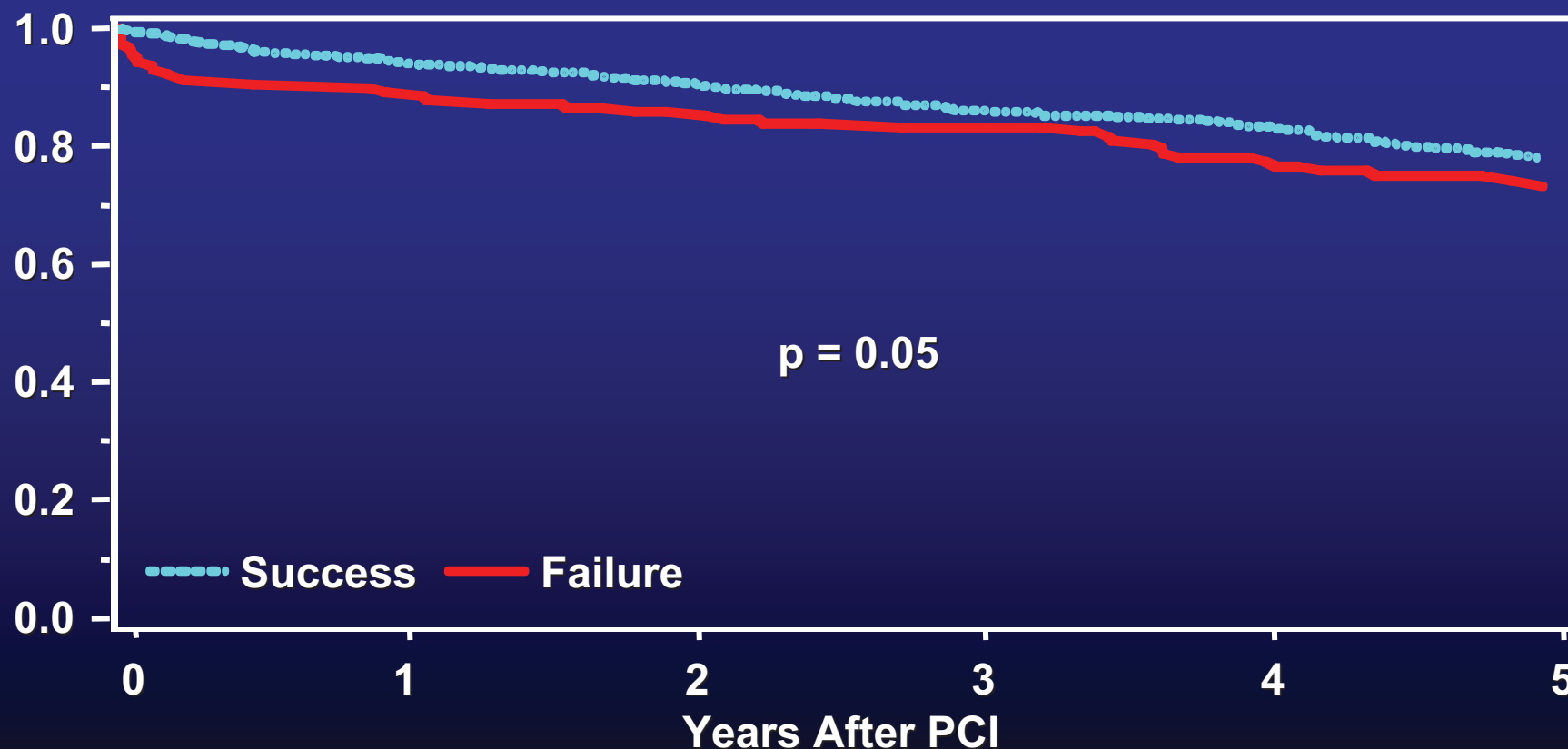
NDM	2085	2005 (96%)	1907 (94%)	1803 (93%)	1677 (91%)	1562 (88%)
DM	591	547 (93%)	503 (89%)	454 (85%)	416 (81%)	361 (77%)

*MAHI 20-Year Experience*





## Survival of Diabetic Pts with CTO Procedural Success vs. Those Without Success



Success	434	407 (94%)	376 (91%)	337 (86%)	315 (83%)	275 (78%)
Failure	157	139 (89%)	126 (85%)	115 (82%)	100 (77%)	85 (72%)

MAHI 20-Year Experience



## **Procedural Outcomes and Long-Term Survival Among Patients Undergoing PCI of a CTO: A 20-Year Experience**

### ***Conclusions:***

- ♥ **Striking long-term survival advantage with a successfully opened occluded artery (73.2% vs 65.5%,  $p = 0.001$ )**
- ♥ **Supports a concept of time independent benefit of reperfusion**
- ♥ **Similar 10-year survival for successful CTO and matched cohort of non-CTO vessels. Superior survival in SV disease.**
- ♥ **Statistically significant increase in technical and procedural success over the last 10 years**
- ♥ **No significant increase in MACCE rates**



## **Procedural Outcomes and Long-Term Survival Among Patients Undergoing PCI of a CTO: A 20-Year Experience**

### ***Conclusions (cont.):***

- ♥ **Multivessel intervention can be attempted at the same setting of opening a CTO without significantly increasing MACCE or LOS, compared to an SV procedure**
- ♥ **Survival of diabetic pts with CTO lower than non-diabetics. However, successful PCI of CTO improves survival regardless of diabetic status**
- ♥ **No difference in resource utilization between CTO and matched non-CTO cohorts. Offset by individual patient risk factors**
- ♥ **These data support an aggressive attempt to open chronically occluded vessels**