Clinical Considerations for CTO Revascularization

Whom to treat, Who derives benefit and What can we achieve?

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CTOs in Perspective

Despite novel technologies/DES, frequency of attempted CTOs has not changed over the past decade[1,2]

- Technical/procedural challenges
- Misperceptions regarding viability, collateral flow
- Uncertainty regarding which patients may benefit balanced by
- Concern for complications in patients who may not derive clinical benefit

SYNTAX CTO Prevalence[3]

Randomized Trial: 10% vs CABG Registry: 40%

Srinivas et al. *Circulation* 2002
Christofferson et al. *Am J Cardiol* 2005
Serruys et al. *JACC Interven* 2008

Frequency and Impact of Incomplete Coronary Revascularization

SYNTAX Trial

- SYNTAX CTO Prevalence

  Randomized Trial: 10% vs CABG Registry: 40%

- Complete Revascularization: 57% PCI vs 63% CABG (*P*=0.005)

New York State Database

- 68.9% of MVD patients undergoing PCI had incomplete revascularization
- 30.1% had CTOs and/or ≥2 diseased major vessels with incomplete revascularization

Mortality highest in this subgroup (HR 1.36, 1.12-1.66)

Serruys et al. *JACC Interven* 2008
Serruys et al. *ESC* 2008
Hannan et al. *Circulation* 2006

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Why the Occluded Artery Trial (OAT) Does Not Apply to CTO Revascularization

- OAT: Subacute (3-28 days) total occlusions following MI
- OAT: Relatively asymptomatic population excluding severe ischemia by functional study, rest angina and multivessel disease
- Absence of improvement in LV function in OAT substudy
  - *Baseline LVEF 48% (difficult to improve upon relatively normal)*
  - *Spontaneous recanalization (TIMI 2/3) observed at 1 year in 25% of medical therapy cohort*
  - *Reocclusion in ~9% of PCI cohort; no DES*
  - *Greatest predictor of improved LVEF was having a patent target vessel at 1 year follow up*

Hochman et al. *NEJM* 2006
Dzavik et al. *Circulation* 2006

Theoretical Rationale for CTO Revascularization ‘Open Artery Hypothesis’

- Increase long-term survival
- Improve left ventricular function
- Electrical stability of myocardium and reduced predisposition to arrhythmic events
- Increased tolerance of future coronary occlusion events

Long-term Survival with Successful CTO Revascularization

Support for the Late Open Artery Hypothesis

Trial	Success (N)	Failure (N)	Follow-up Duration (years)	Mortality (%)		
				Success	Failure	*P* value
British Columbia Cardiac Registry[1]	1118	340	6	10.0	19.0	<0.001
Suero et al.[2]	1491	514	10	26.0	35.0	0.001
TOAST-GISE[3]	286	83	1	1.1	3.6	0.13
Aziz et al.[4]	377	166	2.4	2.5	7.3	0.049
Hoye et al.[5]	568	306	5	6.5	12.0	0.02
Valenti et al.[5]	344	142	2	91.6	87.4	0.025

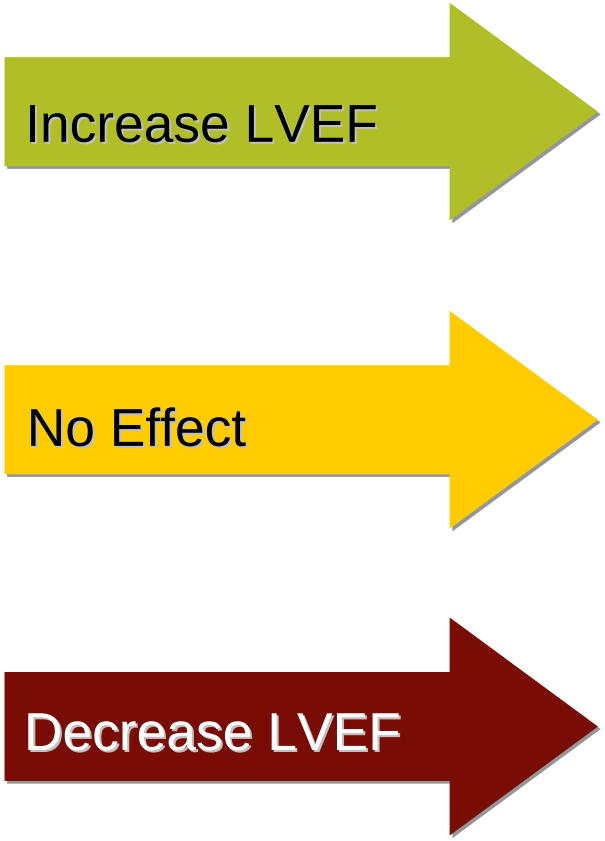
[1]Ramanathan. *TCT* 2003; [2]Suero. *JACC* 2001; [3]Olivari. *JACC* 2003; [4]Aziz. *TCT* 2005; [5]Hoye *Eur Heart J* 2005; [5]Valenti *Eur Heart J* 2008

Patient Selection
Clinical Considerations

- Is this patient symptomatic, and how? Angina? Heart failure? Arrhythmia?
- What is the chance of procedural success?
- Will successful recanalization improve this patient's symptoms?
- Will successful recanalization improve this patient's prognosis?
- What are the risks of attempted recanalization in this patient?

Recovery of LV Function After CTO Recanalization

Predictors of Improvement in LV Function



- Baseline LV dysfunction
- Preserved microvasculature

- Collateral development
- Prior MI
- Duration of occlusion
- Nonocclusive restenosis

- Reocclusion

Werner GS et al. *Am Heart J* 2005

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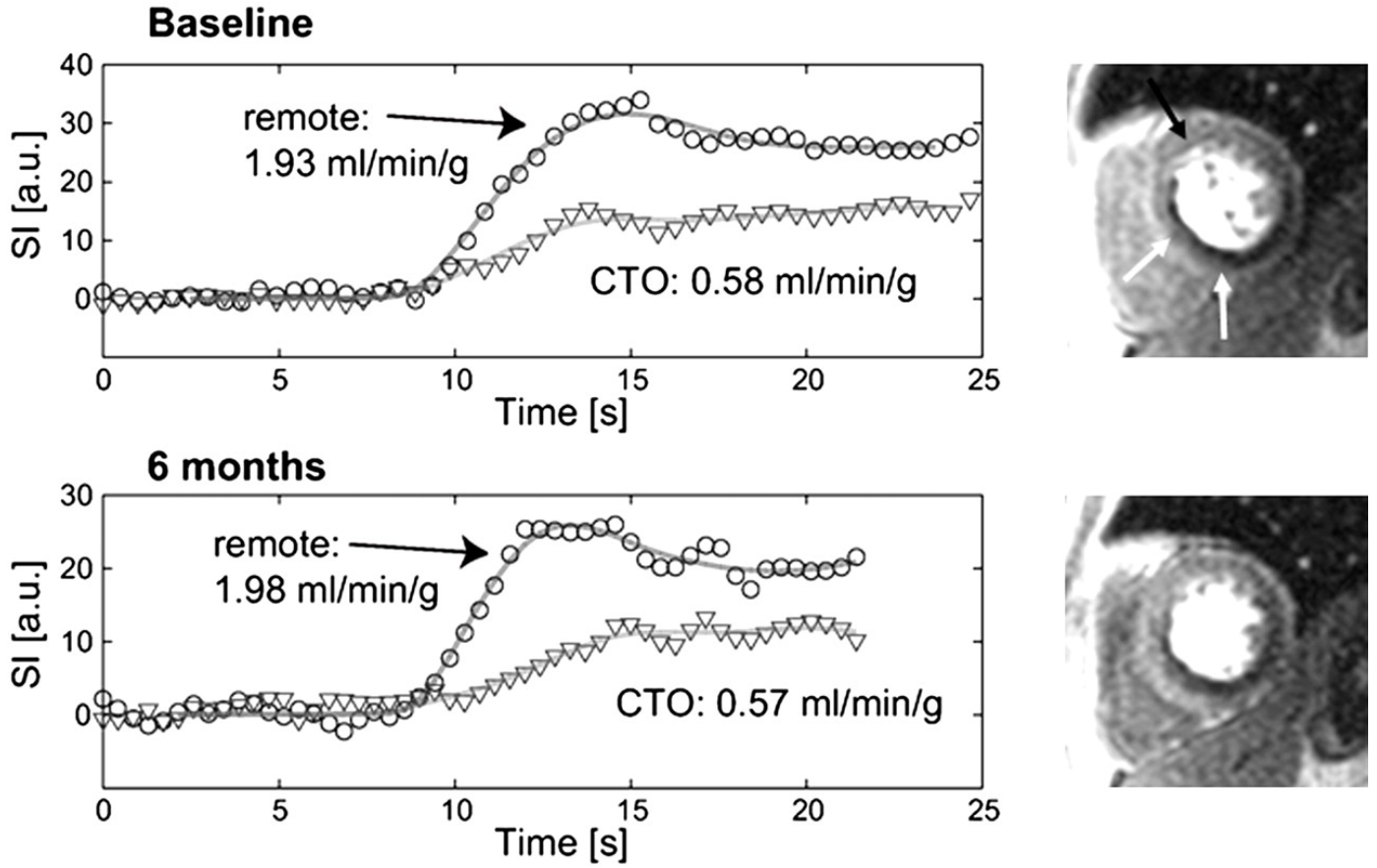
Shifting Focus Downstream from CTOs

Insights to Myocardial Recovery Following CTO Recanalization



Signal Intensity-Time Curves and Stress Perfusion Images Demonstrating No Change in Hyperemic MBF in a Medically Managed Patient With a CTO

Cheng et al. *JACC Intv* 2008

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Shifting Focus Downstream from CTOs

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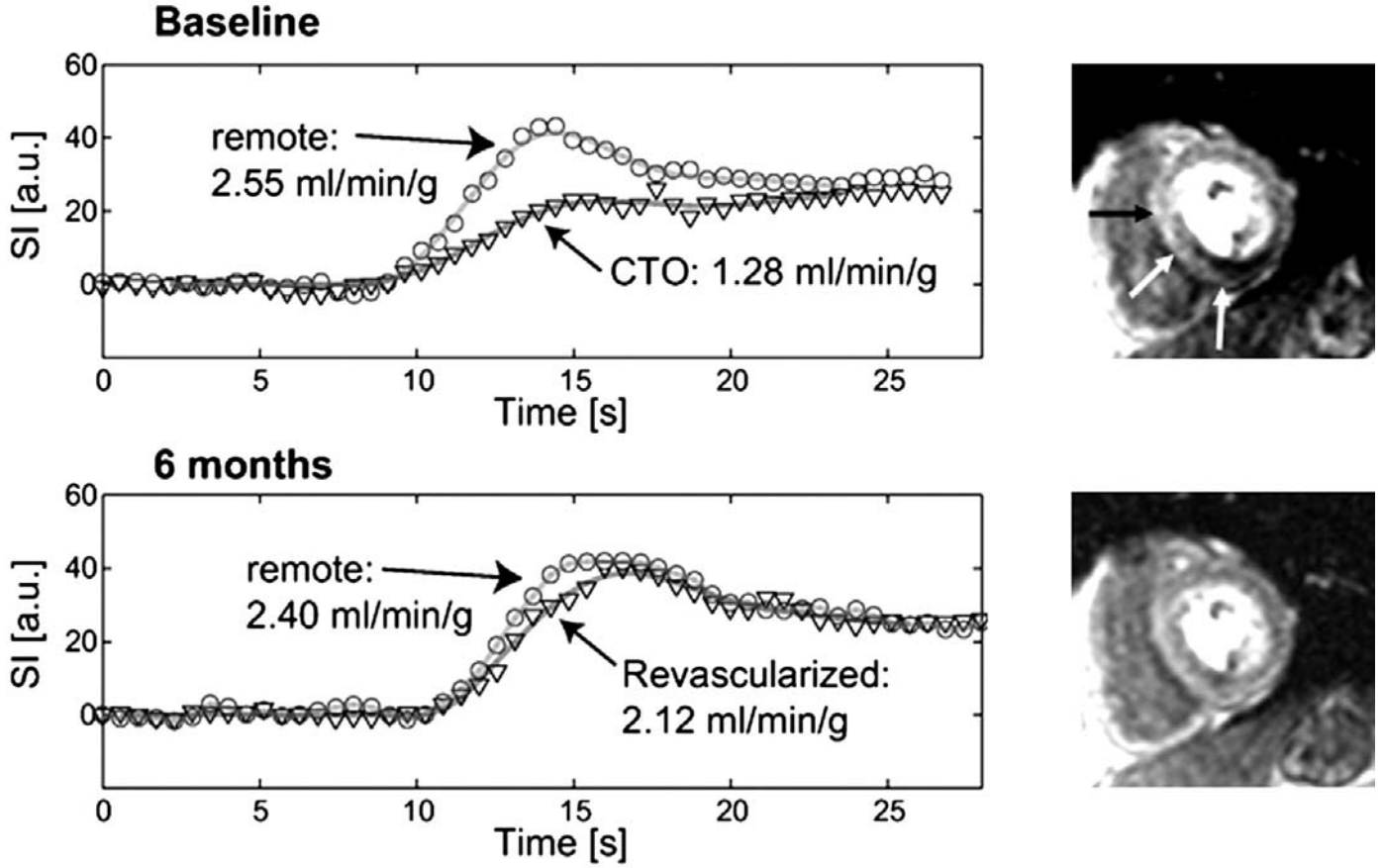

Signal Intensity-Time Curves and Stress Perfusion Images Demonstrating Changes in Hyperemic MBF After CTO PCI

Cheng et al. *JACC Intv* 2008

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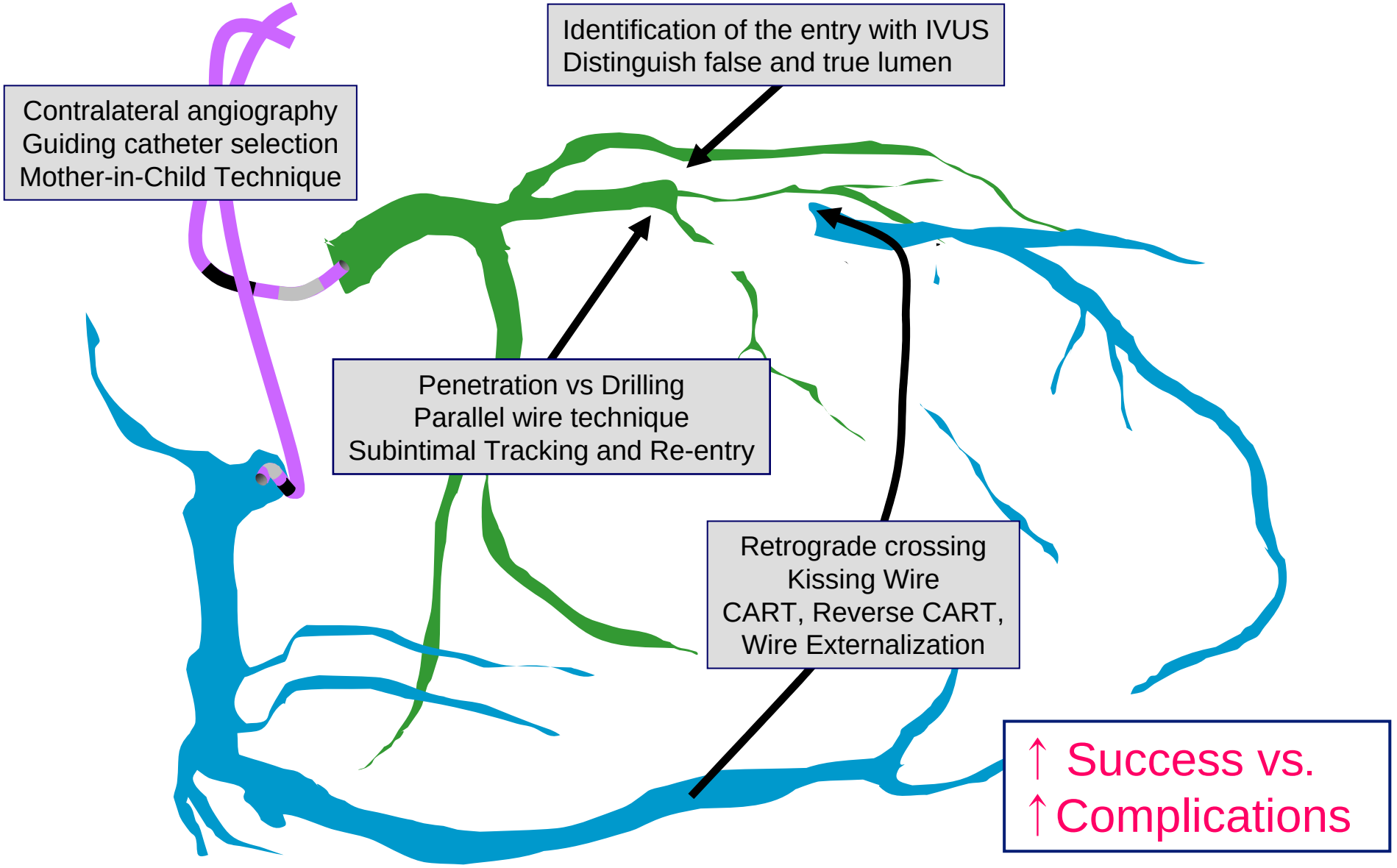
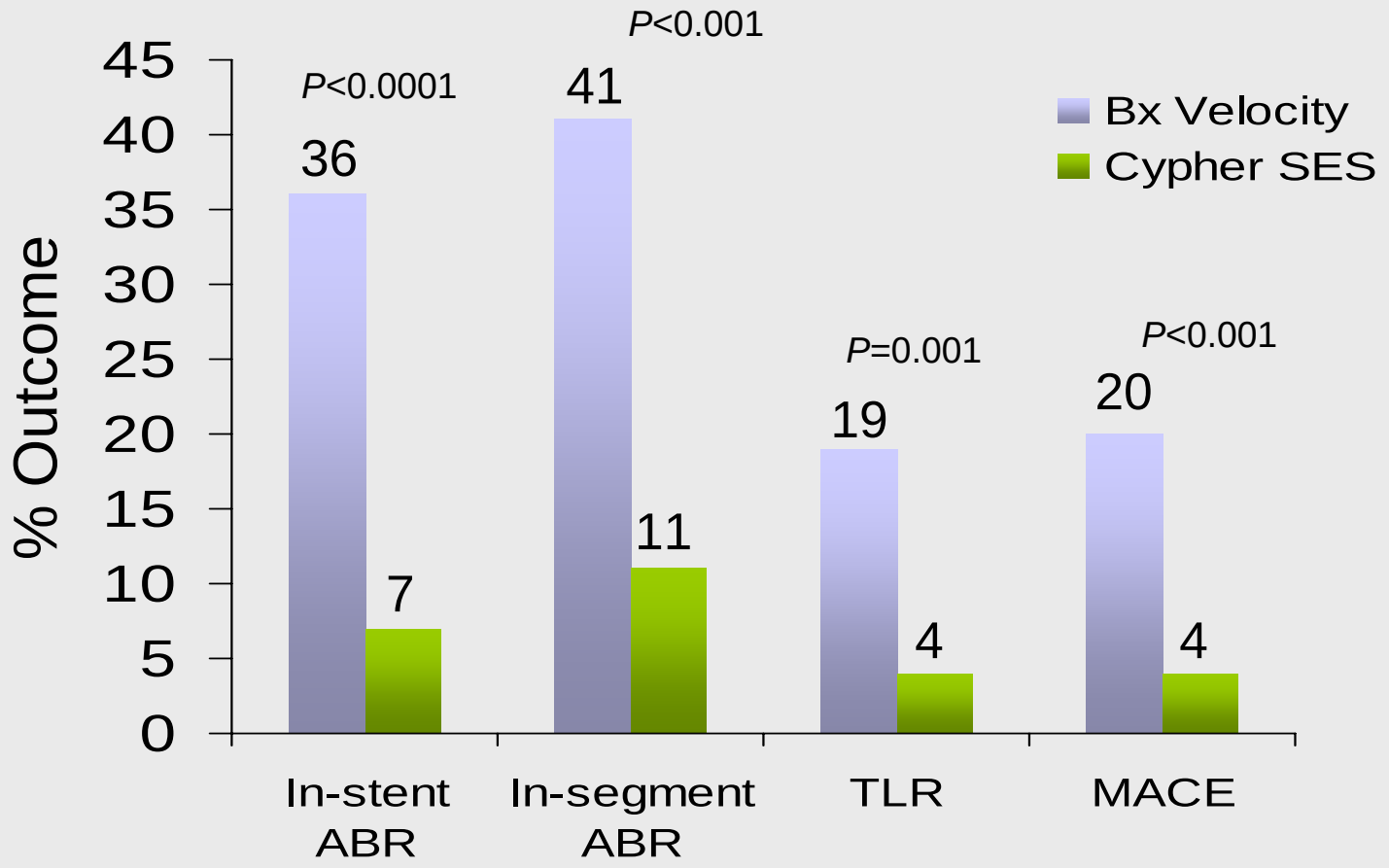
Principles of CTO Revascularization

Advanced Strategies and Technique



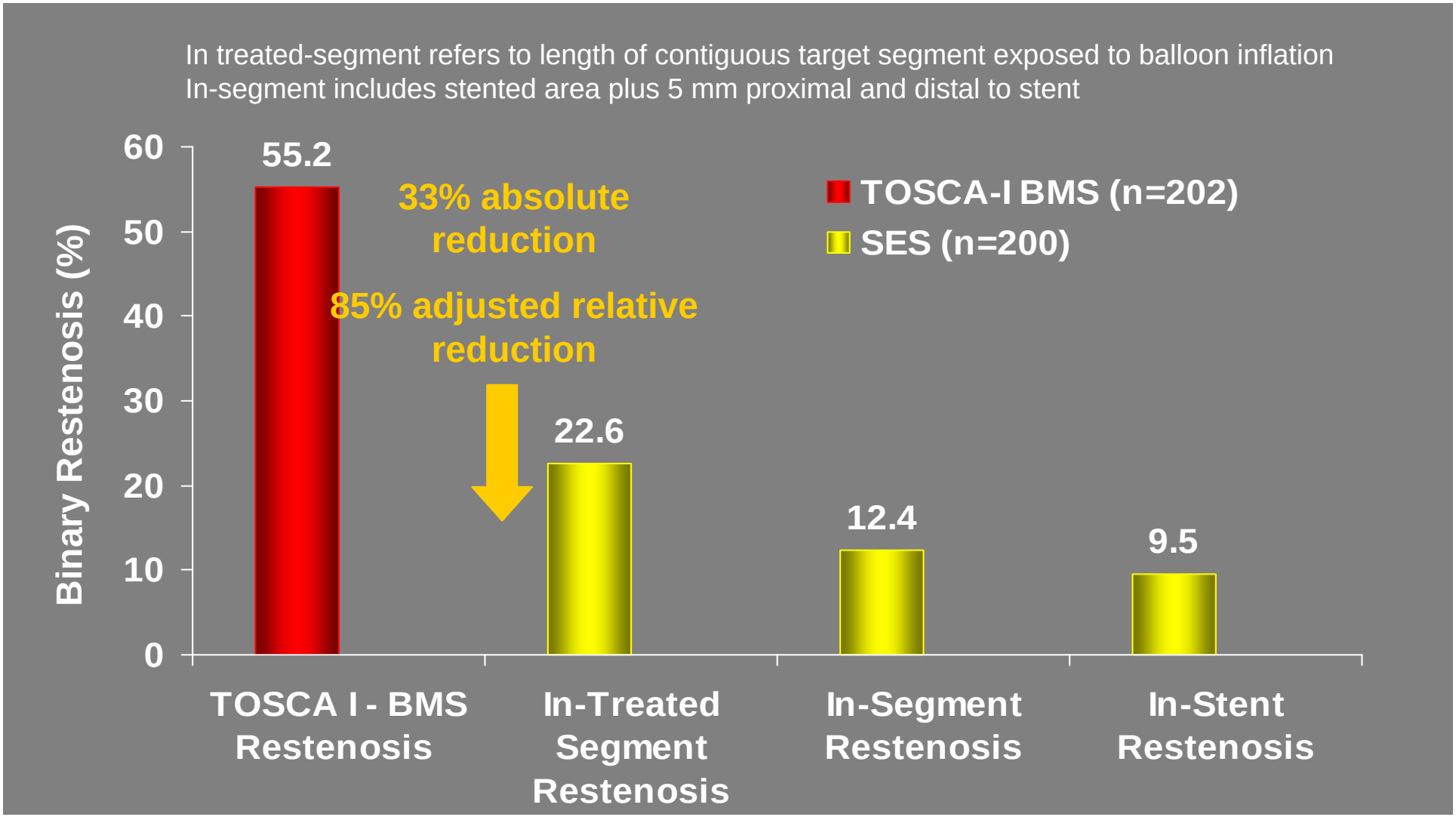
PRISON II



Suttorp, M., et al., *Circulation* 2006;114(9):921-8.

ACROSS – CYPHER

6 Month Angiographic Restenosis



Kandzari et al. JACC Interv *In press*

CTO Revascularization and Late Clinical Benefit with DES: 2 year Survival

	CTO PCI Failure n = 142	CTO PCI Success n = 344	*P* Value
Overall	87.4 ± 2.9%	91.6 ± 2.0%	0.025
Single vessel disease (N=70)	93.3 ± 6.4%	93.6 ±3.6%	0.986
Multi vessel disease (N=416)	86.6 ±3.1%	91.4 ± 2.2%	0.021

Valenti et al. *Eur Heart J* 2008

Alternative to DES in CTO Revascularization: Drug-Eluting Balloon

PEPCAD CTO

- *Sample size:* 48 pts with *de novo* CTO, 2.5 to 4.0 mm RVD
- *Study design*: Non-randomized, single arm
- *Treatment:* Paclitaxel drug-eluting balloon (SeQuent Please) and bare metal stents
- *DAPT regimen:* 6 months
- *Primary Endpoint:* 6-month late loss compared with PACTO study historical control
- *Status:* TCT 2009 presentation

Source: www.clinicatrials.gov, Prof. Gerald Werner

Rationale for CTO Revascularization
Summary

- Treatment of CTOs has introduced new benefits, new dilemmas
  - Historical predictors of procedural success are ‘historic’
  - Patient identification with non-invasive imaging
  - Strut fracture and LSM may be more common; clinical implications uncertain
- DES are a revolutionary step toward improving CTO outcomes (but there is need for technology to improve procedural success!)
  - Aside from ↓ABR, long term patency with DES may be associated with preservation of improved LV function
  - Implications for technique: ↑ restenosis when less DES coverage
- Despite more advanced strategies and technologies, there is little systematic evidence that procedural outcomes have changed for the better or worse
  - New techniques, new complications
  - Need CTO-specific clinical trials that better inform procedural outcomes