Controversies of Percutaneous Coronary Intervention in Complex Lesions ; Interventional Strategy in Coronary Chronic Total Occlusion with Good Collaterals

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CTO (Chronic Total Occlusion)

1. Definition

; The duration of occlusion (TIMI 0 or 1) was ≥ 3 months

2. Clinical Significance/Challenging Points

1) Definite clinical benefits of revascularization
2) Lower procedural success rate
3) High clinical and angiographic restenosis rate

CTOs in Real World Clinical Practice

1. Approx 30% of all coronary angiograms.
2. PCI of CTOs; 10-20% of all PCI activity.
3. The presence of CTO; the commonest reasons for referral for CABG.
4. Many CTOs are left untreated due to the uncertainty regarding procedural success and long-term benefit…

Azis S. et al. CCI 2007 70;15-20

Epidemiology; More CTO Factoids

1. Prevalence of CTO increases with age for RCA and LAD

2. CTO post STEMI:

No PCI/thrombolysis	45% at 1 month
Thrombolysis	30% at 3-6 months
PCI	5-10% at 7 months

3. May have little or no symptoms but + stress imaging.

Stone et al Circ 2005;112:2364

PCI for CTO in Stable Angina

1. Class IIa Level of evidence C. Be aware of possible side branch occlusion and perforation. Eur Soc Cardiol Eur Heart J 2005;26:804

2. CTO (>3 months and/or bridging collaterals) considered high risk lesion type (for technical failure/restenosis). Would qualify as type IV lesion. ACC/AHA/SCAI Circulation 2006;113:e166

Is CTO PCI Risk Free?

	CTO%	N-CTO%
Death	1.3	0.8
MI	2.4	3.0
Q	0.5	0.6
Non-Q	1.9	2.4
Urgent CABG	0.7	1.1
Urgent PCI	1.5	2.0
MACE	3.8	3.7
Stroke	0.01	0.1
Vascular Comp	1.7	2.5

*ALL P = NS

Stone et al. Circ 2005;112:2530

Rentrop Classification of Collateralization

1. Grade 0 No visible collateral vessels
2. Grade 1 Faintly visible collaterals to branches but no filling of the recipient parent epicardial artery
3. Grade 2 Collaterals with partial filling of the recipient artery
4. Grade 3 Complete filling of the recipient artery.

Coronary Steal in CTO

1. Pts with CTO and collateral dependent circulation are subject to coronary steal during microvascular vasodilatation.

2. Usually accompanies donor arterial obstruction but may also result from lack of vasodilatory reserve of distal recipient circulation.

3. This may result in left ventricular dysfunction.

Werner et al. JACC 2006;48:51

Opening the CTO

1. Rapid ‘de-recruitment’ of collaterals after stenting such that ischemia brought on by subsequent balloon occlusions is less well tolerated.

2. This may place the patient at risk if there is sudden re-occlusion of the intervened upon artery.

Zimarino et al JACC 2006;48:59

Clinical Characteristics and Midterm Outcomes of Chronic Total Coronary Occlusion Intervention According to the Different Collateral Grades

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TCT AP 2010

Background

1. Chronic total occlusion (CTO) intervention is still challenging because of the limited procedural success rate and higher target failure.

2. It is not clear whether different collateral grade will have impact on the angiographic and clinical outcomes of CTO intervention in drug eluting stent (DES) era.

Purpose

We investigated whether there are differences in Clinical Characteristics and Midterm Outcomes of Chronic Total Coronary Occlusion Intervention According to the Different Collateral Grades.

Methods

1. Study Population

; A total of 177 patients (pts) underwent CTO intervention were divided into the two groups according to grade of collaterals from June 2004 to June 2009.

Collateral grade 2,3 : n=99 pts

Collateral grade 1 : n=78 pts

2. Study Definition

1) CTO; Total occlusion (TIMI 0-1), for longer than 3 months from the onset of occlusion)
2) Multi-vessel disease; two or more target vessels.

Methods

3) The collateral vessels were graded according to the Rentrop classification.

a) Grade 0 is non filling of collateral channel.

b) Grade 1 is barely detectable filling of collateral channels without opacification of the occluded artery.

c) Grade 2 is partial filling of the CTO artery.

d) Grade 3 is brisk flow that fills the CTO artery completely. In-hospital and 6-month outcomes were compared between the 2 groups.

Angiographic and Clinical Outcomes at 6 months

Variables, n (%)	Collateral grade 2,3 (n = 99 pts)	Collateral grade 1 (n = 78 pts)	P Value
Previous_MI	16 (15.7)	13 (16.7)	1.00
Success rate	98 (97)	70 (90.9)	0.10
Binary stenosis	23 (23.2)	23 (29.4)	0.68
Late loss (mm, mean ± SD)	0.52 ± 0.55	0.70 ± 0.63	0.36
Cardiac death	0 (0.0)	0 (0.0)	1.00
Total death	0 (0.0)	1 (1.5)	0.45
Q-wave MI	0 (0.0)	1 (1.5)	0.45
TLR	2 (2.5)	6 (9.1)	0.14
TVR	3 (3.8)	6 (9.1)	0.62
All MACE	4 (5.1)	6 (9.1)	0.51

Results

1. The baseline clinical characteristics were similar between the two groups.

2. The overall procedural success rate was similar between the two groups (98% vs 97.9%, p=0.10).

3. Procedural characteristics and procedure related complication were not different between two groups.

Results

4. At 6 months, these two groups had similar clinical outcomes and angiographic outcomes including the rate of binary restenosis, late loss, death, Q-MI, TVR and MACE (Table).

Conclusions

1. CTO intervention in the setting of different collateral grade showed similar safety profile, procedural success rate, complication rate and mid-term outcomes, possibly due to high procedural success rate by improved devices, technical development and the DES usage.

2. Long-term follow up with larger population will be necessary to get the clear conclusion.

My Concept regarding Good Collaterals in Patients with CTO

1. 'collateral is just collateral' by Dr Rha SW and Well-developed collaterals cannot replace optimal global perfusion by intact epicardial artery and metabolic requirements of offending myocardium.

2. 지방도로, 국도가 그럭저럭 해도 확실한 고속도로만 못하고, 장거리를 갈 수록 더 그렇다....

Why I Attempt PCI on CTOs?

1. Presence of symptoms
2. Improve left ventricular function
3. Improve Survival & Prognosis
4. Complete revascularization (CABG to PCI)
5. Because of the challenge; “Last Frontier”
6. Radiation badge had low reading last month
7. Other Reasons….

Late Percutaneous Coronary Intervention for the Totally Occluded Infarct-Related Artery: A Meta-Analysis of the Effects on Cardiac Function and Remodeling

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Background: Late percutaneous coronary intervention (PCI) of a totally occluded infarct-related artery (IRA) in stable patients is currently not recommended based on the lack of clear clinical benefits in randomized controlled trials. We sought to perform a systematic review and meta-analysis of randomized controlled trials comparing PCI with optimal medical therapy in patients with IRA occlusion more than 12 hr after onset of acute myocardial infarction (AMI), focusing on left ventricular function and remodeling. **Methods and Results:** PubMed, CENTRAL, and mRCT were searched for eligible studies. Studies were included in the analysis if they were randomized controlled trials comparing conservative medical management with PCI performed at least 12 hr after the onset of symptoms of AMI, and data on left ventricular ejection fraction (LVEF) at baseline and follow-up were available. Studies were excluded if randomization occurred less than 12 hr after symptom onset, or if patients were hemodynamically unstable. Change in LVEF was the primary outcome of interest, with changes in left ventricular end-diastolic volume index (LVEDVI) and end-systolic volume index (LVESVI) analyzed as secondary endpoints. We retrieved five studies in which baseline and follow up LVEF data were available enrolling a total of 646 patients: 342 patients randomized to PCI and 306 to medical treatment. There was a statistically significant difference in LVEF changes over time favoring PCI (+3.1%, 95% CI +1.0 to +5.2, $P = 0.003$). In addition, there were statistically significant differences changes in both LVEDVI (−5.1 ml in favor of PCI, 95% CI of −9.4 to −0.8, $P = 0.020$) and LVESVI (−5.3 ml in favor in PCI, 95% CI of −8.3 to −2.4, $P = 0.0005$). **Conclusions:** This meta-analysis suggests that late revascularization of an occluded IRA may improve left ventricular systolic function and remodeling, supporting the "open artery hypothesis." The reason why these changes have not resulted in clinical benefits in large clinical trials is subject to debate.

Key words: meta-analysis; myocardial infarction; late; revascularization; percutaneous coronary intervention; total occlusion; remodeling

CCI 71;772-781 (2008)

Evaluation of Left Ventricular Function Three Years After Percutaneous Recanalization of Chronic Total Coronary Occlusions

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We investigated early and late effects of percutaneous revascularization for chronic total coronary occlusion on left ventricular (LV) function and volumes. Magnetic resonance imaging was performed in 21 patients before and 5 months and 3 years after recanalization. Global LV function and volumes and segmental wall thickening (SWT) were quantified on cine images. The 2 viability indexes used were the transmural extent of infarction (TEI) on delayed contrast enhancement images and end-diastolic wall thickness at baseline. Significant decreases in mean end-diastolic (86 ± 14 to 78 ± 15 ml/m^2; p = 0.02) and mean end-systolic volume indexes (35 ± 13 to 30 ± 13 ml/m^2; p = 0.03) were observed 3 years after recanalization. Mean ejection fraction tended to improve (60 ± 9% to 63 ± 11%; p = 0.11). SWT significantly increased at 5-months' follow-up (p <0.001), and an additional improvement was found at 3 years' (p = 0.04) follow-up in segments with TEI <25%. In segments with TEI of 25% to 75%, SWT was unchanged at 5-month follow-up (p = 0.89), but improved at 3 years (p = 0.04). SWT was unchanged in segments with transmural scars. For segmental functional recovery, TEI was a better predictor than end-diastolic wall thickness at baseline (odds ratio 5.6, 95% confidence interval 1.5 to 21.1, p = 0.01 vs odds ratio 2.5, 95% confidence interval 0.7 to 8.3, p = 0.14). In conclusion, a positive effect on LV remodeling and ejection fraction was observed up to 3 years after recanalization. Both early and late improvements in regional LV function were observed in the perfusion territory of chronic total coronary occlusion and were related to the transmural extent of infarction on pretreatment magnetic resonance imaging. (Am J Cardiol 2008;101:179–185)

AJC 2008;101:179-185

Percutaneous Coronary Intervention for Chronic Total Occlusions: Improved Survival for Patients with Successful Revascularization Compared to a Failed Procedure

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Background: There are limited data on the impact of successful chronic total occlusion (CTO) revascularization by percutaneous coronary intervention (PCI) on survival. We performed a retrospective study comparing the survival between patients with a successful and a failed CTO revascularization by PCI. Methods: Between January 1, 2000 and June 30, 2004, 543 of 5803 (9.4%) patients underwent PCI for a CTO at our center. A CTO was defined as an occlusion of the artery present for at least 3 months with Thrombolysis in Myocardial Infarction flow grade 0 or 1. Patient records were linked to a national database to monitor all deaths during follow up. Propensity matching was used to balance out case mix differences. Results: Technical success for CTO was 377 of 543 (69.4%). In-hospital mortality was 0.3% and 1.2% for the CTO success and CTO failure patients, respectively. During a mean (SD) follow up of 1.7 (0.5) years, the mortality rate was 2.5% in the CTO success patients and 7.3% in the CTO failure patients. The crude hazard ratio for death with CTO failure was 3.92 (95% confidence intervals 1.56–10.07; $P = 0.004$). The rates of coronary artery bypass were 3.2% vs. 21.7% ($P < 0.001$) for the CTO success and CTO failure patients, respectively. Our propensity matched 157 CTO success to CTO failure patients and the associated hazard ratio for death with CTO failure was 4.63 (95% confidence interval 1.01–12.61; $P = 0.049$). Multivariate analysis showed that CTO failure was an independent predictor of death. Conclusion: Patients with a successful revascularization of a CTO by PCI have an increased survival rate compared to patients with a failed CTO procedure.

Key words: chronic total occlusion; angioplasty; stents

CCI 2007, 70;15-20

Survival Benefit

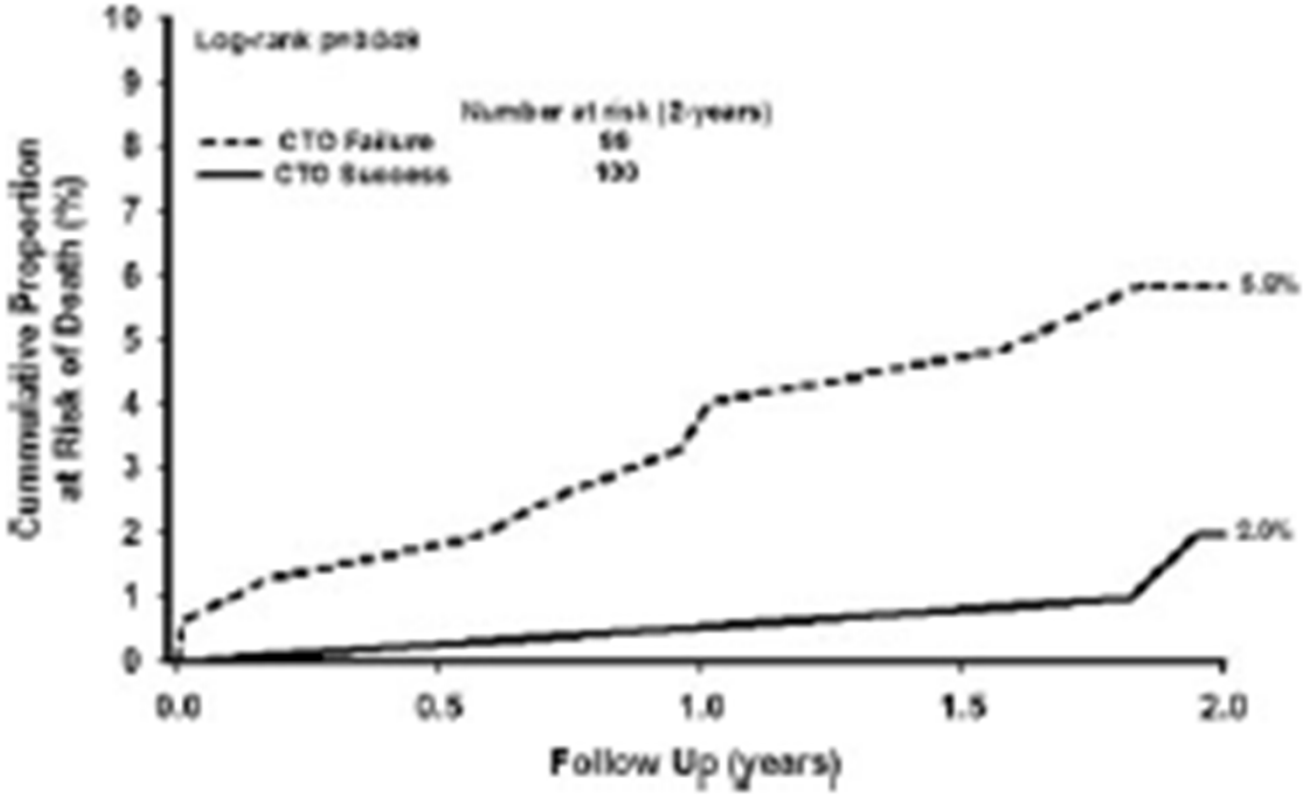

Fig. 2. Mortality curves for CTO success and CTO failure patients in the propensity matched groups.

European Heart Journal (2008) 29, 2336–2342
doi:10.1093/eurheartj/ehn357

CLINICAL RESEARCH
Interventional cardiology

Impact of complete revascularization with percutaneous coronary intervention on survival in patients with at least one chronic total occlusion

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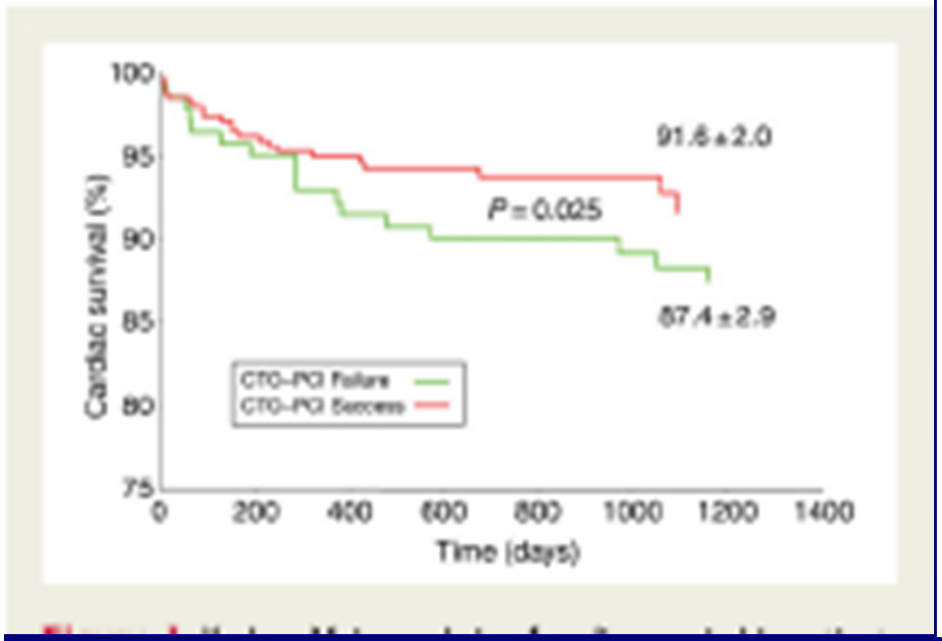
Aims This study sought to determine the impact on survival of successful drug-eluting stent-supported percutaneous coronary intervention (PCI) for chronic total occlusion (CTO).

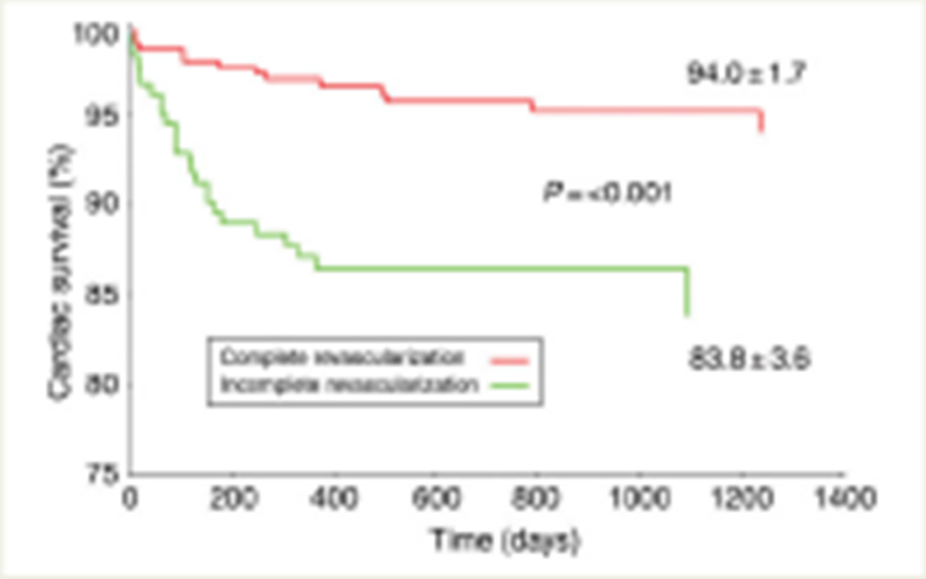
Methods and results Comparison of long-term cardiac survival of consecutive patients who underwent PCI for at least one CTO and who were stratified into successful and failure procedures. From 2003 to 2006, 486 patients underwent PCI for 527 CTO. CTO–PCI was successful in 344 patients (71%) and 361 lesions (68%). Multivessel PCI was performed in 62% in the CTO–PCI failure group and in 71% in the CTO–PCI success group ($P = 0.062$). Cardiac survival rate was higher in the CTO–PCI success group compared with CTO–PCI failure group (91.6 ± 2.0 vs. $87.4 \pm 2.9\%$; $P = 0.025$), in patients with multivessel disease and CTO–PCI success compared with CTO–PCI failure (91.4 ± 2.2 vs. $86.6 \pm 3.1\%$; $P = 0.021$), and in patients with complete revascularization when compared to patients with incomplete revascularization (94.0 ± 1.7 vs. $83.8 \pm 3.6\%$; $P < 0.001$).

Conclusion Successful CTO–PCI confers a long-term survival benefit. Improvement in survival is driven by the differences in the outcome of patients with multivessel disease and who were completely revascularized.

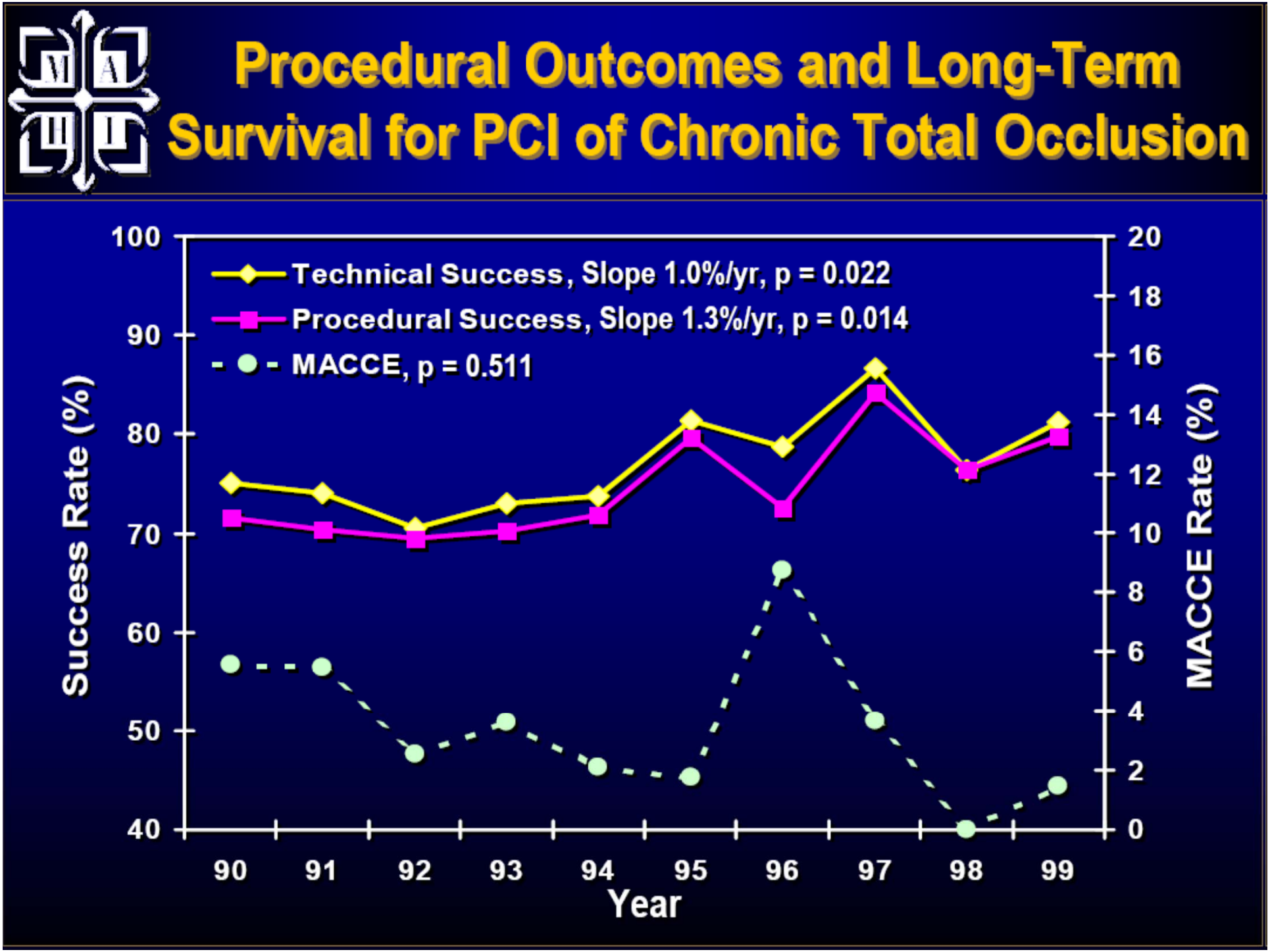
Keywords Percutaneous coronary intervention • Chronic total occlusion • Drug-eluting stent

Survival Benefits





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



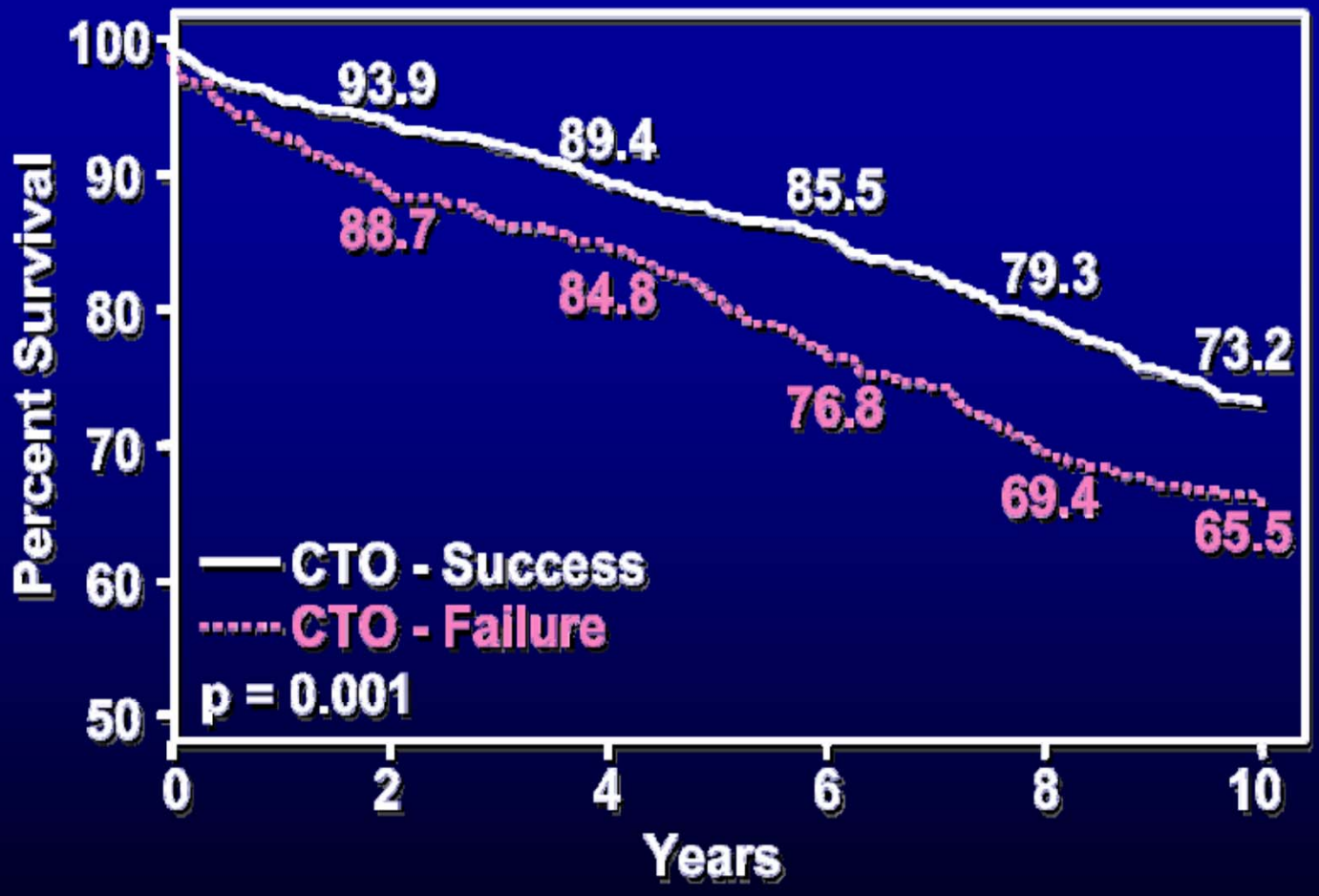
Chronic Total Occlusion:
In-Hospital Complications

	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

Multivariate Predictors of Survival After PCI of CTO

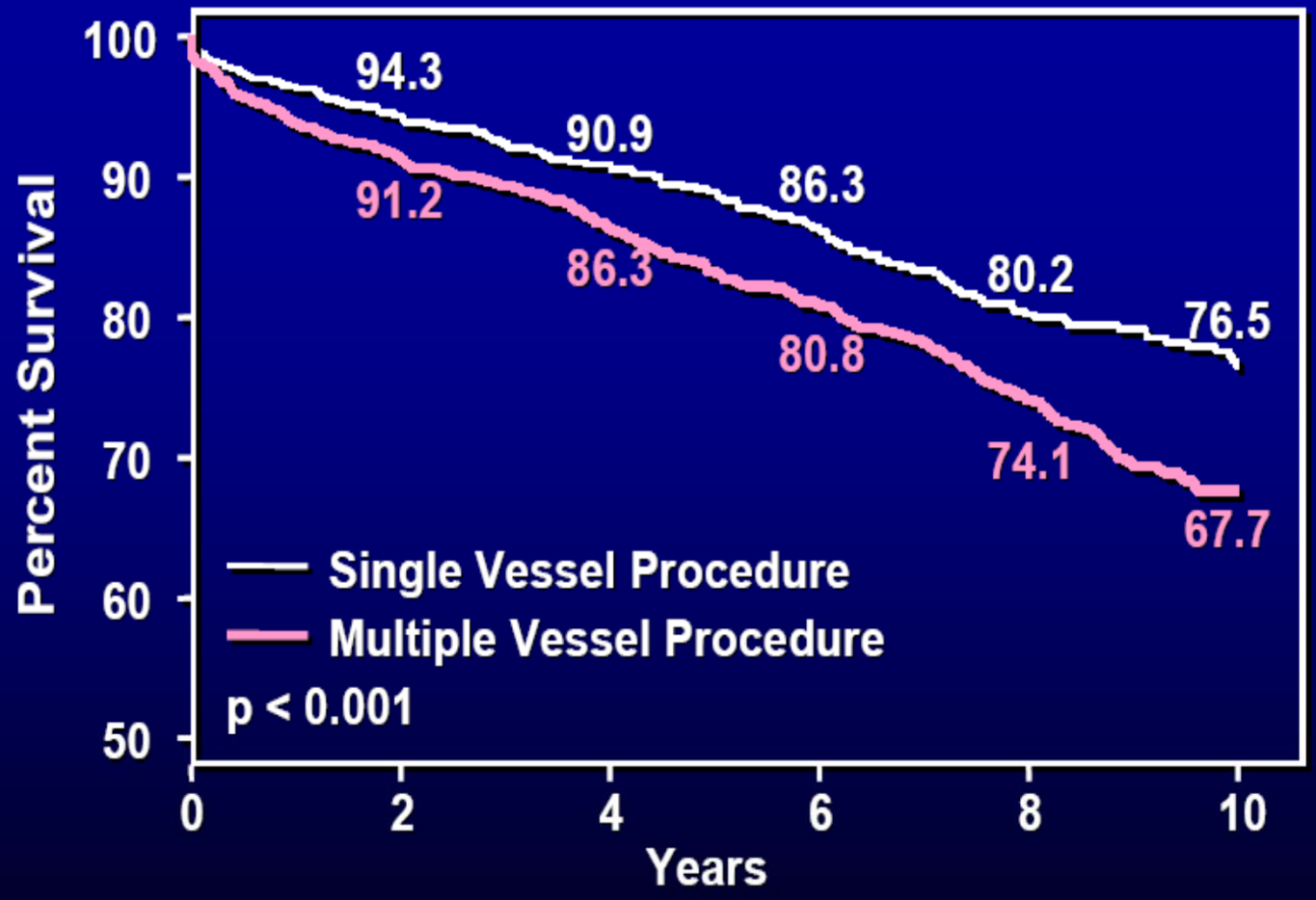
	Hazard Ratio	95% CI	P-value
CTO Success	0.7	0.5-0.8	< 0.0003
Age > 70 yrs	1.9	1.5-2.4	< 0.001
EF < 40%	2.1	1.7-2.7	< 0.001
Diabetes mellitus	1.4	1.1-1.8	0.004
2-vessel disease	1.5	1.1-2.2	0.02
3-vessel disease	1.9	1.4-2.7	< 0.001
Creatinine > 2.0 mg/dl	2.2	1.3-3.9	0.005
Unstable angina	1.3	1.0-1.6	0.03

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



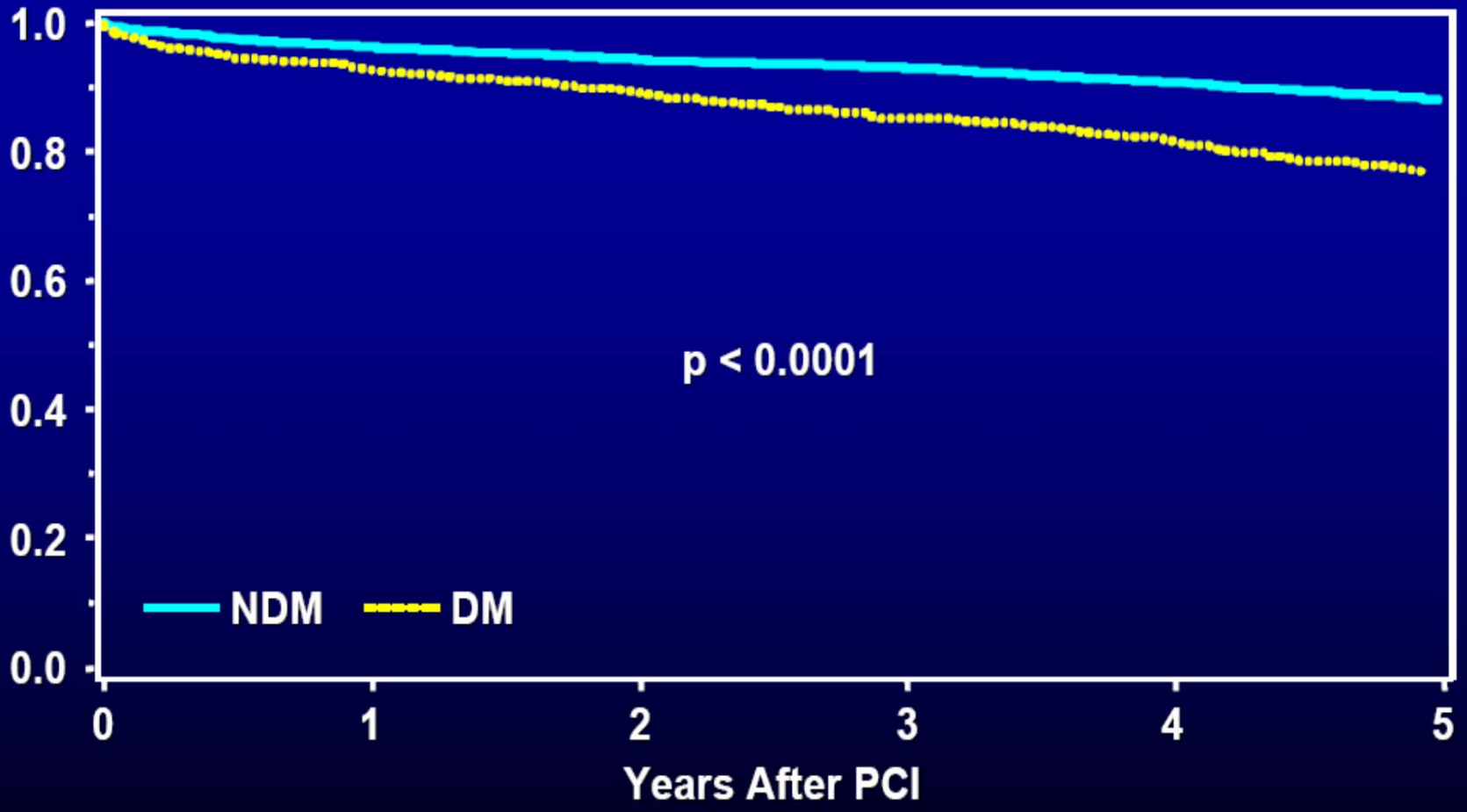
CTO, n =	1486	1294	1065	806	582

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

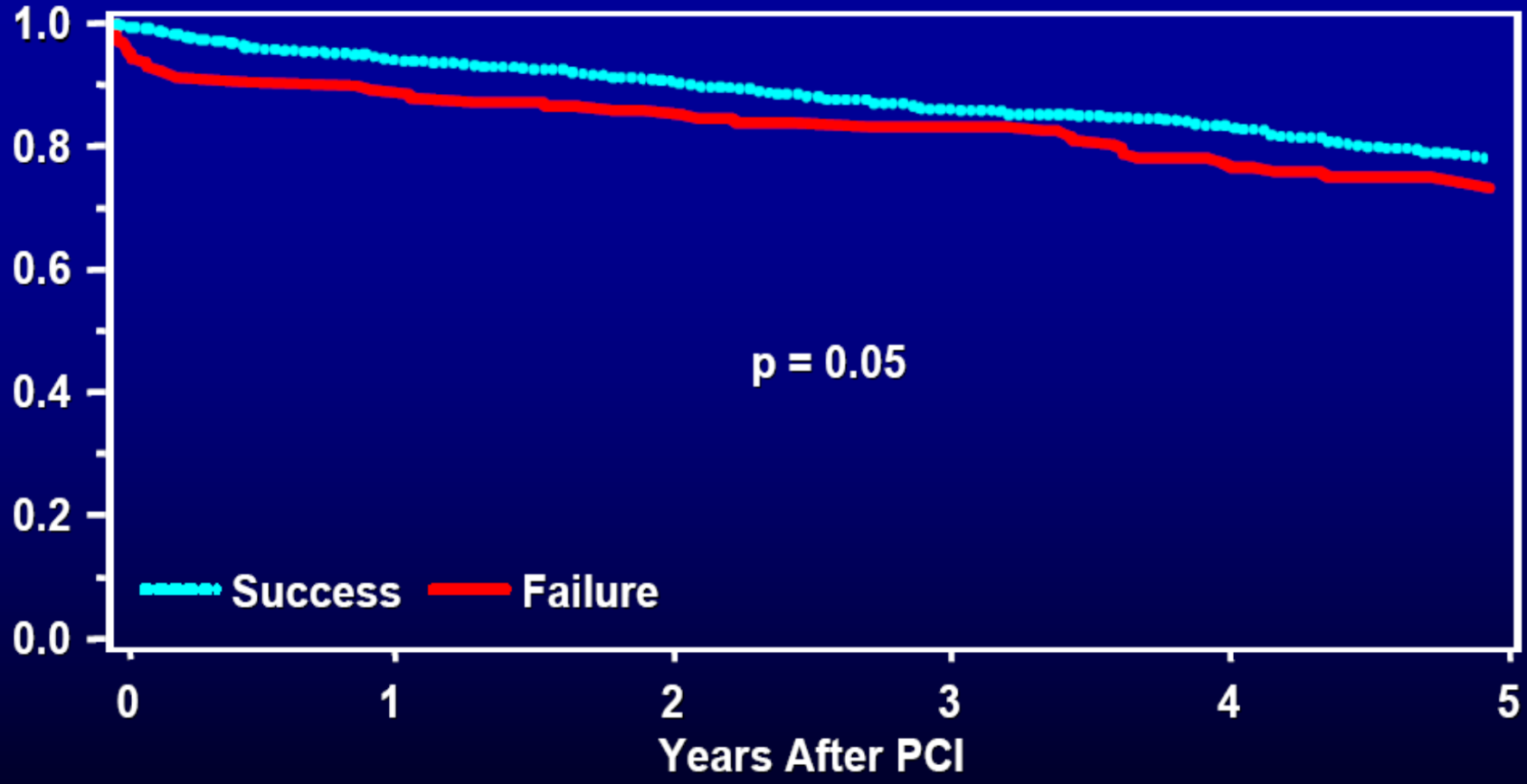
Survival of CTO Patients with Diabetes vs. No Diabetes



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

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%)

Olivari et al. JACC 2003;41:1672

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

Olivari et al. JACC 2003;41:1672

One Year Clinical Outcomes After Successful PCI on Chronic Total Occlusions:

Results from a Multicenter, Prospective Study (TOAST)

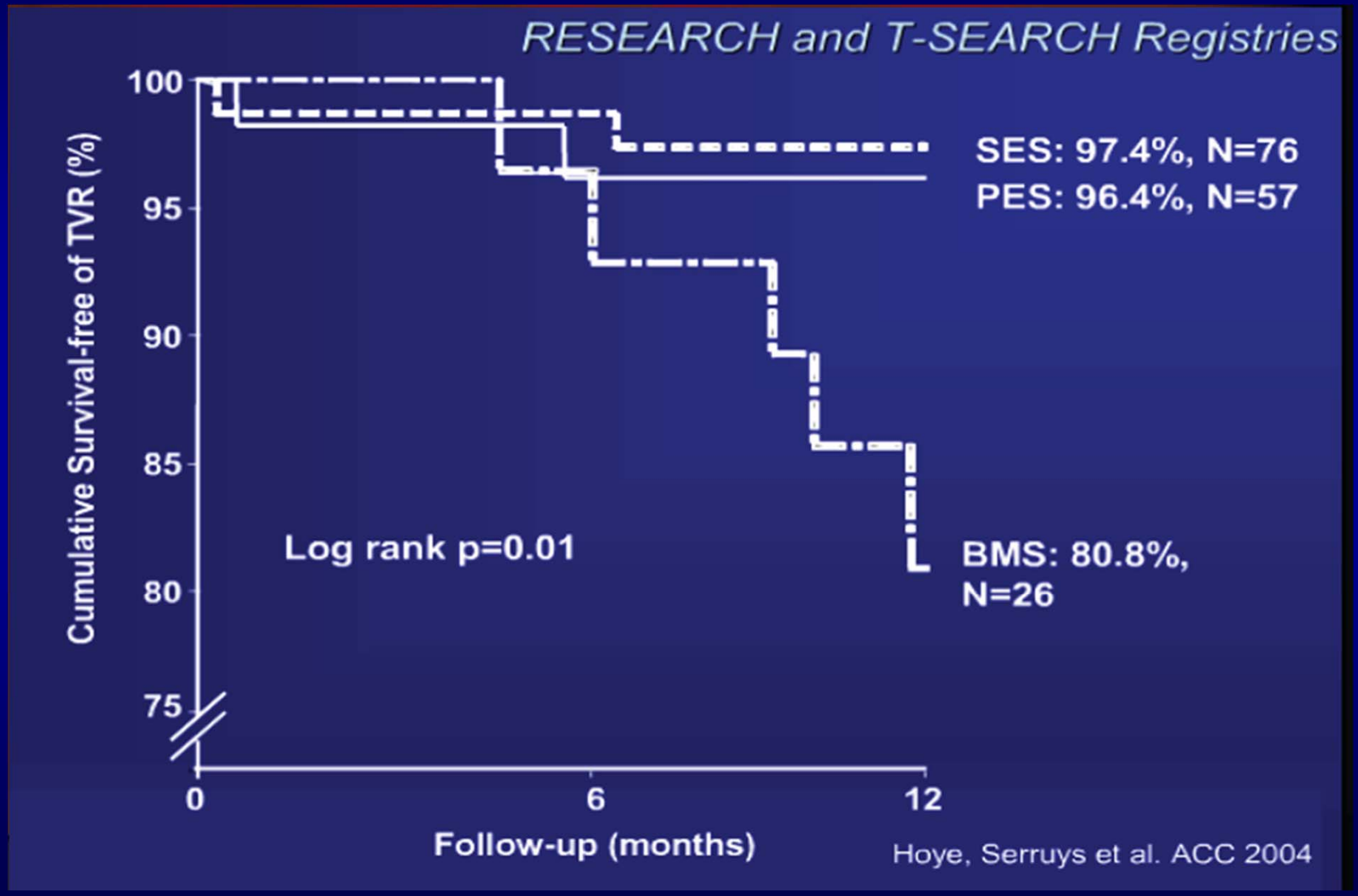
432 pts, 458 CTO's attempted
Success achieved 77.3%, MACE 2.5%

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*

Z. Olivari et al. JACC 2002;39:29A

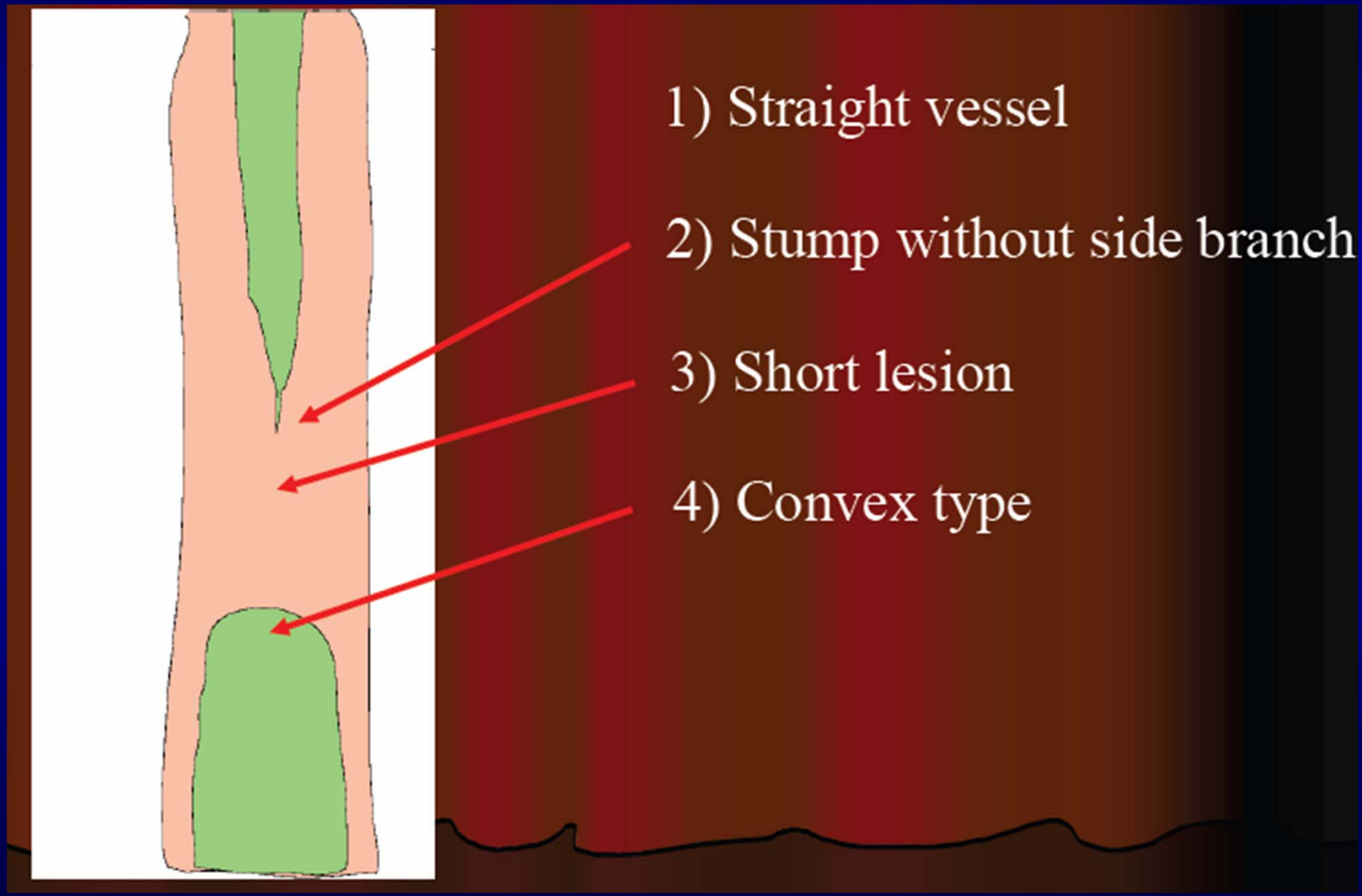
BMS vs DES in CTO Outcomes



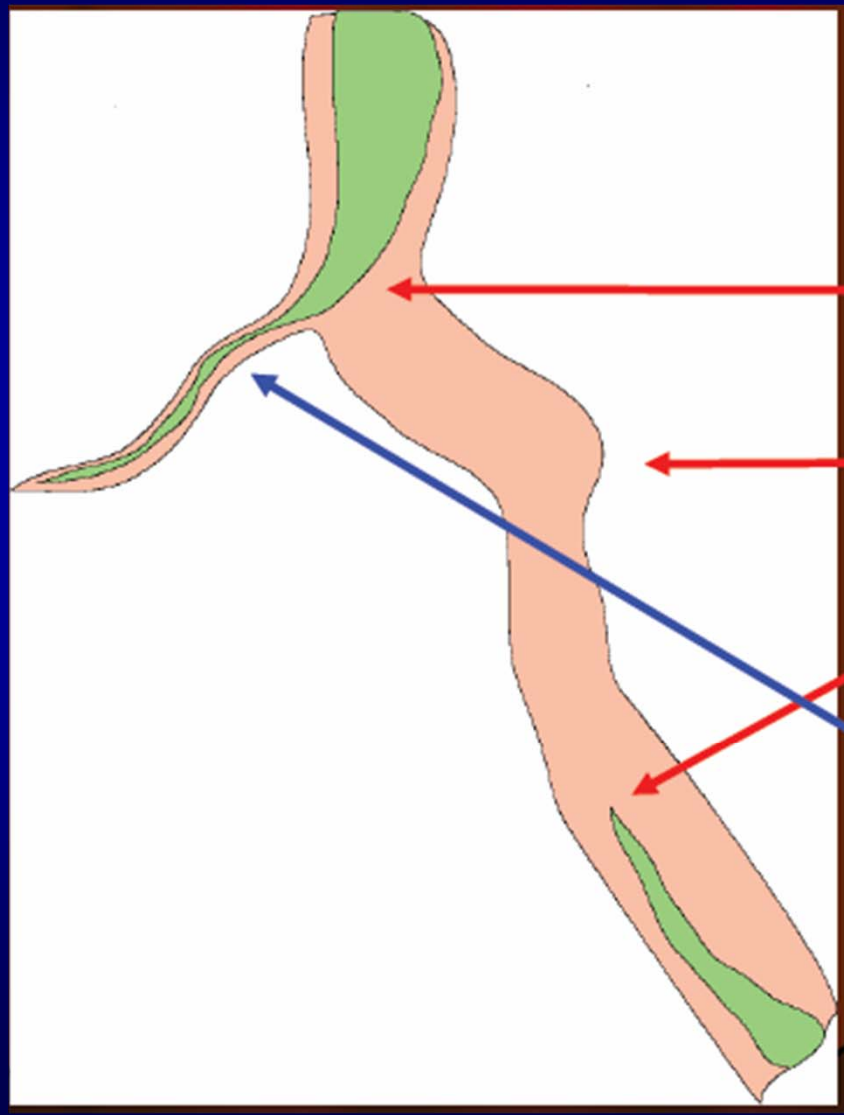
Factors for Success or Failure

1. Duration of occlusion
2. Length of occluded segment
3. Absence of stump
4. Bridging collaterals
5. Occlusion in bypass graft
6. Heavy Calcifications
7. Others; *'Impatience' and 'careless' of operators*…

“Easy” CTO


1) Straight vessel
2) Stump without side branch
3) Short lesion
4) Convex type

“Tough” CTO



1) Tortuous vessel

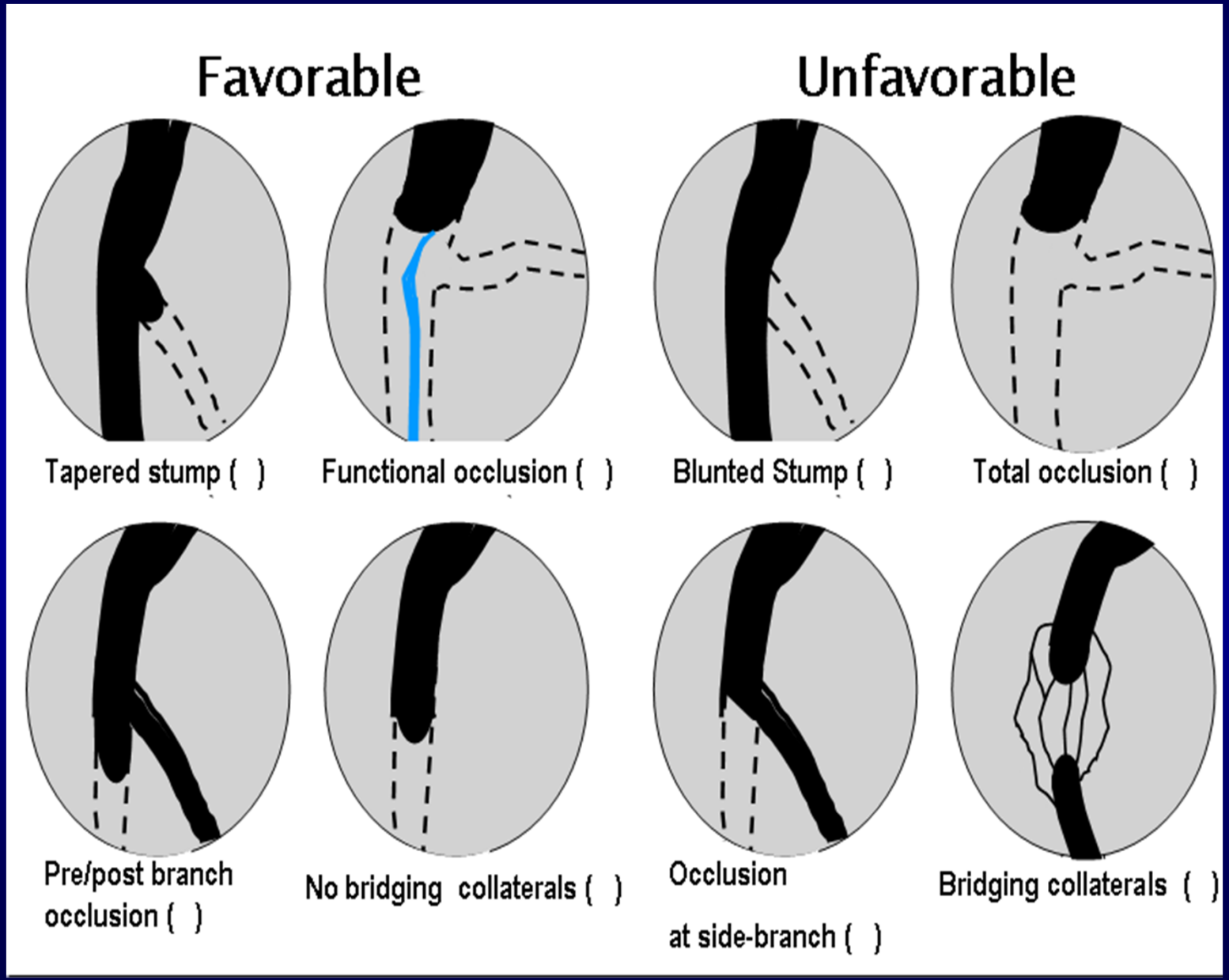
2) No stump with side branch

3) Long lesion

4) Tapered type

5) Small side branch where IVUS cannot be inserted

Angiographic Lesion Morphology of CTO



Predictors for Late Death in CTO

1. Age
2. Poor LV function (EF<40%)
3. DM
4. Creatinine >1.5
5. CVA
6. Unopened CTO

Shizuta S, ACC 2000, 1040-79

Chronic Total Occlusion
Selection of Patients for PCI

Favorable Anatomy

- Tapered point of occlusion
- Visible microchannels
- No side branch
- Bridging collaterals absent
- CTO < 3 months old
- Short gap < 15-20 mm
- Mild calcification

Complex Anatomy

- Blunt occlusion
- No visible channel
- Side branch at site of CTO
- Bridging collaterals present
- CTO > 3 months old or unknown
- Gap > 20 mm
- Severe calcification

Indications of CTO Revascularization

1. Consider balanced benefit…

2. Amount of viable myocardium

Careful Reading of CTO Angiogram

1. Good image angiogram at >2 different view
2. Focus to length, tortuosity & calcium
3. Structure and shape of proximal entry point
4. Vessel angulation and calcium
5. Calcified island in the CTO
6. Branch formation
7. Shape and character of distal reentry point
8. Collateral circulation information

CTO ; Key to Success

1. Proper case selection
2. Careful review of angiogram and MDCT
3. Equipment selection; Device
4. Operator's attitudes; Patience and Perseverance
5. Consider concentrating cases on "CTO day"
6. DES for the long-term results; debate…

Real World CTO Registry

1. Single center (KUGH)
2. Asian (Korean) population
3. Prospective registry for all comer patients undergoing CTO intervention
4. A variety of retrospective analysis can be done

Impact of Favorable versus Unfavorable Angiographic Morphology on Chronic Total Coronary Occlusion Intervention Outcomes

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Jin Oh Na, Soon Yong Suh, Cheol Ung Choi, Jin Won Kim, Eung Ju Kim,
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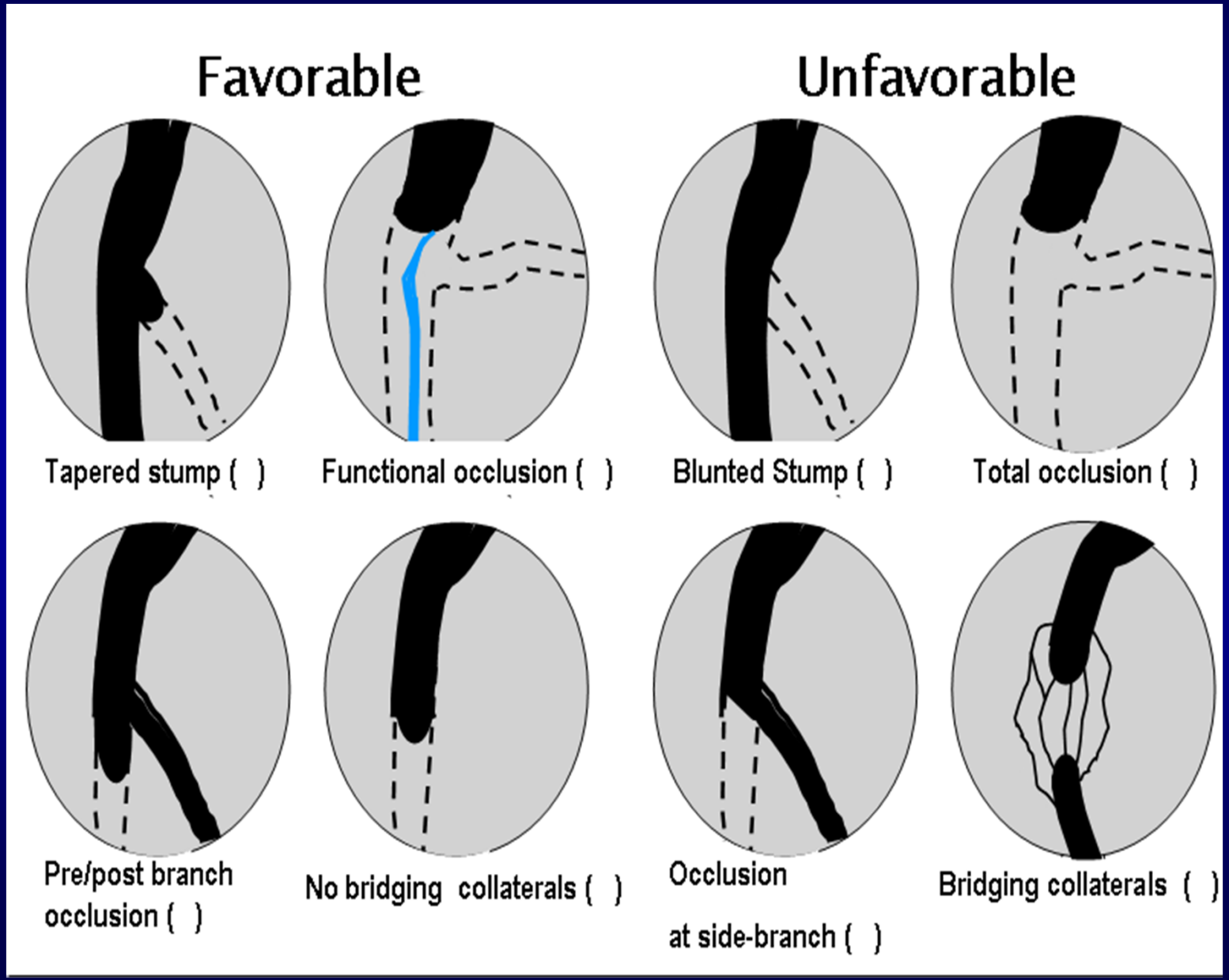
Cardiovascular Center,
Korea University Guro Hospital

CCT 2008

Angiographic Lesion Morphology of CTO



Baseline Clinical Characteristics

Variable, n (%)	Favorable (n=30 pts)	Unfavorable (n=52 pts)	*P* value
Male	21 (70.0)	37 (71.2)	0.912
Age (years)	60.79 ± 9.23	58.38 ± 12.32	0.371
Current smoking	11 (36.7)	19 (36.5)	0.991
Diabetes mellitus	14 (46.7)	11 (21.2)	0.016
Hypertension	16 (53.3)	26 (50.0)	0.771
Hyperlipidemia	7 (23.3)	8 (15.4)	0.370
Left ventricular ejection fraction (%)	48.24 ± 11.70	47.44 ± 11.34	0.782
Chronic heart failure	11 (36.7)	24 (46.2)	0.403
Unstable angina	13 (43.3)	27 (51.9)	0.454
Old myocardial infarction	7 (23.3)	17 (32.7)	0.370
Previous PTCA	5 (16.7)	19 (36.5)	0.057
Previous CABG	1 (3.3)	0 (0)	0.366
Number of diseased vessels	1.70 ± 0.87	1.86 ± 0.78	0.411

Baseline Angiographic Characteristics

Variable, n (%)	Favorable (n=34 lesions)	Unfavorable (n=71 lesions)	*P* value
Median occlusion duration (months, interquartile range)	3.00 (1.00 - 6.75)	4.00 (1.25 - 12.00)	0.261
De novo lesion	34 (100)	58 (81.7)	0.008
Previous stented CTO	0 (0)	13 (18.3)	0.008
Target vessel			
RCA	17 (50.0)	42 (59.2)	0.376
LAD	7 (20.6)	18 (25.4)	0.592
LCX	10 (29.4)	11 (15.5)	0.095
Lesion length (mm)	35.31 ± 15.78	48.97 ± 32.92	0.031
Reference diameter (mm)	2.88 ± 0.44	2.93 ± 0.52	0.449
Collateral grade	1.07 ± 1.05	1.56 ± 0.95	0.039

Procedure-related Outcomes

Variable, n (%)	Favorable (n=30 pts)	Unfavorable (n=52 pts)	*P* value
Wire number	2.43 ± 1.29	2.71 ± 1.70	0.443
Guiding catheter number	1.36 ± 0.56	1.75 ± 1.16	0.411
Amount of contrast dye (mL)	480.36 ± 155.36	526.92 ± 134.82	0.167
Fluoroscopic time (min)	96.07 ± 51.09	117.98 ± 73.03	0.172
Procedure time (min)	96.07 ± 51.09	112.25 ± 69.22	0.281
Acute thrombosis	1 (3.3)	1 (1.9)	1.000
Coronary dissection	8 (26.7)	13 (24.5)	0.868
No reflow	1 (3.3)	4 (7.7)	0.648
BNP	1157.18 ± 784.98	1262.46 ± 754.35	0.925
Failed procedure	2 (6.7)	13 (25.0)	0.039

The Procedural Characteristics

Variable, n (%)	Favorable (n=31 lesions, 58 stents)	Unfavorable (n=52 lesions, 98 stents)	*P* value
Stent types			
Cypher	14 (24.1)	24 (24.5)	0.961
Taxus	37 (63.8)	61 (62.2)	0.847
Endeavor	7 (12.1)	12 (12.2)	0.974
BMS	0 (0)	1 (1.0)	0.443
Stent length (mm)	25.72 ± 6.28	27.27 ± 5.41	0.122
Stent diameter (mm)	2.81 ± 0.38	2.92 ± 0.40	0.106
Stents number per lesion	1.86 ± 1.01	1.86 ± 1.03	0.979
Maximal inflation pressure (atm)	14.59 ± 3.58	15.28 ± 3.36	0.428
Residue stenosis (%)	10.54 ± 7.21	11.83 ± 8.01	0.323
MLD After stenting (mm)	2.91 ± 0.38	3.03 ± 0.61	0.234

Angiographic and Clinical Outcomes at 6 Months in Patients with Successful PCI

Variable, n (%)	Favorable (n=28 pts, 31 lesions)	Unfavorable (n=39 pts, 52 lesions)	*P* value
Binary restenosis	5 (16.1)	13 (21.3)	0.554
MLD (mm)	1.82 ± 0.88	1.63 ± 1.19	0.407
Restenosis percent (%)	27.96 ± 23.06	40.73 ± 36.35	0.190
Late loss (mm)	1.48 ± 1.17	1.53 ± 1.14	0.715
Cardiac death	0 (0)	0 (0)	--
Total death	0 (0)	1 (2.6)	1.000
New/recurrent angina	2 (7.1)	2 (5.1)	1.000
Q-Myocardial Infarction	0 (0)	0 (0)	--
CABG	0 (0)	0 (0)	--
TLR	2 (7.1)	2 (5.1)	1.000
TVR	2 (7.1)	2 (5.1)	1.000
TVR-MACE	2 (7.1)	3 (7.7)	1.000
Stent thrombosis	1 (3.6)	1 (2.6)	1.000

Conclusion

1. Recanalization of CTO lesions with unfavorable lesion morphology was associated with higher failure rates compared with the favorable morphology.

2. Because the mid-term angiographic and clinical outcomes were similar regardless of the lesion morphology once if the CTO intervention was successful, every newer devices and improved intervention technologies should be considered for the CTO lesion with unfavorable lesion morphology to improve the overall success rate.

Korean e-CTO Club

1. Retrospective multicenter CTO registry
2. Prospective randomized multicenter CTO-IVUS trial

Multicenter Korean CTO Registry

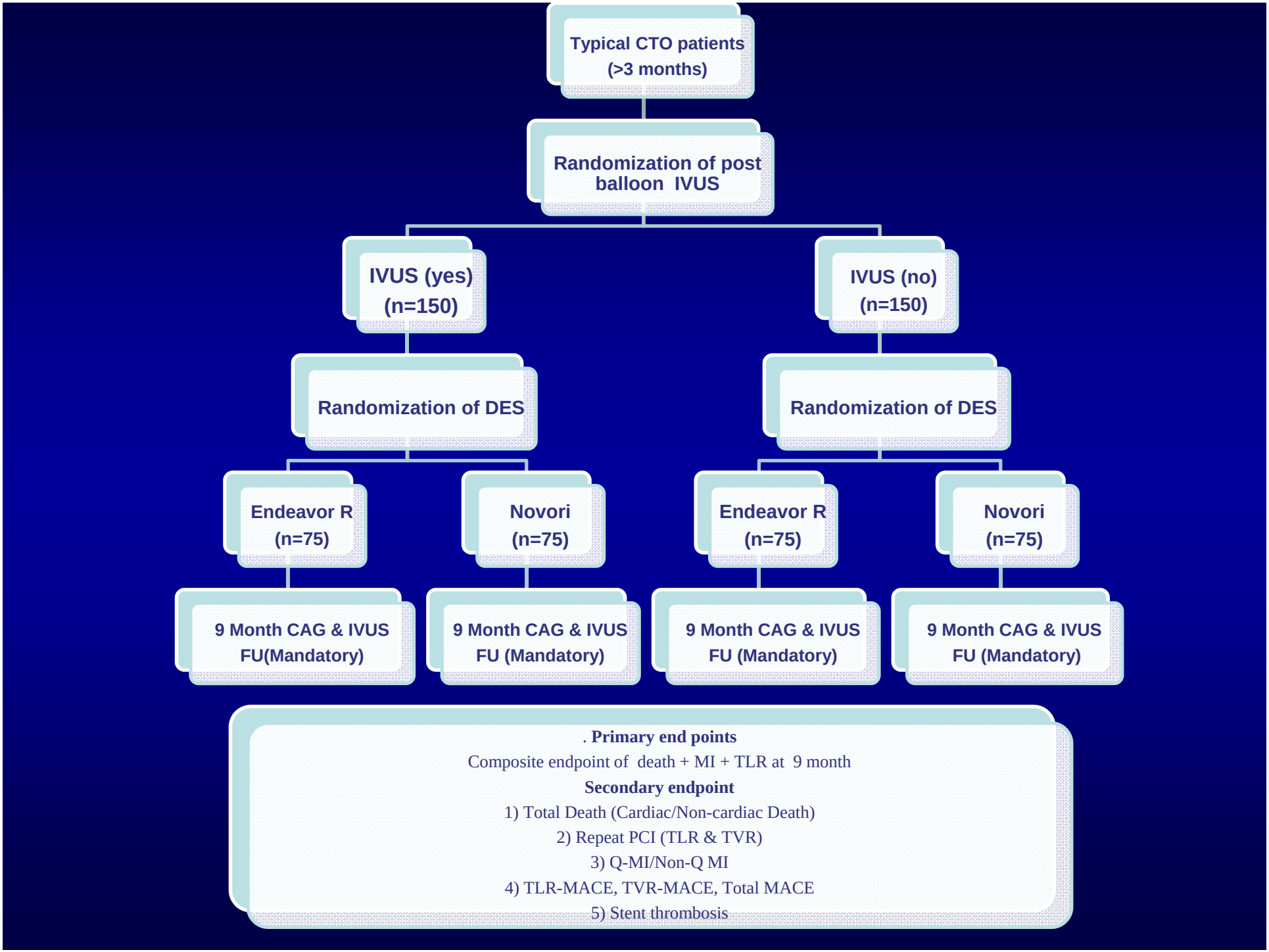
1. Web-based data collection
2. Adjusted expected enrollment period
   1) *Jan 1, 2007-Dec 31 2009 (3 years)*
   2) Clinical follow up; 6 months, 1, 2, 3 years
3. *All comer CTO PCI cases*
   1) Regardless of success or failure
   2) No exclusion, Real-world clinical practice
4. Organizing & Steering; Rha SW/Jang YS
5. Coordination; 현정현, 손미정 (CVRC)

Impact of IVUS-guided Chronic Total Occlusion Intervention with Drug-eluting Stents on Mid-term Angiographic and Clinical Outcomes

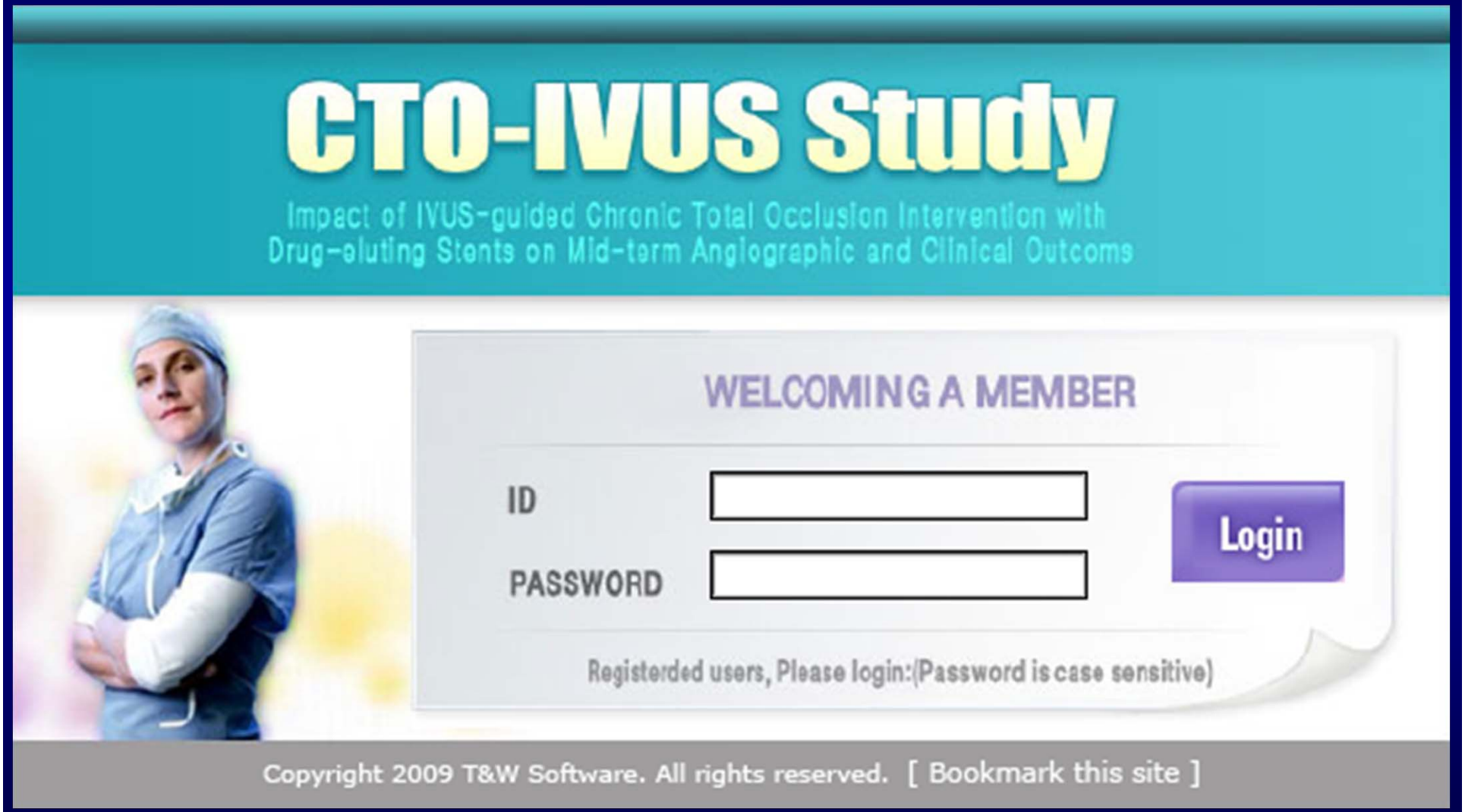
만성 완전 폐쇄성 병변 환자에서 혈관내 초음파 유도하 약물방출스텐트를 이용한 경피적 중재 시술이 중기 혈관조영술적 및 임상적 결과에 미치는 영향

Seung-Woon Rha, Choel-Ung Choi,
Jung Rae Cho, Yang Soo Jang et al.

On behalf of e-CTO Club investigators


Typical CTO patients (>3 months)
Randomization of post balloon IVUS
IVUS (yes) (n=150)
IVUS (no) (n=150)
Randomization of DES
Randomization of DES
Endeavor R (n=75)
Novori (n=75)
Endeavor R (n=75)
Novori (n=75)
9 Month CAG & IVUS FU(Mandatory)
9 Month CAG & IVUS FU (Mandatory)
9 Month CAG & IVUS FU (Mandatory)
9 Month CAG & IVUS FU (Mandatory)
. Primary end points
Composite endpoint of death + MI + TLR at 9 month
Secondary endpoint
1) Total Death (Cardiac/Non-cardiac Death)
2) Repeat PCI (TLR & TVR)
3) Q-MI/Non-Q MI
4) TLR-MACE, TVR-MACE, Total MACE
5) Stent thrombosis

e-CRF http://www.ecrf.kr/ctoivus



Research Fellow 2010

Kanhaiya L Poddar

Meera Kumari

Research Fellow 2011

Amro Elnagar, Benha University Hospital, Egypt

Research Fellow & Visiting Professor 2011

Dr Amro Elnagar from Egypt, Korean Visiting Professors

CCI Program

Complex Cardiovascular Intervention Program

COURSE OVERVIEW

- Instructor : Dr. Rha Seung Woon
- Technical Improvement in Complex Coronary & Peripheral Intervention
- Clinical Research in Cardiovascular Field

REGISTRATION

Personal Information

Name _____

Hospital & Specialty _____

E-mail address _____

Telephone/Mobile _____

Areas of Interests

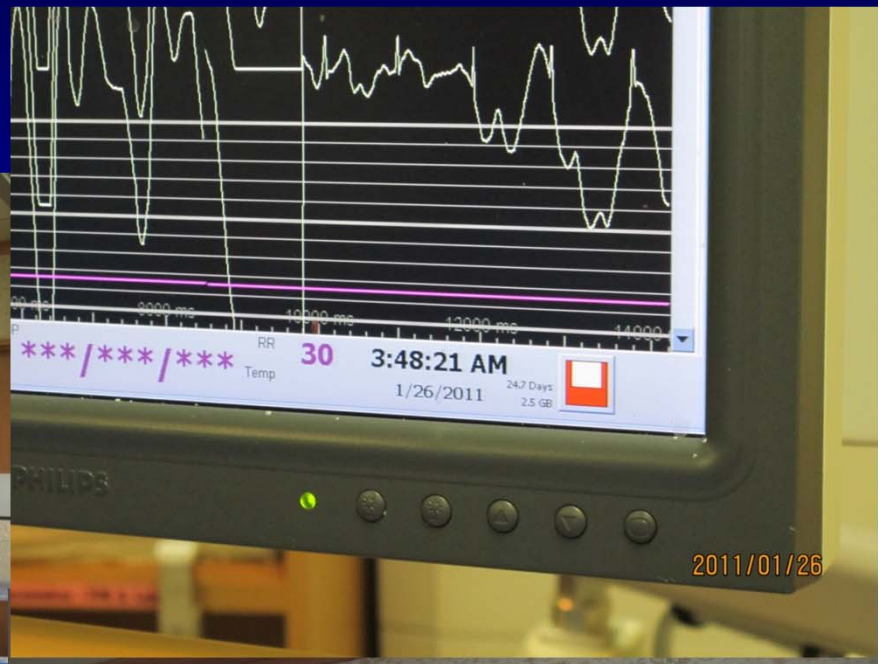
- ☐ How to get out of trouble (procedural complication)
- ☐ How to get accesses in difficult CTO Case
- ☐ Current treatment strategies and device selection
- ☐ Clinical Research in Cardiovascular Field

Korean Visiting Professors

Prof. Park SH & Cho YH's Live

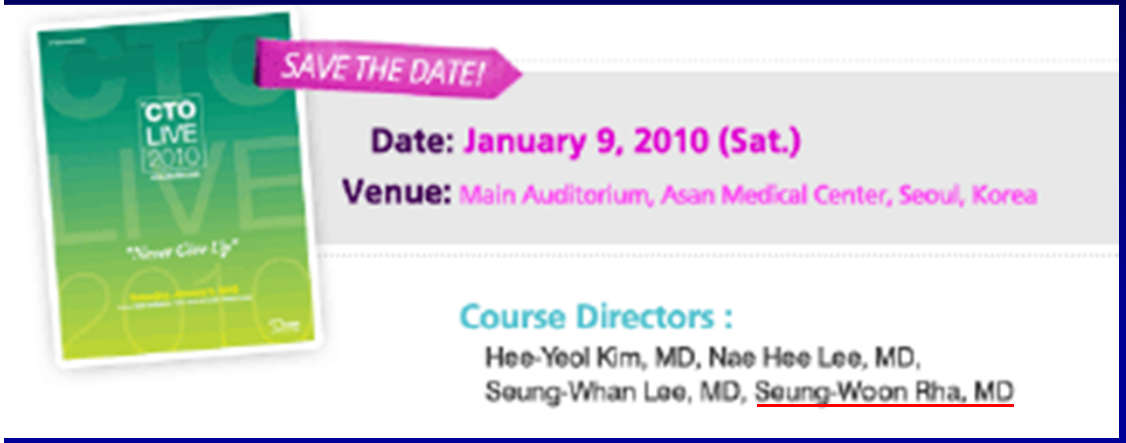
Visiting Professor 2011; Young & Ambitious Drs

Never Give Up & Until Happy Ending



Korean Visiting Professors; Happy Endings!!

I am one of known CTO guy….



e-CTO Club

e-Chronic Total Occlusion Club

1. **CTO PCI Expert & Preceptorship**
2. **Director in Scientific Committee**
3. **CTO live in many hospitals…**

Why I'm still doing CTO intervention despite of good collaterals?

1. Presence of symptoms
2. Improve left ventricular function
3. Improve Survival & Prognosis
4. Complete revascularization (CABG to PCI)
5. Because of the challenge; "Last Frontier"
6. Radiation badge had low reading last month
7. Other Reasons….

Thank You for Your Attention!!