Latest Techniques of CTO PCI from Western Point:

The Hybrid Approach

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Perspectives on Coronary Chronic Total Occlusions:
The Canadian Multicenter CTO Registry; April 08-July 09

- 14,439 pts had angiography. At least 1 CTO in 2,630 (18.2%).
- Excluded Grps: Post CABG pts, 1 CTO in 54%
  Post STEMI pts, 1 CTO in 10%

History of AMI	40%
Presenting with ACS	46%
CCS 2, 3 or 4	87%
Significantly ↓ LVEF	17%

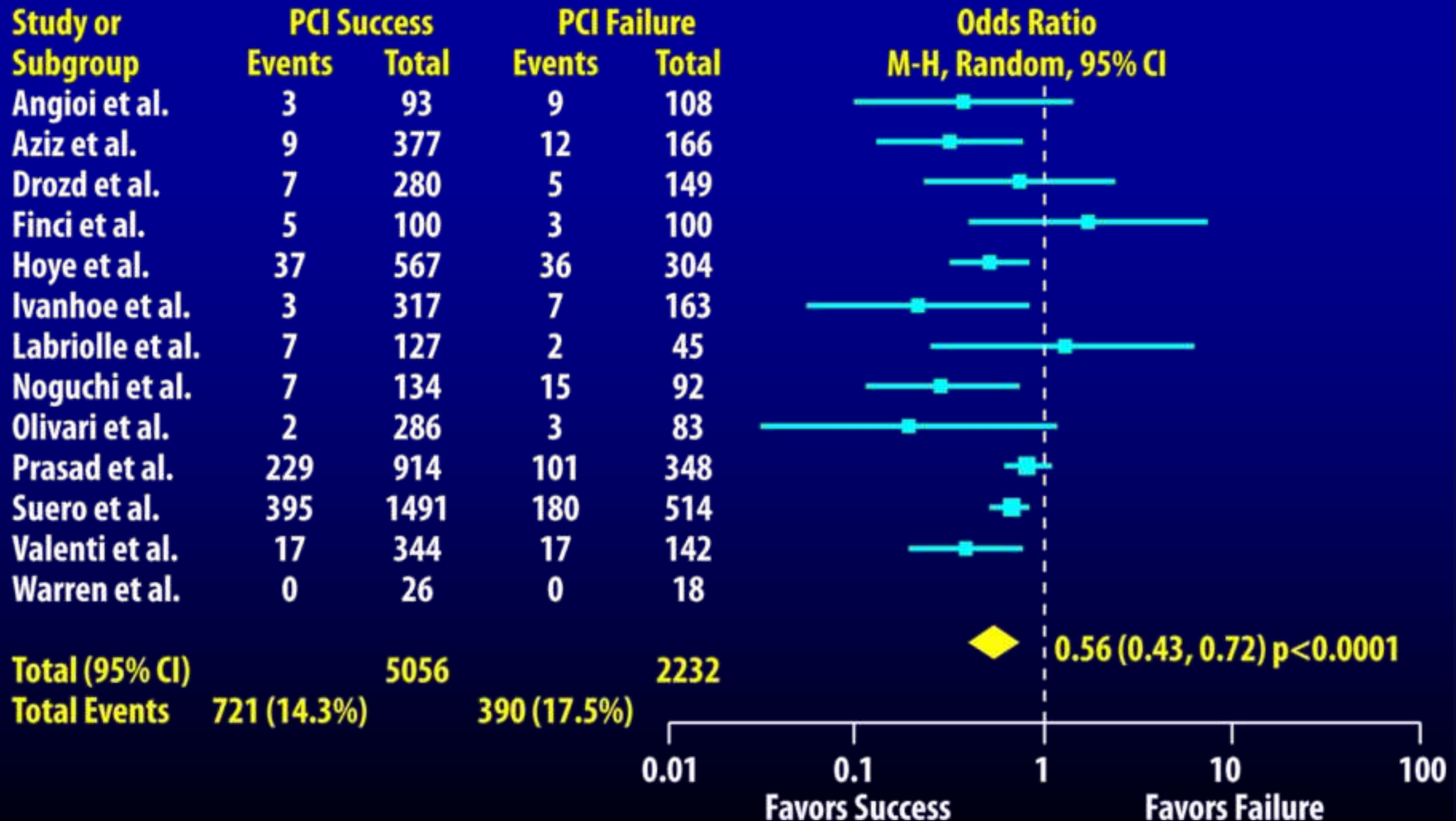
CTO Vessel	RCA	47%
	LAD	20%
	LCX	16%
CTO Location, prox/mid		78%
EKG, Q waves		26%

Conclusion: Overall, CTO prevalence is 18.2%. Majority have preserved LVEF. Greater than 87% have CCS ≥ 2 symptoms. Recanalization attempted in only 10%. Success rate 70%. CABG 26%.

P. Fefer et al. JACC 2012;59:991

Effectiveness of CTO Recanalization: *A Systematic Review of 13 Observational Studies (7288 pts; Mean F/U 6 yrs)*

Success vs Failure on All-cause Mortality

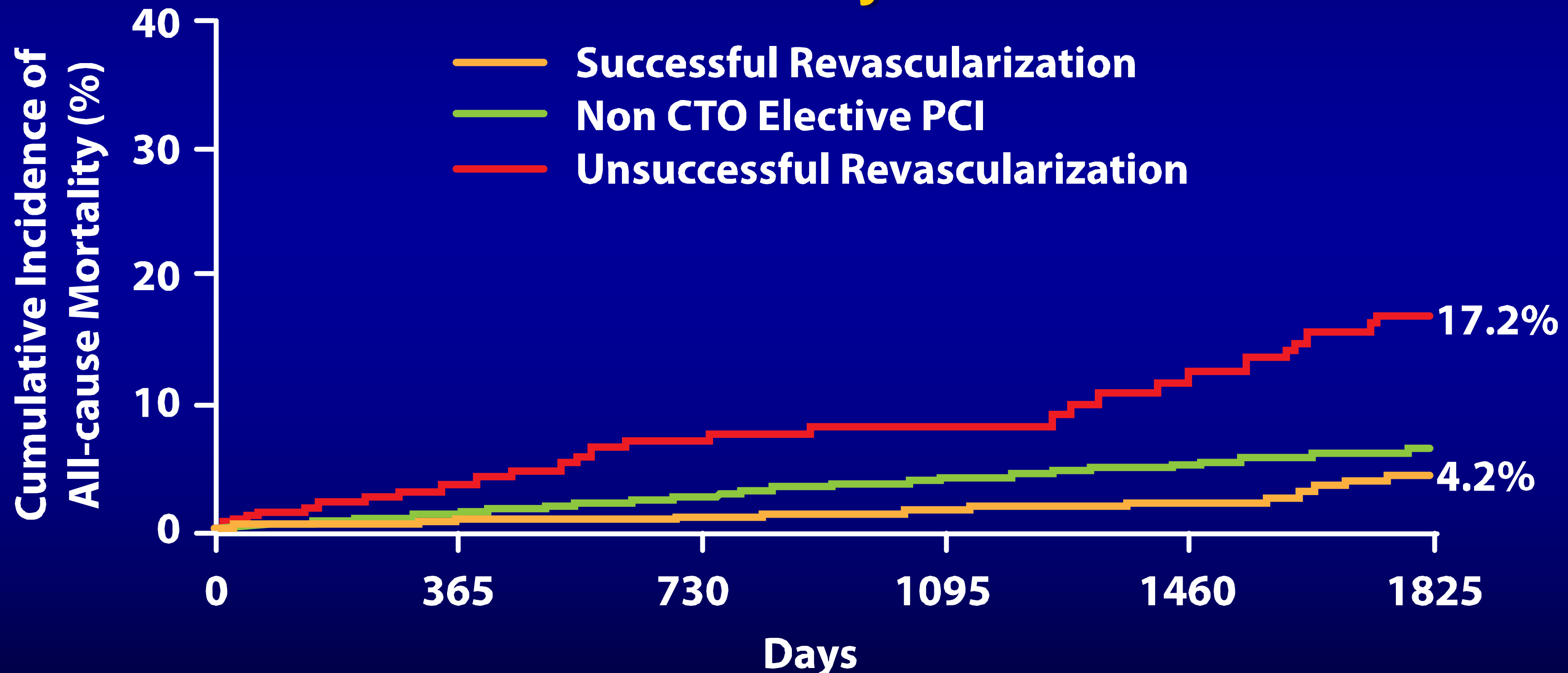


Study or Subgroup	PCI Success Events	PCI Success Total	PCI Failure Events	PCI Failure Total
Angioi et al.	3	93	9	108
Aziz et al.	9	377	12	166
Drozd et al.	7	280	5	149
Finci et al.	5	100	3	100
Hoye et al.	37	567	36	304
Ivanhoe et al.	3	317	7	163
Labriolle et al.	7	127	2	45
Noguchi et al.	7	134	15	92
Olivari et al.	2	286	3	83
Prasad et al.	229	914	101	348
Suero et al.	395	1491	180	514
Valenti et al.	17	344	17	142
Warren et al.	0	26	0	18
Total (95% CI)		5056		2232
Total Events	721 (14.3%)		390 (17.5%)	

D. Joyal et al. Am Heart J. 2010;160:179-87

Successful Recanalization of CTO Associated with Improved Long Term Survival: *Barts, London & Yale, USA; 2003-2010*

- 6996 pts elective PCI; 836 (11.9%) for CTO;
- Success 69.6%; MACE: Unsuccessful 3%; Success 2.1%



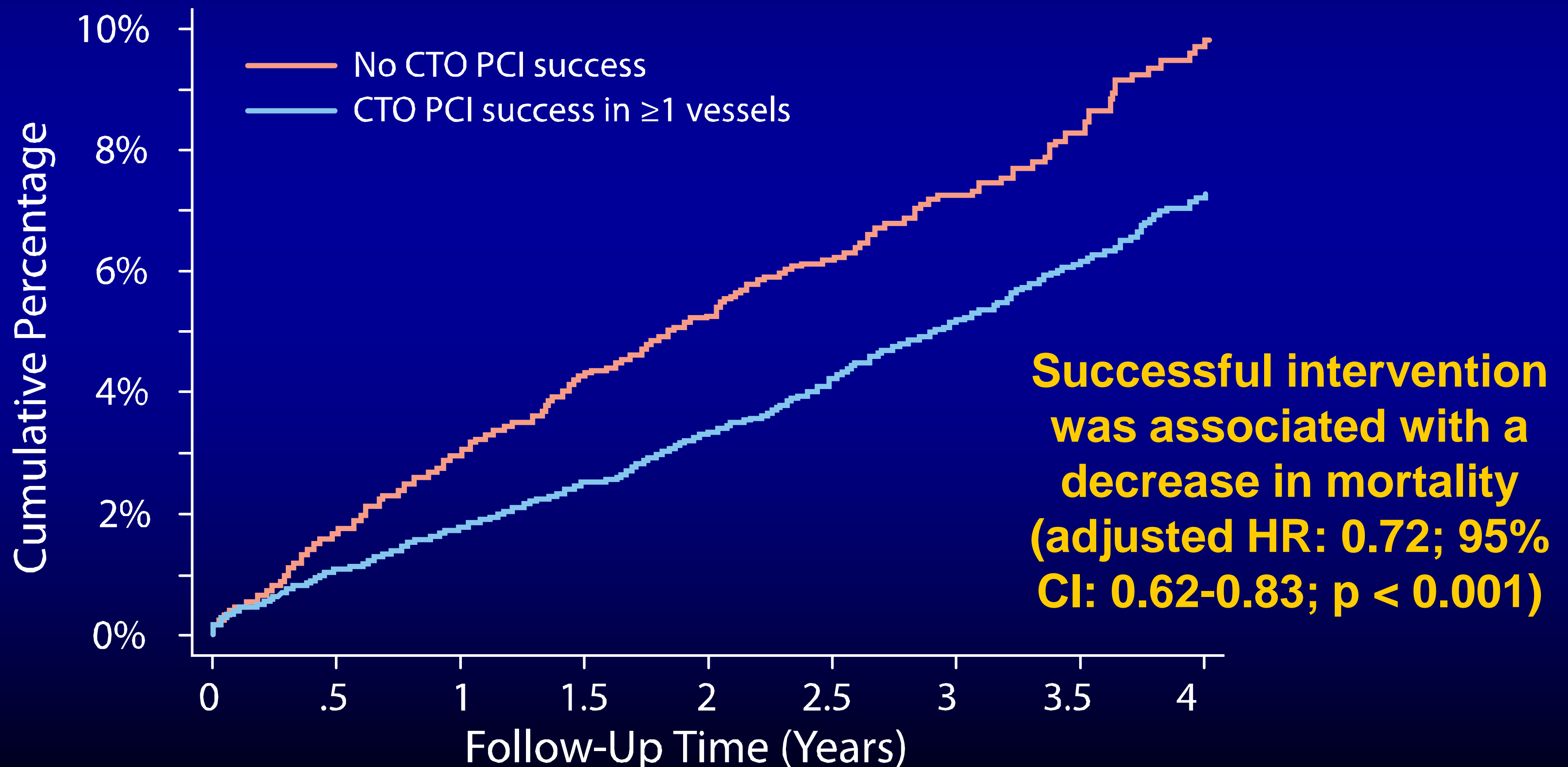
- **Conclusion**: Successful recanalization of a CTO is associated with a survival advantage to 5 years

D. Jones, et al. JACC 2011;58:B1

Long Term Follow Up of Elective CTO PCI:
Analysis from the UK Central Cardiac Audit Database

- 13,443 pts, Jan 2005-Dec 2009 in England & Wales

KM Curve Showing Differences in Mortality Between Those Procedures with Successful and Failed CTO Interventions



S. George et al. *JACC* 2014;64:235

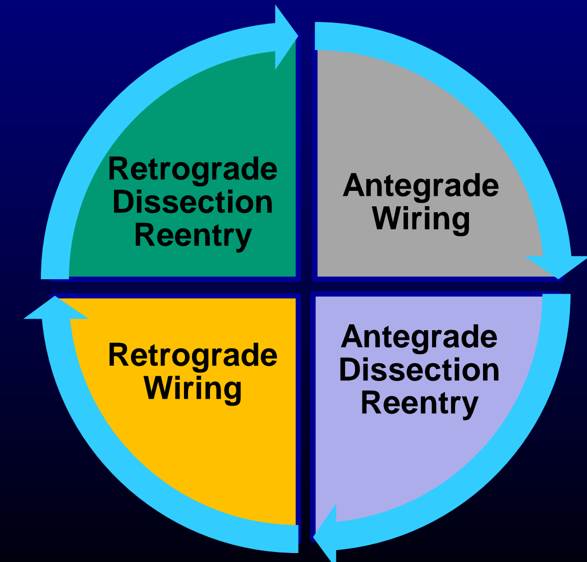
The Efficacy & Safety of the "Hybrid" Approach to CTO:
Insights from a Contemporary Multicenter Registry and Comparison with Prior Studies

Conclusions:

- Efficacy of CTO-PCI has significantly improved
- Experienced operators across various hospitals
- High success rates achieved without incurring increased rates of complications

Hybrid Approach Development

- **The Objective:**
  - Have a rationale approach to pts with clinical indication for CTO PCI
  - Remove the barriers of complex anatomy
  - Eliminate unnecessary nuance and confusion
  - Improve education
  - Increase access and adoption of CTO PCI
  - Eliminate concerns over safety, reproducibility, inefficiency, and expense



Hybrid Approach Development

- 17 patients (9 previous failures)
- 13 physicians
  - 5 CTO operators working in pairs
  - C Thompson, B Lombardi, A Grantham, T DeMartini, M Wyman
- Strategy determined by group blinded to operator assignment
  - Hybrid approach
  - Initial strategy/device
  - Time and progress parameters to switch strategies
- Operator unblinding immediately prior to case
  - Primary and secondary operator
  - Execute assigned strategy

Outcome of Bellingham

Efficiency

Case time (mean)	89.9 min
Cases < 2hrs	82%
Contrast	273.5 cc
Fluoro Time	39.6 min

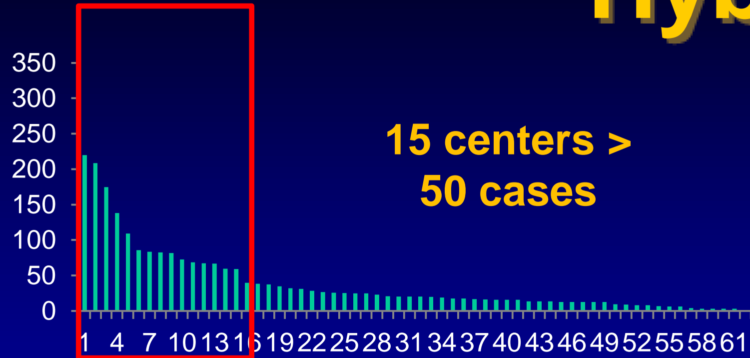
Effectiveness

Technical Success	100%

Safety

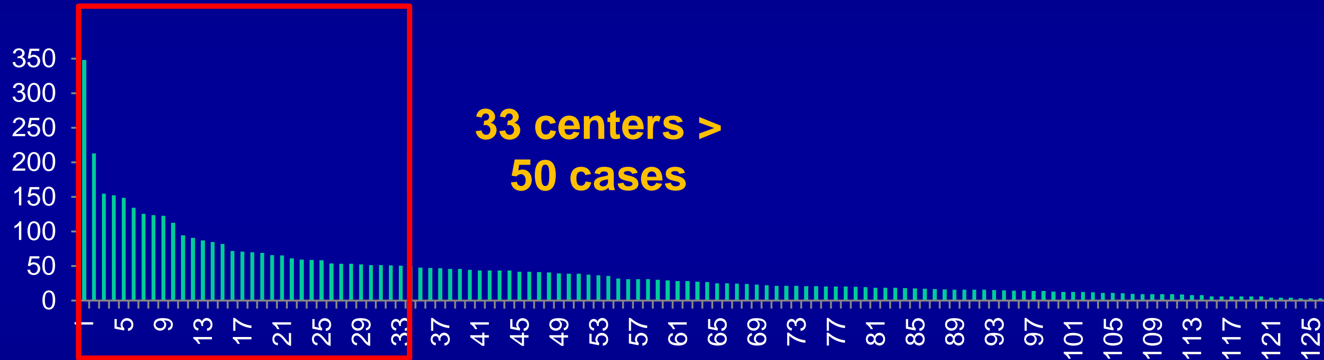
MACE	5.8% (perf)
Death/MI	0%

Hybrid Teaching



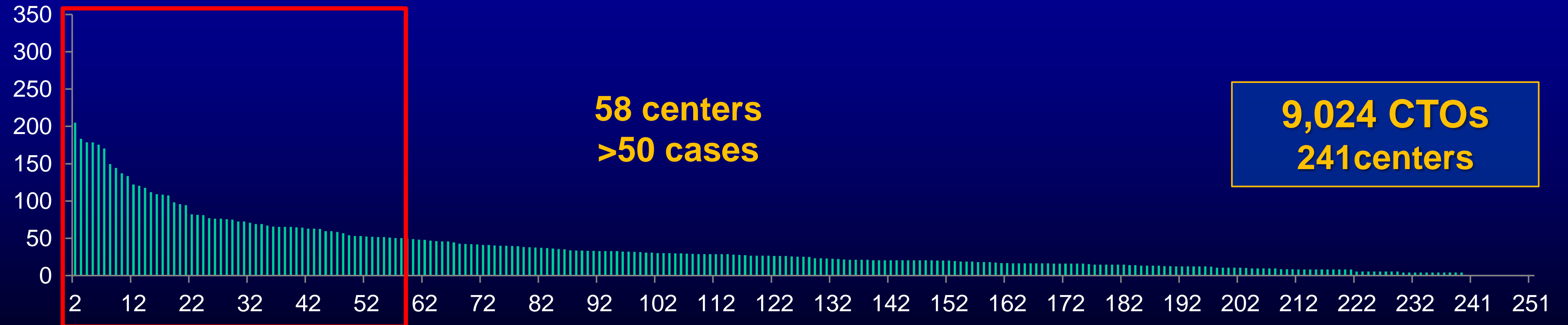
15 centers > 50 cases

2,375 CTOs
62 centers



33 centers > 50 cases

5,208 CTOs
127 centers



58 centers >50 cases

9,024 CTOs
241centers

Industry estimates data on file at Boston Scientific

The Hybrid Approach to Chronic Coronary Artery Occlusion

- No antegrade vs. retrograde approach
- Prepare for antegrade / retrograde approach and dissection reentry
- Selection of equipment anticipating all approaches

The Hybrid Approach to Chronic Coronary Artery Occlusion

Anatomy Dictates Initial Strategy

1. Proximal cap location and morphology
   - Ambiguous vs. non-ambiguous
2. Target vessel at the distal cap, size, disease, side branches
3. Lesion length: > or < 20 mm
   - Long lesions – re-entry or retrograde approach
   - Short lesions – initial antegrade approach
4. Size and suitability of the septal and epicardial collaterals

The Hybrid Approach to Chronic Coronary Artery Occlusion

- Procedural Efficiency
  - Time
  - Radiation
  - Contrast Load
  - Equipment Use
- Changes of strategy should occur quickly and cycle rapidly
- No more than 10-15 minutes in one mode
- Radiation: Notification at 2 Gy intervals
High awareness > 6 Gy
Definitely stop at 10 Gy

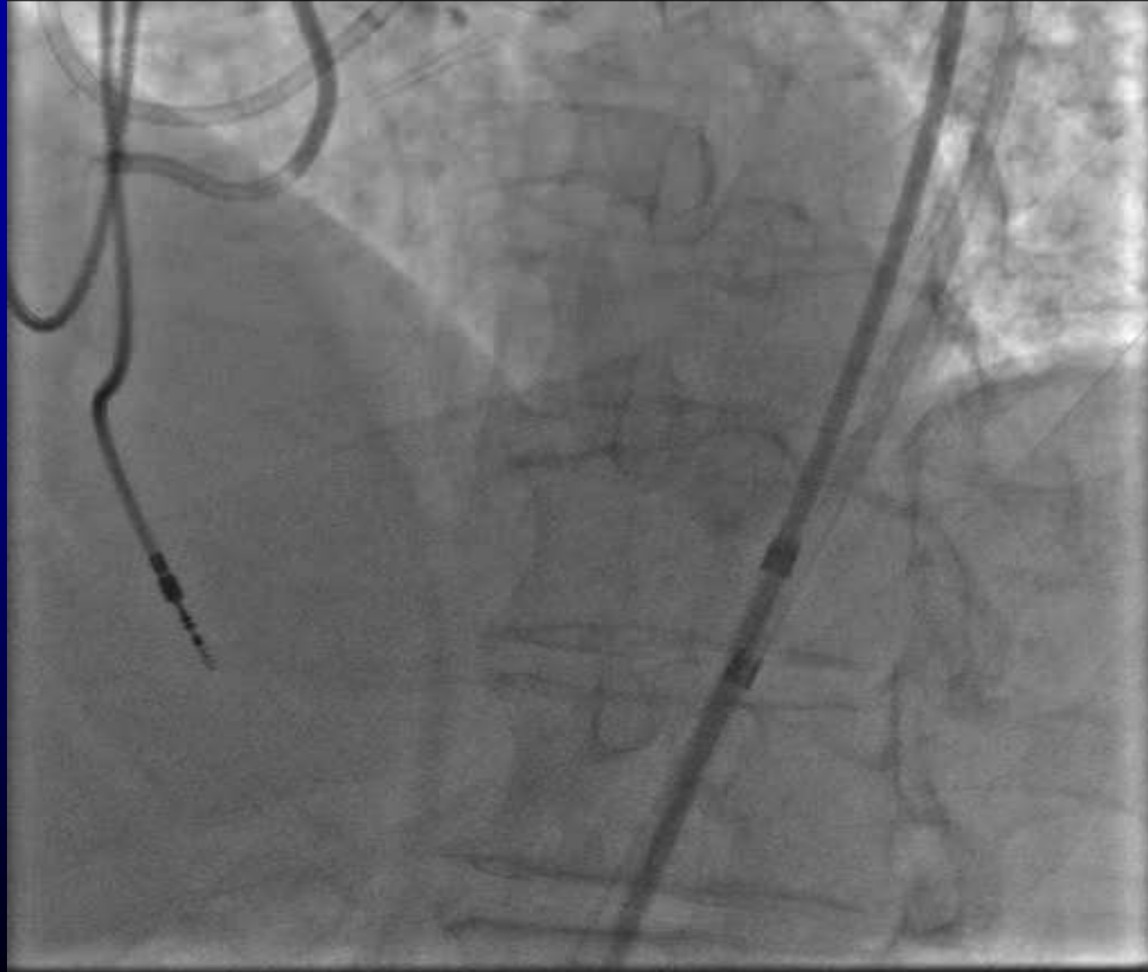
The Hybrid Algorithm for CTO PCI
Provisional Approaches

Dual Catheter Angiography

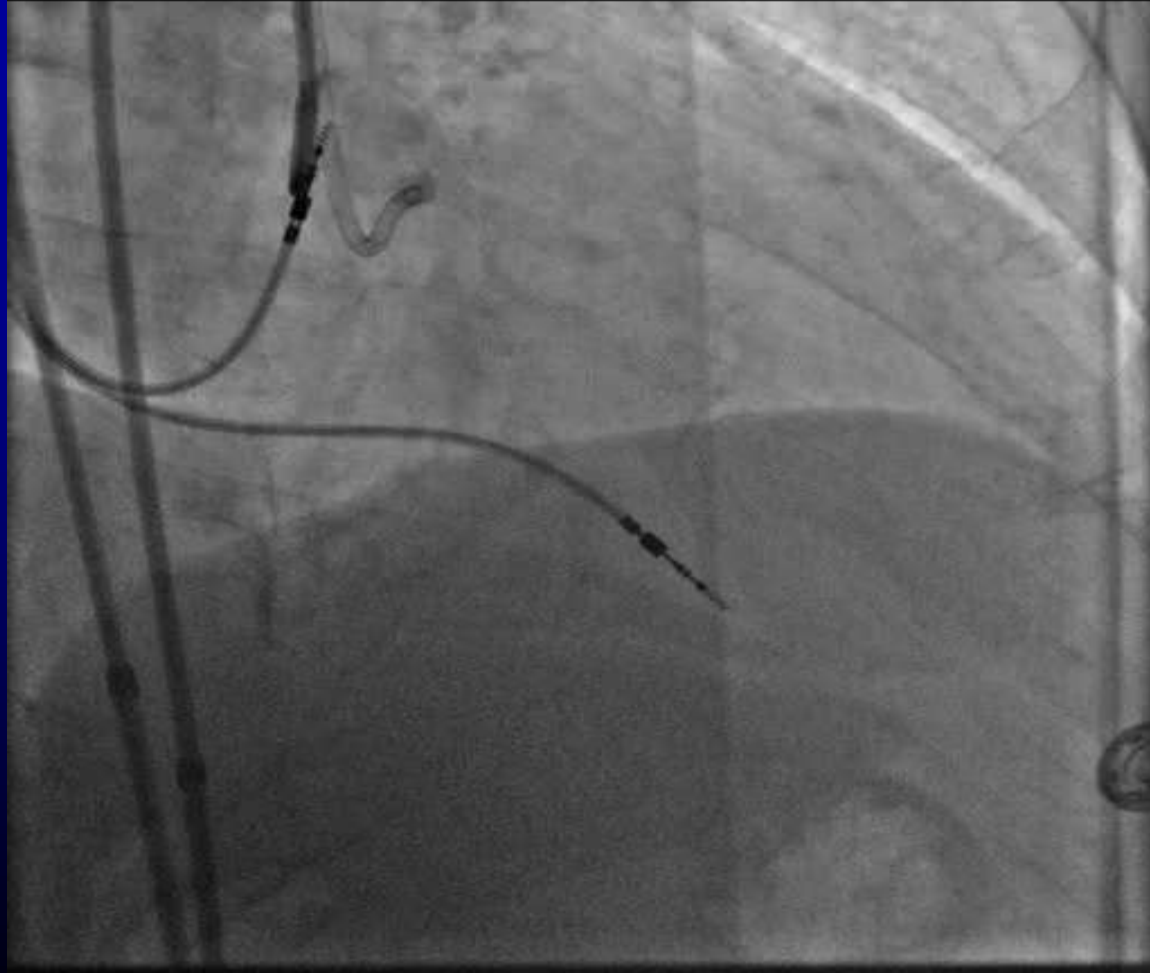
1. Clear proximal cap
2. Good distal target
3. Length < 20mm

- yes → **Antegrade**
  - yes → Wire escalation
    - fail → Dissection Reentry (crossboss-stingray)
  - no → Dissection Reentry (crossboss-stingray)
    - fail → Dissection Reentry (reverse CART)
- no → **Retrograde**
  - yes → Wire escalation
    - fail → Dissection Reentry (reverse CART)
  - no → Dissection Reentry (reverse CART)
    - fail → Dissection Reentry (crossboss-stingray)

Hybrid Case



Baseline Coronary Angiogram

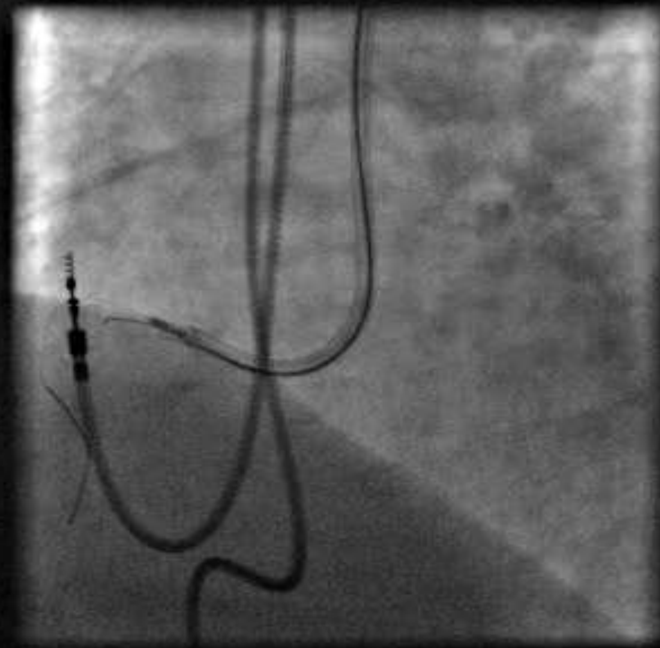


Algorithm

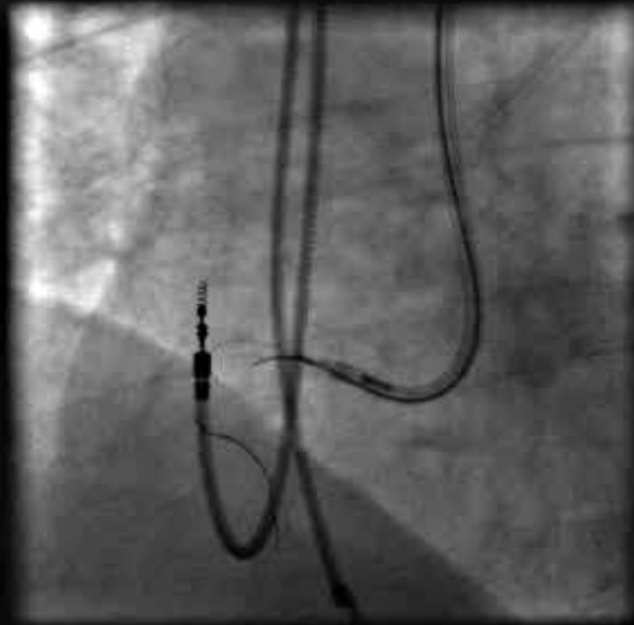
- Proximal cap ambiguous = retrograde approach
- Target favorable = antegrade approach
- Collateral epicardials = difficult retrograde
- Length >20 = Dissection-Reentry

- Antegrade-Dissection-Reentry with proximal cap solution
- Retrograde-Dissection-Reentry bailout septal, then epicardial

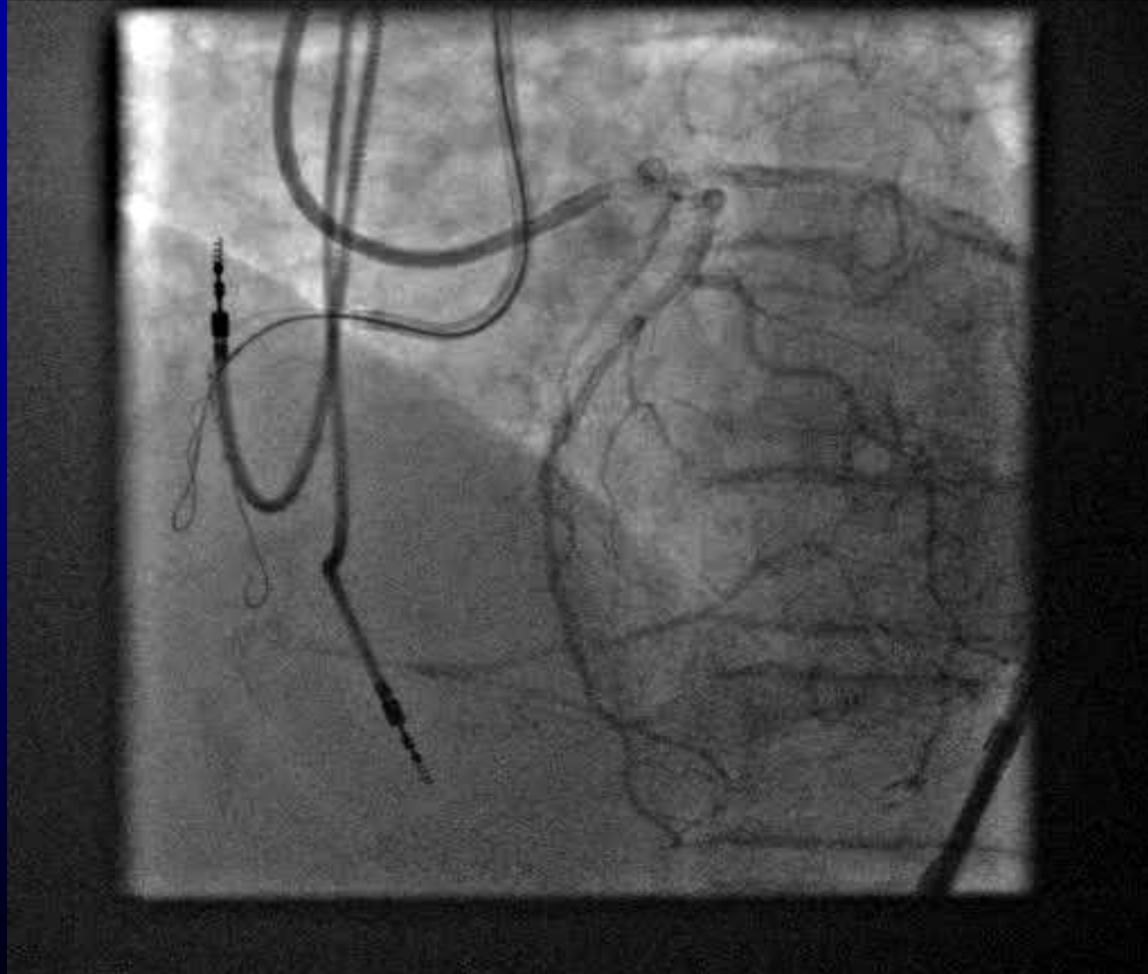
IVUS Guided Antegrade Puncture



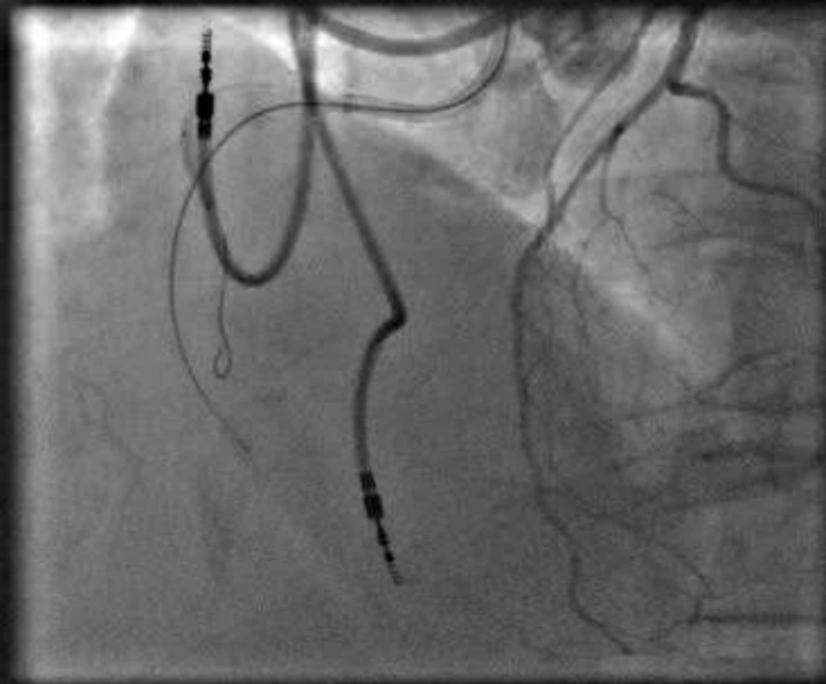
Corsair into Sub-Intimal Space



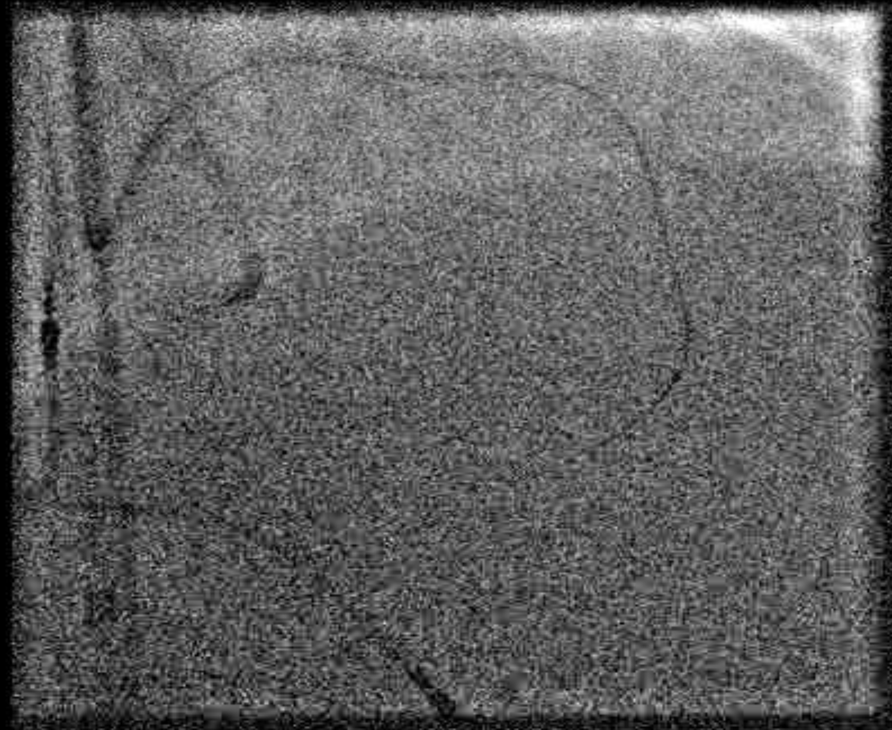
Knuckle Wire Dancing



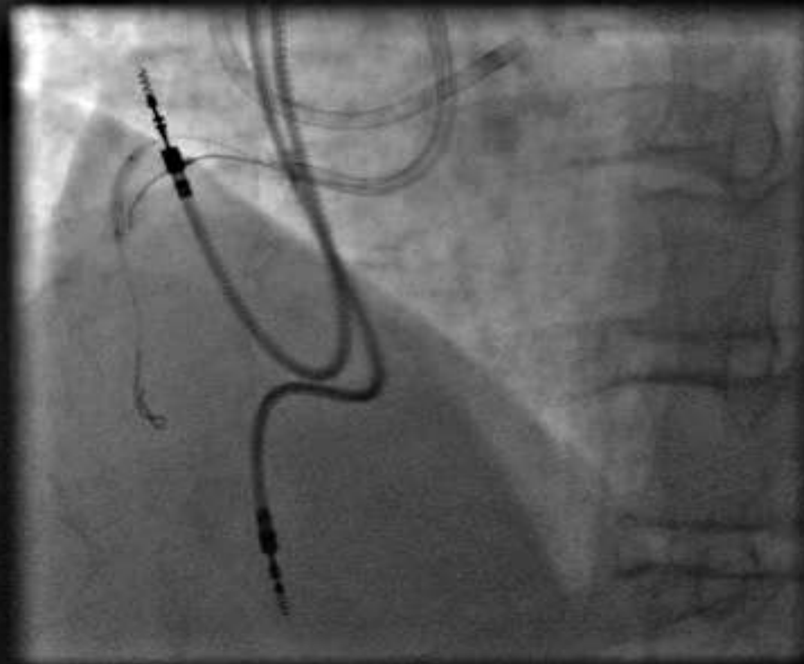
CrossBoss Not Dancing - in Sidebranch



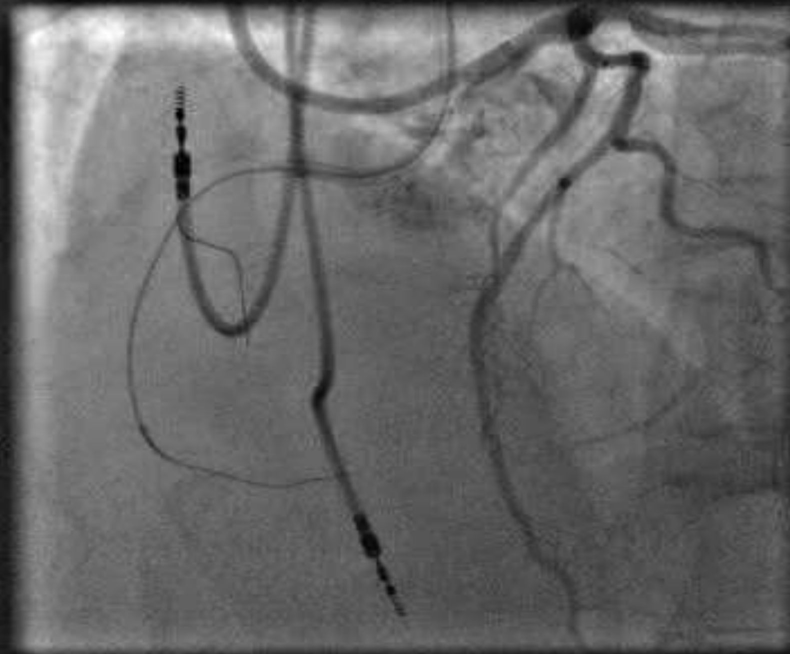
Switch to Retrograde – Septal Surfing



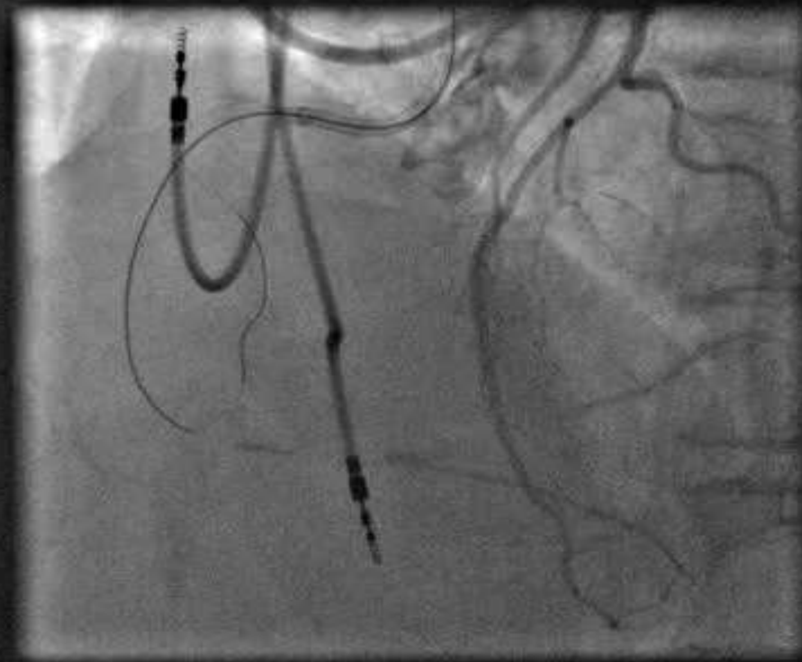
Back to Antegrade - IVUS guided redirect



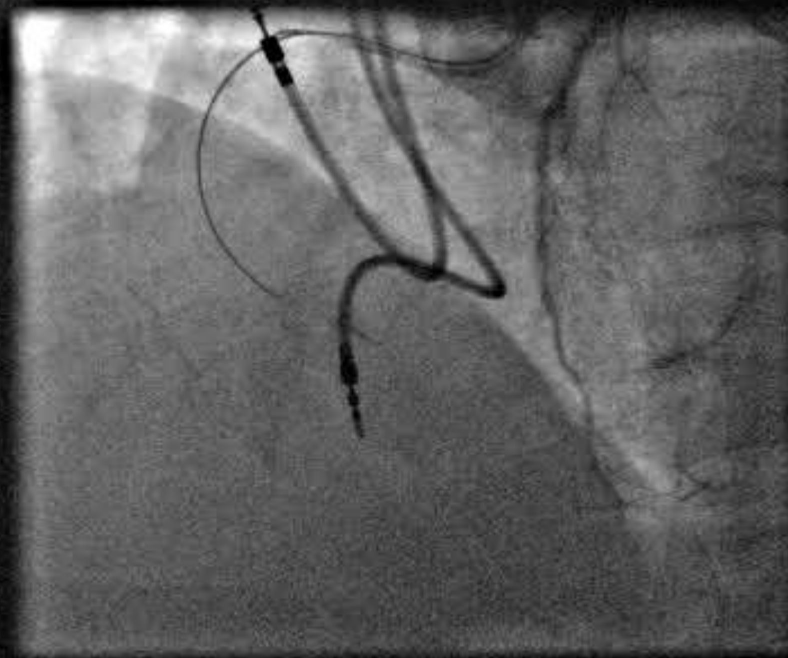
Pilot 200 redirect



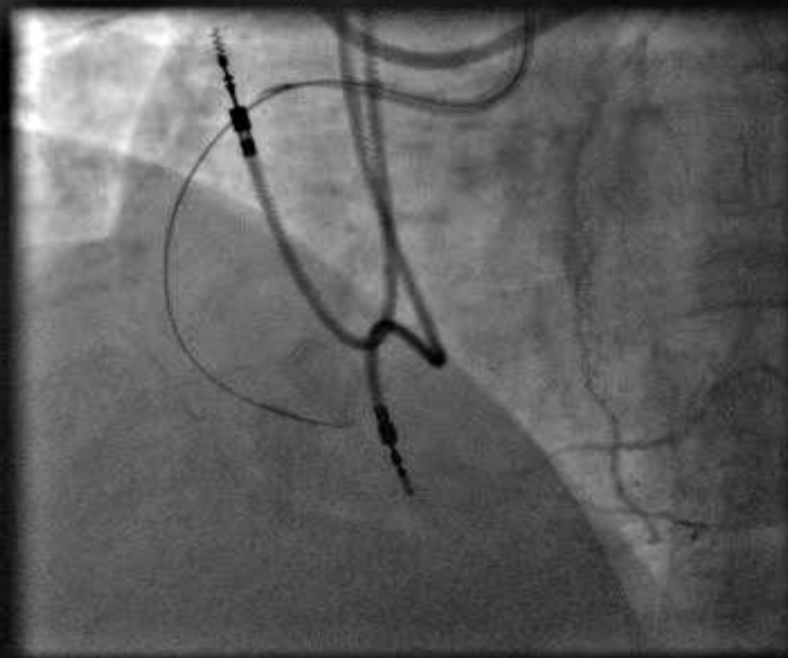
Sub-Intimal Hematoma



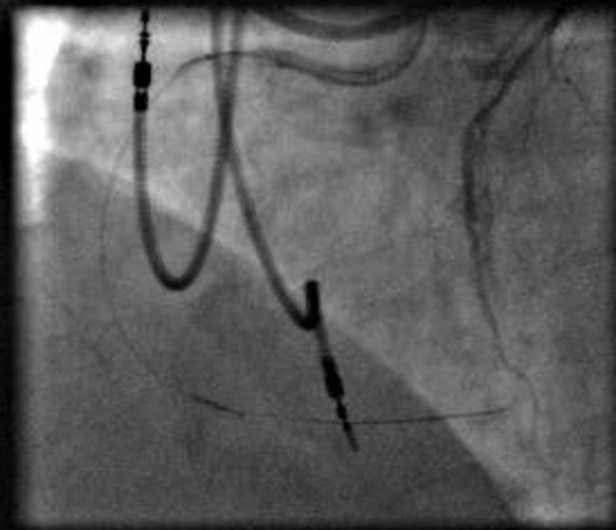
Sub-Intimal Transcatheter Withdrawal (STRAW)



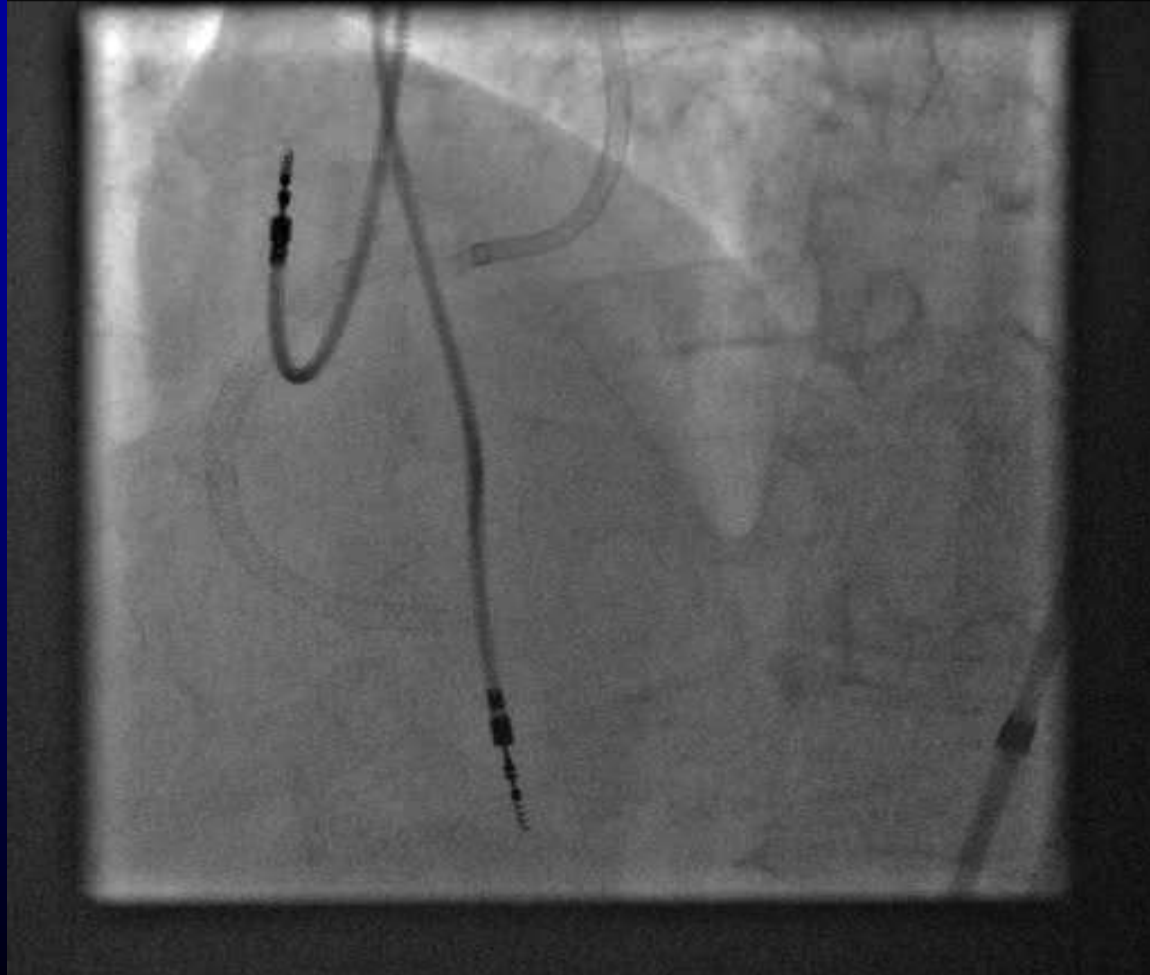
Stick
CrossBoss Wire or Confianza Pro 12



Swap
Pilot 200



Final



Case Summary

- IVUS guided antegrade puncture
- Knuckle wire
- Crossboss with redirect
- IVUS redirect
- STRAW
- Stick and swap
- 2.6 Gy
- 220 cc contrast
- 92 min

The Efficacy & Safety of the "Hybrid" Approach to CTO: *Insights from a Contemporary Multicenter Registry and Comparison with Prior Studies*

- January 2012-August 2013; 497 pts at 5 high-volume centers compared to prior studies of ≥ 100 CTO pts (18,536 pts)

	Hybrid Approach N=497	Std Approach N=18,536	P-value
Technical Success	91.5%	76.5%	<0.001
Procedural Success	90.7%	75.2%	<0.001
Death	0.4%	0.4%	0.96
MACE	1.8%	2.0%	0.72
Q-wave MI	1.0%	0.6%	0.28
CVA	0%	0.1%	0.45
Perforation per lesion	3.2%	2.7%	0.49
Tamponade	0.4%	0.5%	0.76
Bleeding	0.6%	0.7%	0.72

G. Christopoulos et al. J Invas Cardiol. 2014;26:427