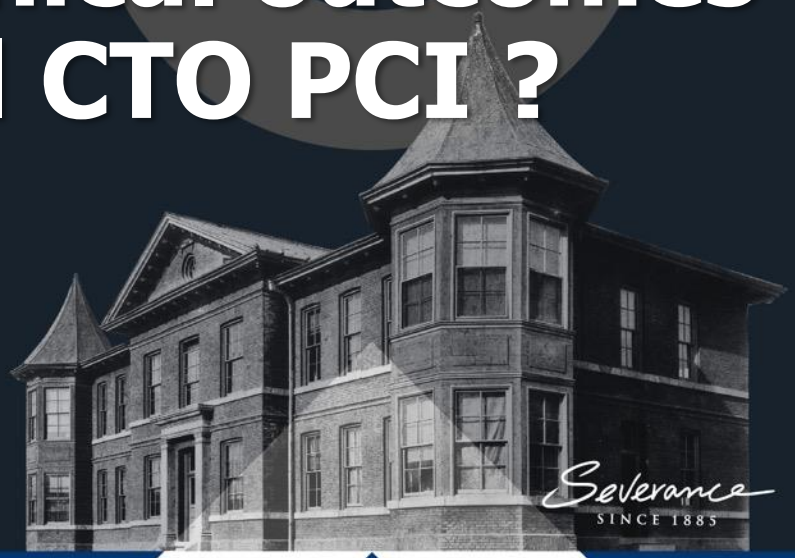
YONSEI UNIVERSITY

How to improve clinical outcomes after successful CTO PCI ?

Byeong-Keuk Kim, MD, PhD
Division of Cardiology, Department of Internal Medicine,
Severance Cardiovascular Hospital,
Yonsei University College of Medicine



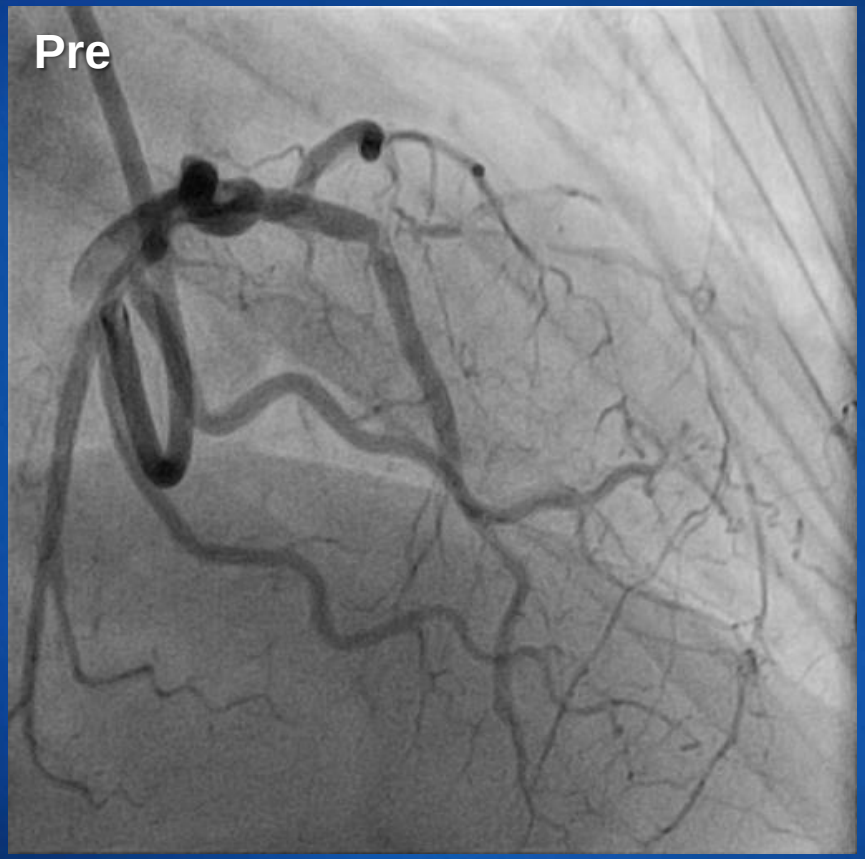
A successful CTO recanalization, Guarantee the successful clinical outcomes?

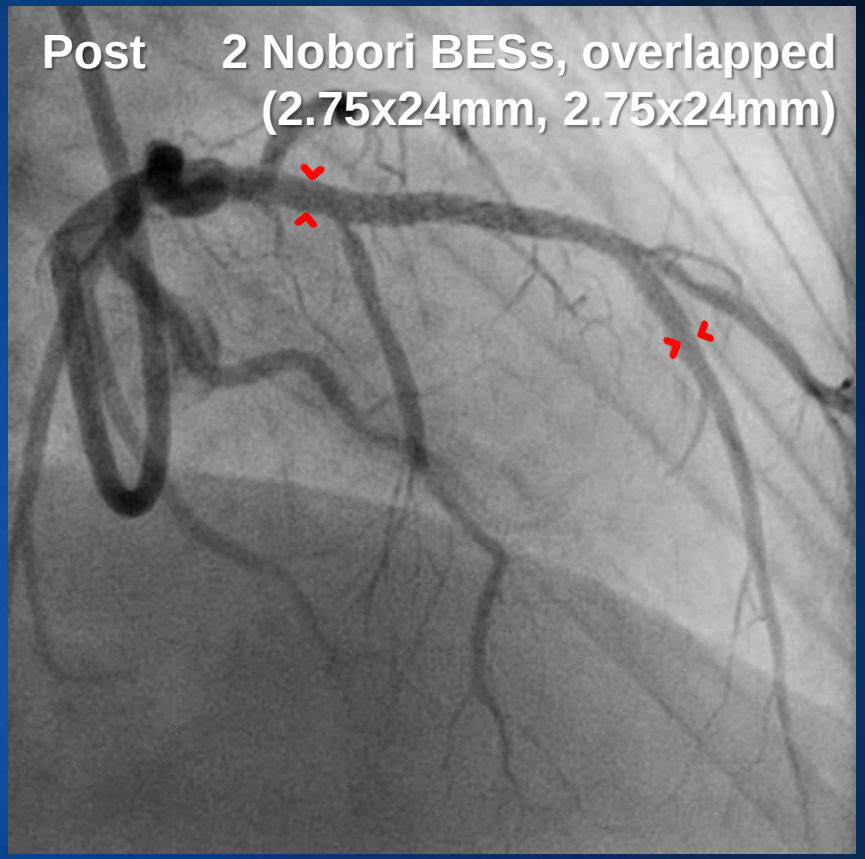
- For the CTO interventionalists, successful wiring is always important.
- For CTO patients, both successful procedures & living-long are important !

☆Is "Successful wiring" "Successful CTO-PCI" ?

Patient 1. LAD-CTO

F/66; Heart failure (EF=35~45%), HiBP

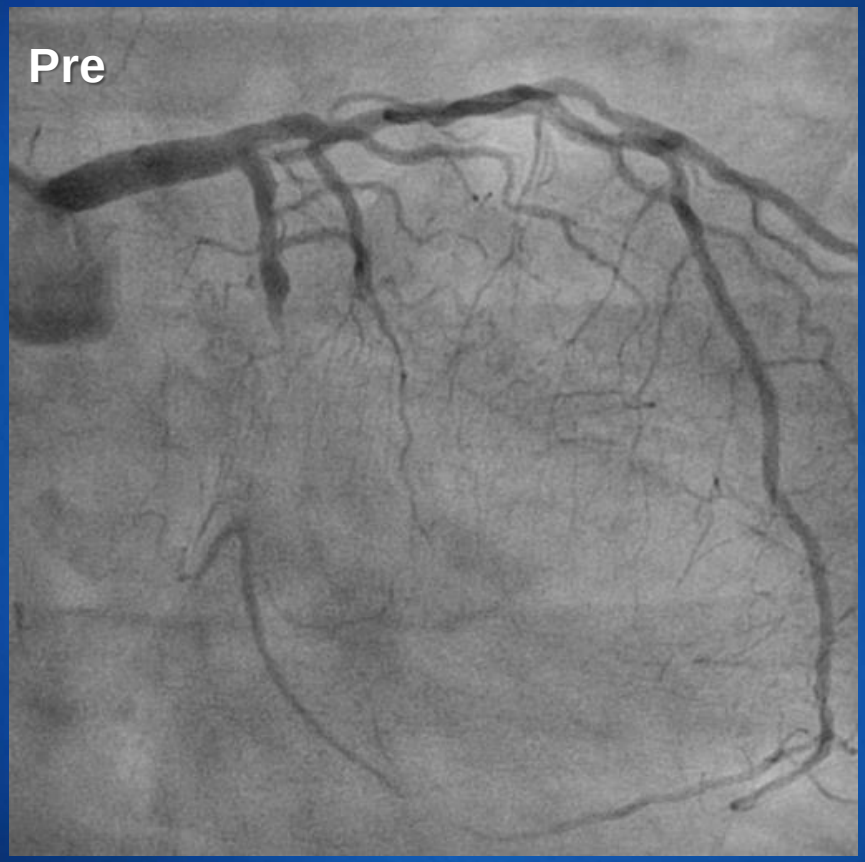


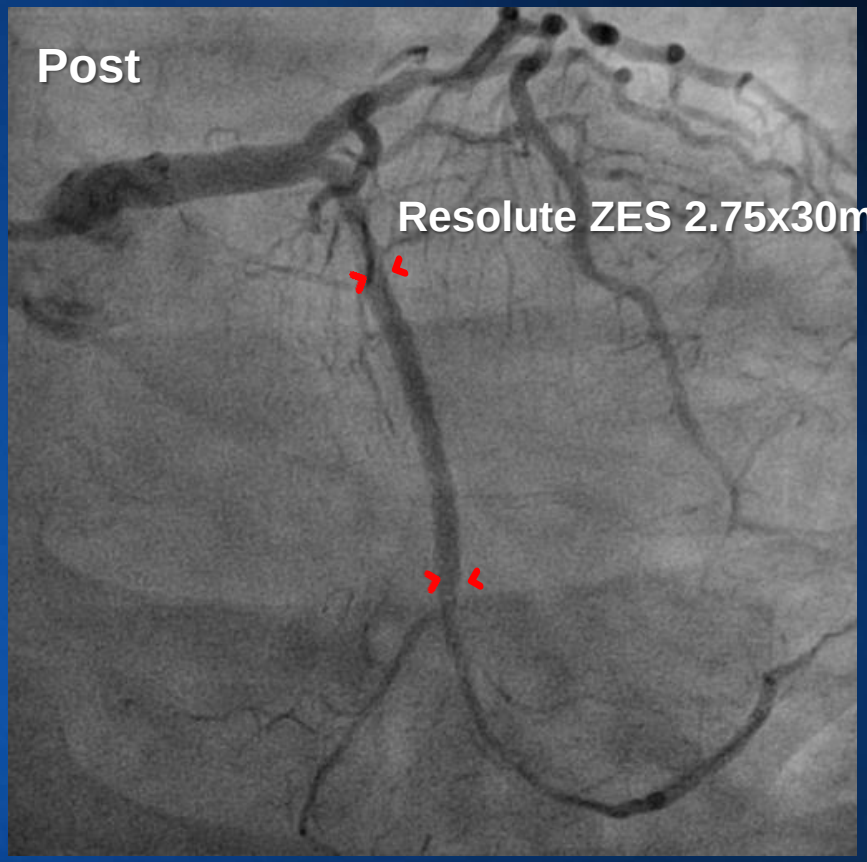


- Antegrade approach → final success by parallel wiring

Patient 2. LCx-CTO

F/55; DM

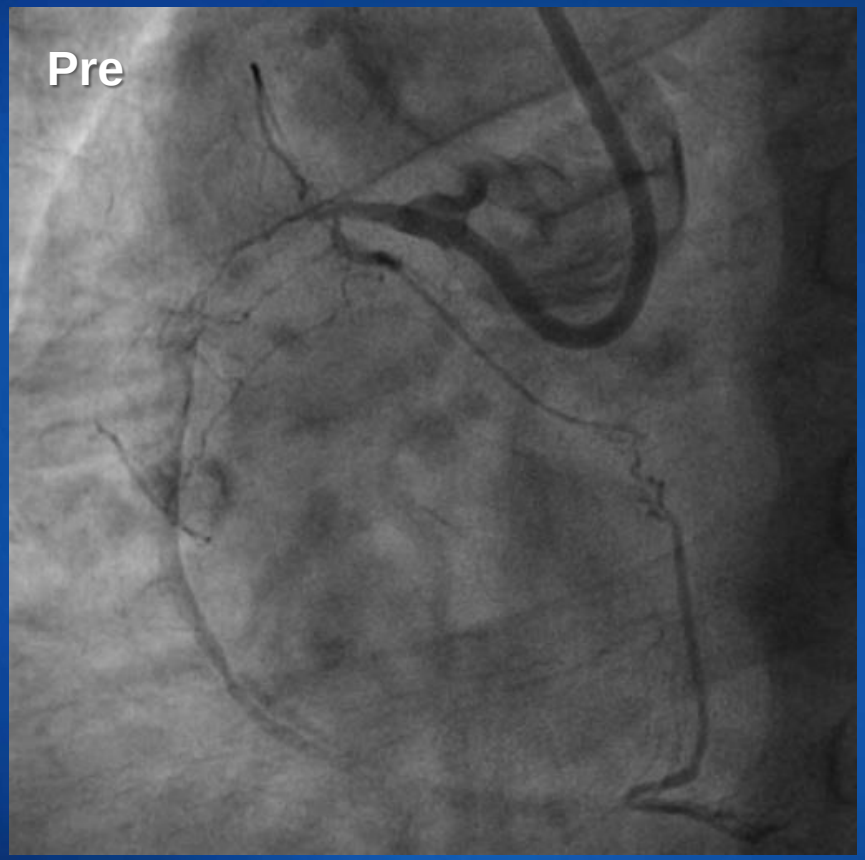


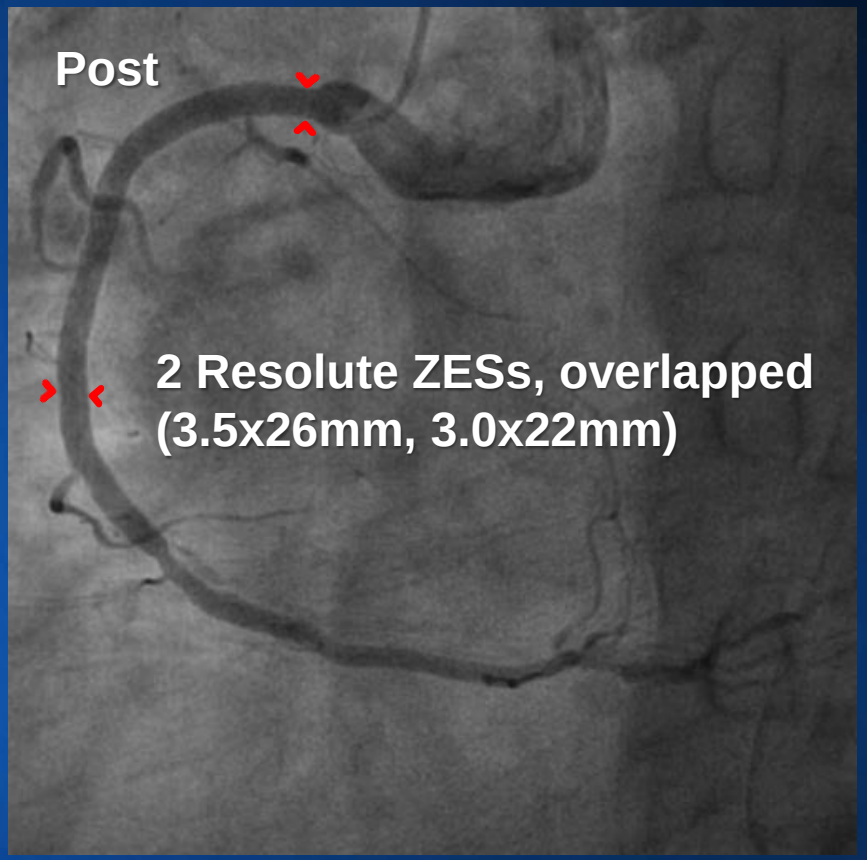


- Ipsilateral collateral channel → finally succeed (procedure time; 4hrs)

Patient 3. RCA-CTO

F/80; HiBP, Smoker

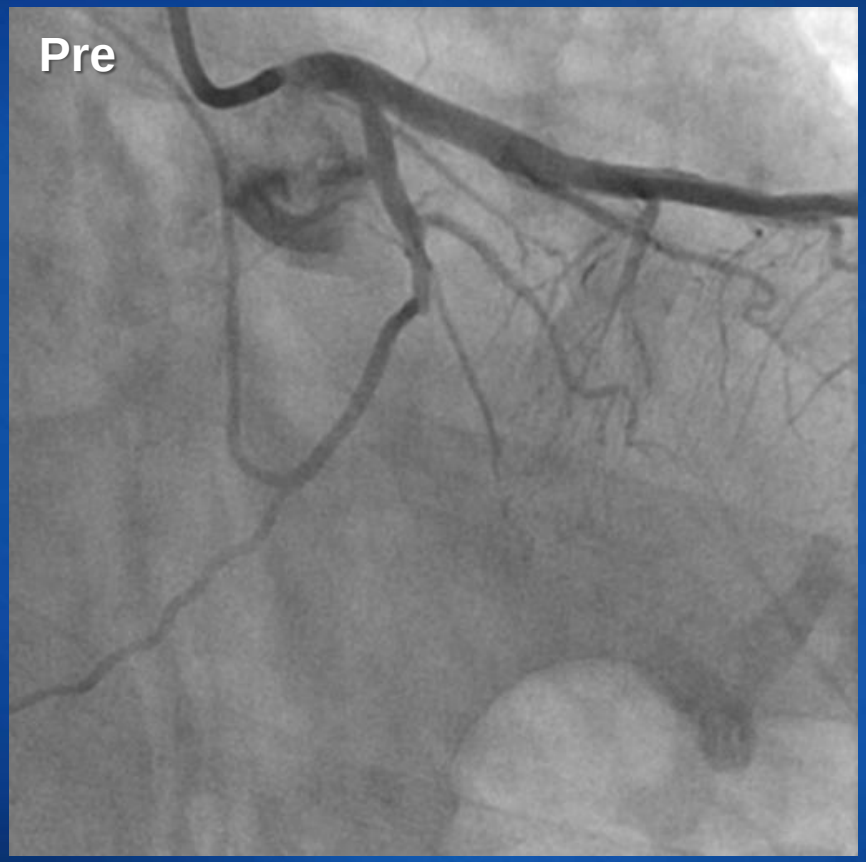


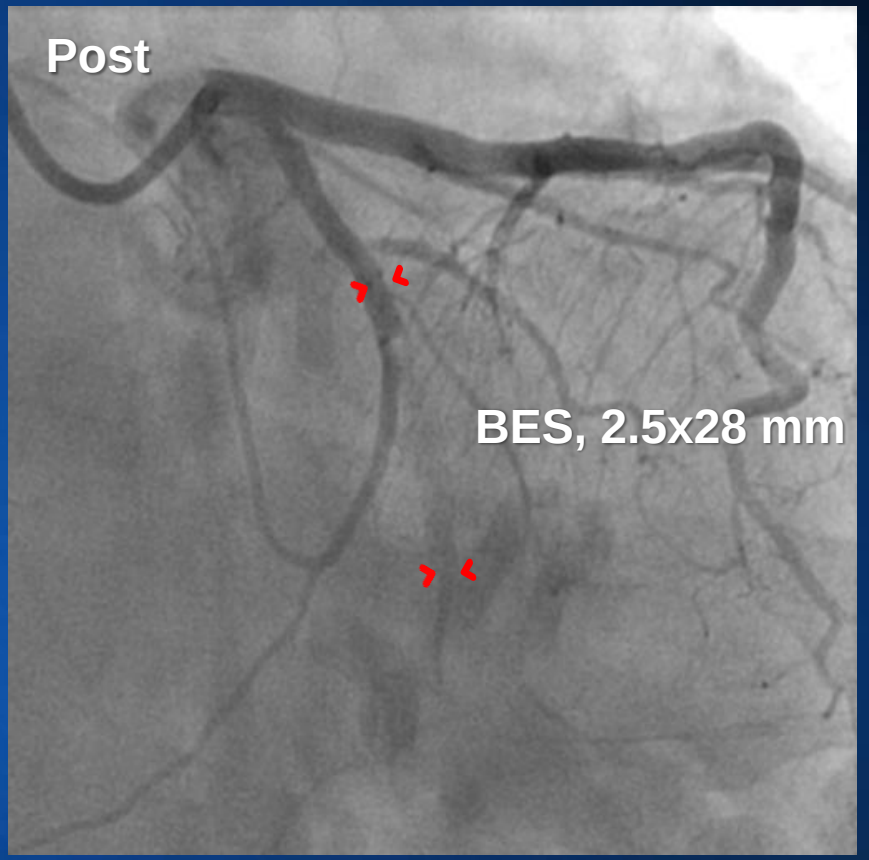


- Start anterograde → Change into retrograde approach
  → finally succeed ! (total No. of wires used; 9)

Patient 4. LCx-CTO

M/70; Heart failure (EF=34%), Smoker



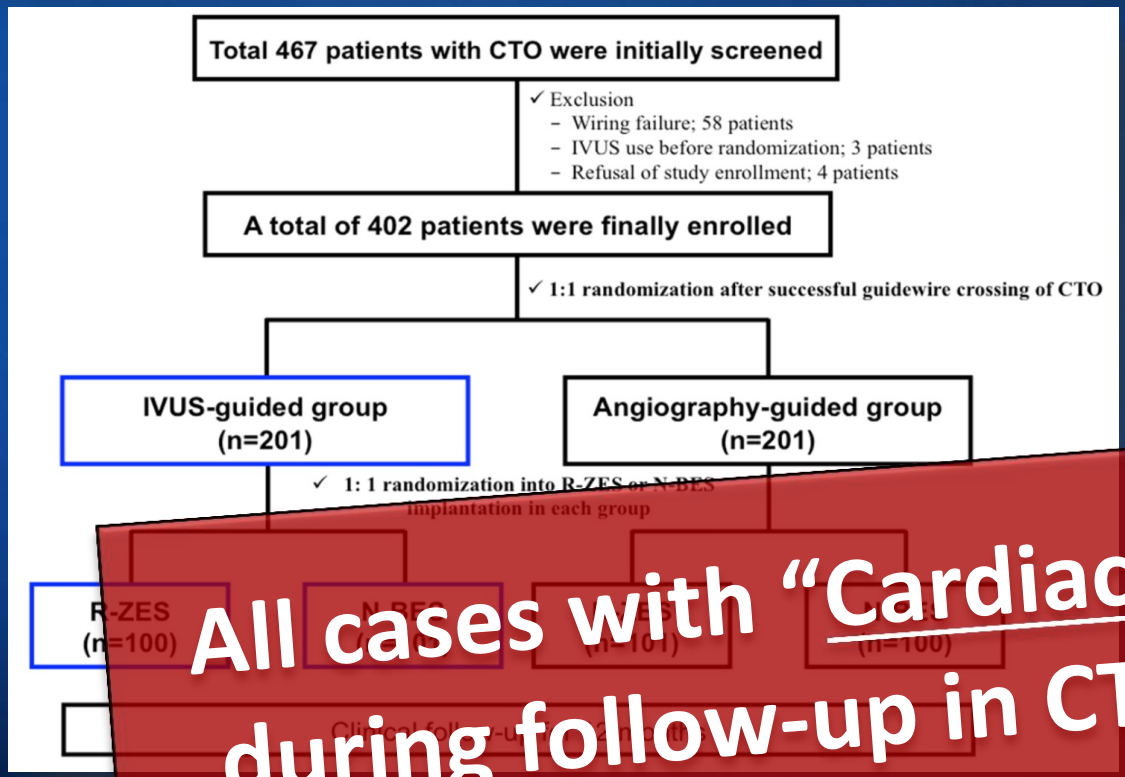


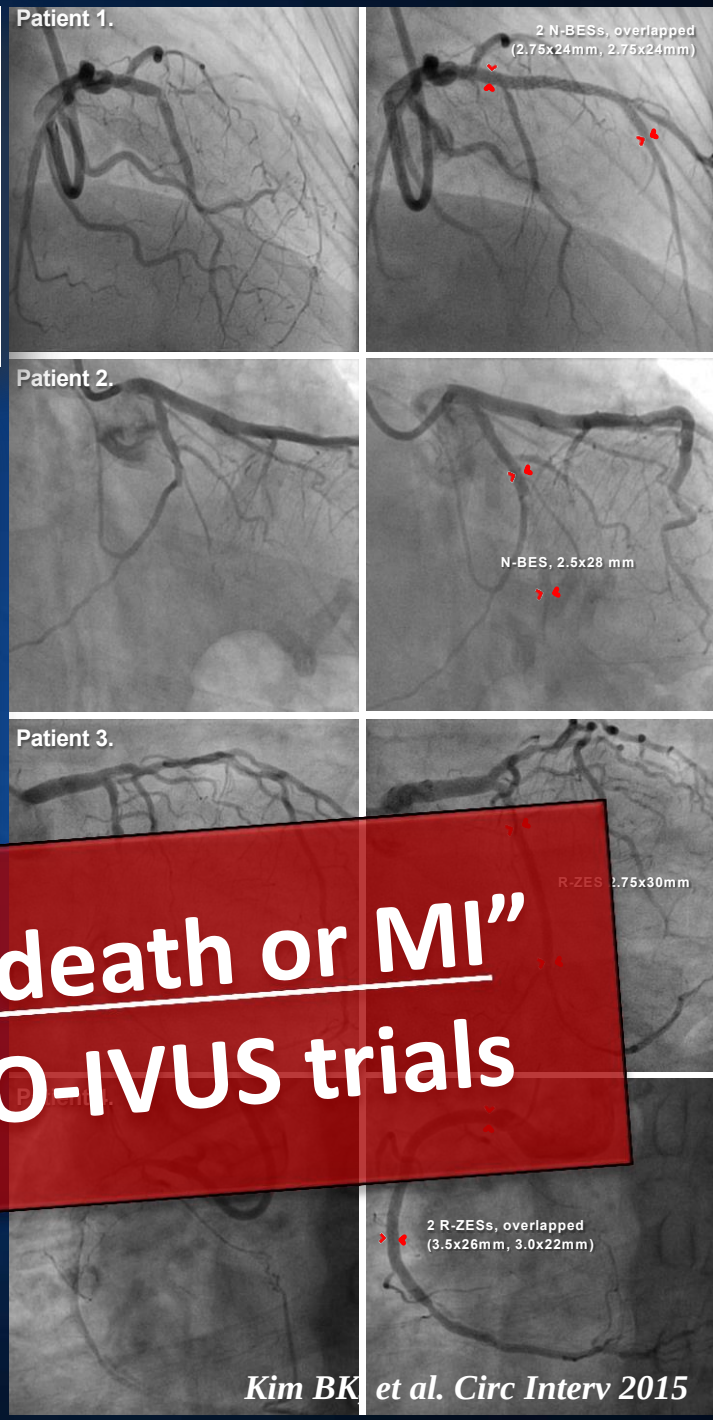
- Successful antegrade wiring within 10 mins → 1 DES implanted
  → However, procedure ended without obtaining TIMI III

Clinical Impact of Intravascular Ultrasound–Guided Chronic Total Occlusion Intervention With Zotarolimus-Eluting Versus Biolimus-Eluting Stent Implantation

Randomized Study

Byeong-Keuk Kim, MD; Dong-Ho Shin, MD; Myeong-Ki Hong, MD; Hun Sik Park, MD; Seung-Woon Rha, MD; Gary S. Mintz, MD; Jung-Sun Kim, MD; Je Sang Kim, MD; Seung-Jin Lee, MD; Hee-Yeol Kim, MD; Bum-Kee Hong, MD; Woong-Chol Kang, MD; Jin-Ho Choi, MD; Yangsoo Jang, MD; for the CTO-IVUS Study Investigators*



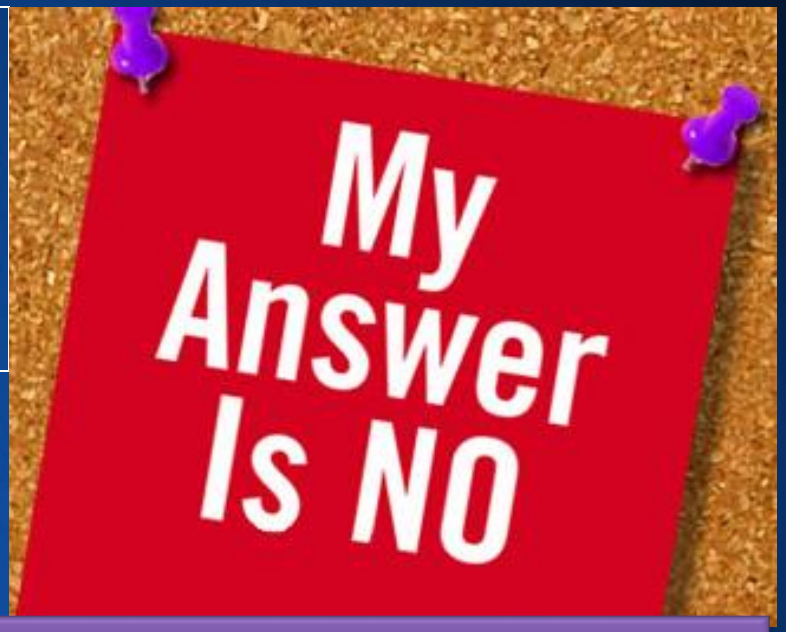


All cases with "Cardiac death or MI" during follow-up in CTO-IVUS trials

Kim BK et al. Circ Interv 2015

A successful CTO recanalization, guarantee the successful clinical outcomes?

☆ **Successful wiring, successful CTO-PCI?**



A Successful CTO-PCI … should be …

"A good long-term clinical outcomes after successful PCI"

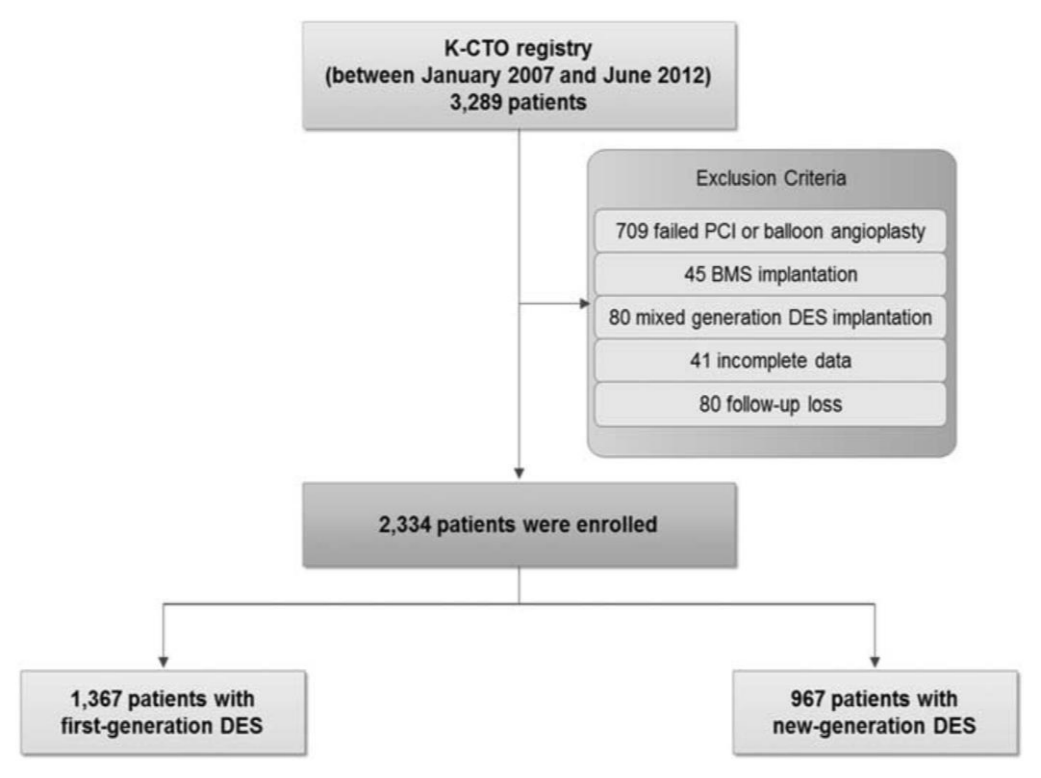
How to improve clinical outcomes after successful CTO PCI ?

1. Patients' and lesions' characteristics predicting the worse clinical outcomes after successful CTO-PCI?

Predictors of poor clinical outcomes after successful chronic total occlusion intervention with drug-eluting stents

Gwang-Sil Kim[a,*], Byeong-Keuk Kim[b,*], Dong-Ho Shin[b], Jung-Sun Kim[b], Myeong-Ki Hong[b], Hyeon-Cheol Gwon[c], Hyo-Soo Kim[d], Cheol Woong Yu[f], Hun Sik Park[g], In-Ho Chae[h], Seung-Woon Rha[e] and Yangsoo Jang[b]; for the K-CTO Registry

- Study population: Korean CTO (K-CTO) registry from 2007 to 2012
  - → **2,334 patients in whom CTO intervention was successful on using same-generation DES** were enrolled.
- Primary endpoint: **composite of cardiac death, MI, and ST** (median follow-up duration: 22 months)



✓ Cumulative incidence of the primary endpoint; **2.5%**

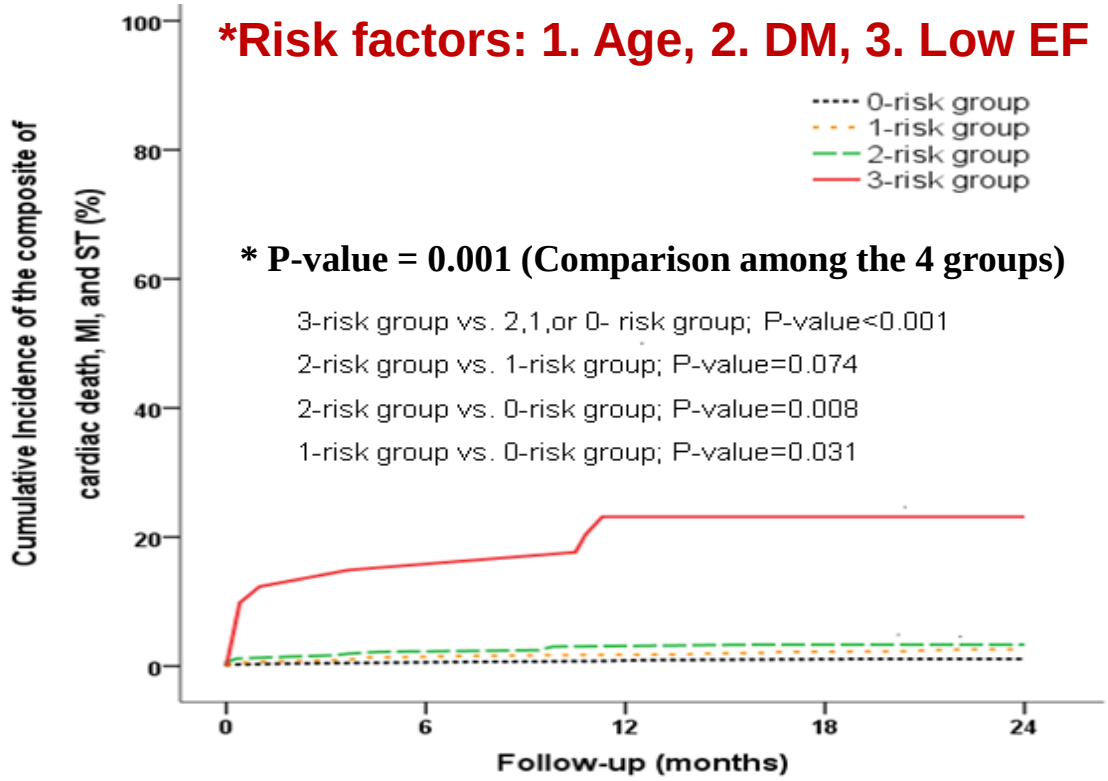
Predictors for the events after successful CTO-PCI?

	Adjusted HR	95% CI	P
Cardiac death, MI or ST			
Age ≥65 years	**1.8**	**1.03-3.05**	**0.041**
Diabetes mellitus	**1.8**	**1.04-3.01**	**0.034**
LVEF <40%	**4.2**	**2.34-7.71**	**0.001**
TVR			
Lesion length ≥ 20 mm	**1.626**	1.129-2.340	**0.009**
Number of implanted stents ≥3	**1.964**	1.301-2.965	**0.001**

Kim et al. 2017 CAD

✓ Outcomes between single- vs. multiple-risked group? … Single predictor increases the risk?

Comparison of the according to the No. of risk factors



No. at risk					
0-risk group	784	730	694	651	620
1-risk group	916	852	810	762	740
2-risk group	403	370	349	320	305
3-risk group	41	31	27	24	20

CAD 2017 Kim et al.

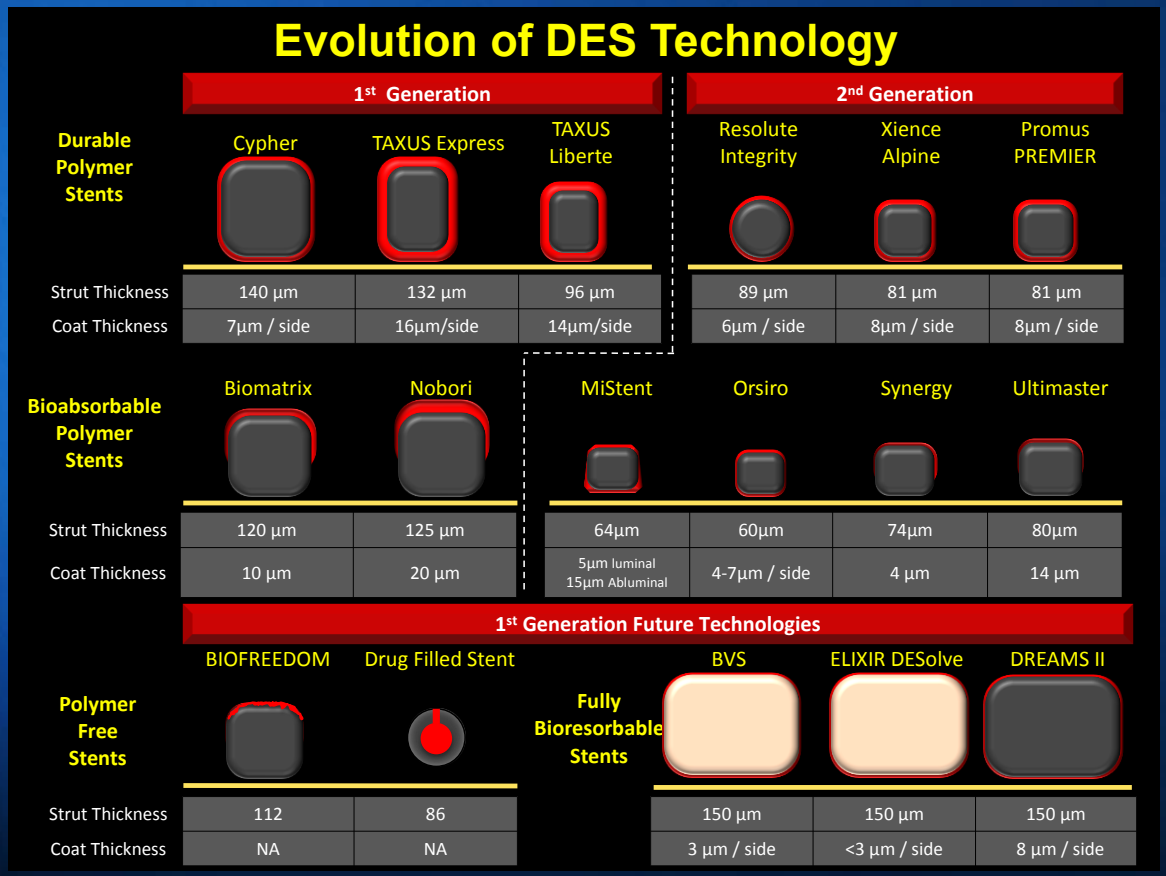
How to improve clinical outcomes after successful CTO PCI ?

1. Patients' and lesions' characteristics predicting the worse clinical outcomes after successful CTO-PCI?

- ✓ **Clinical parameters (old age, DM, & HF)** were independent predictors of **the fatal events** whereas **angiographic/procedural parameters (lesion length & stent No.)** were predictors of **TVR**.
- ✓ The **higher the number of clinical risk factors**, the higher the fatal event rates.
  - ➨ Consideration of the proper revascularization strategy before CTO-PCI (PCI vs CABG?)
  - ➨ A more strict follow-up needed.

How to improve clinical outcomes after successful CTO PCI ?

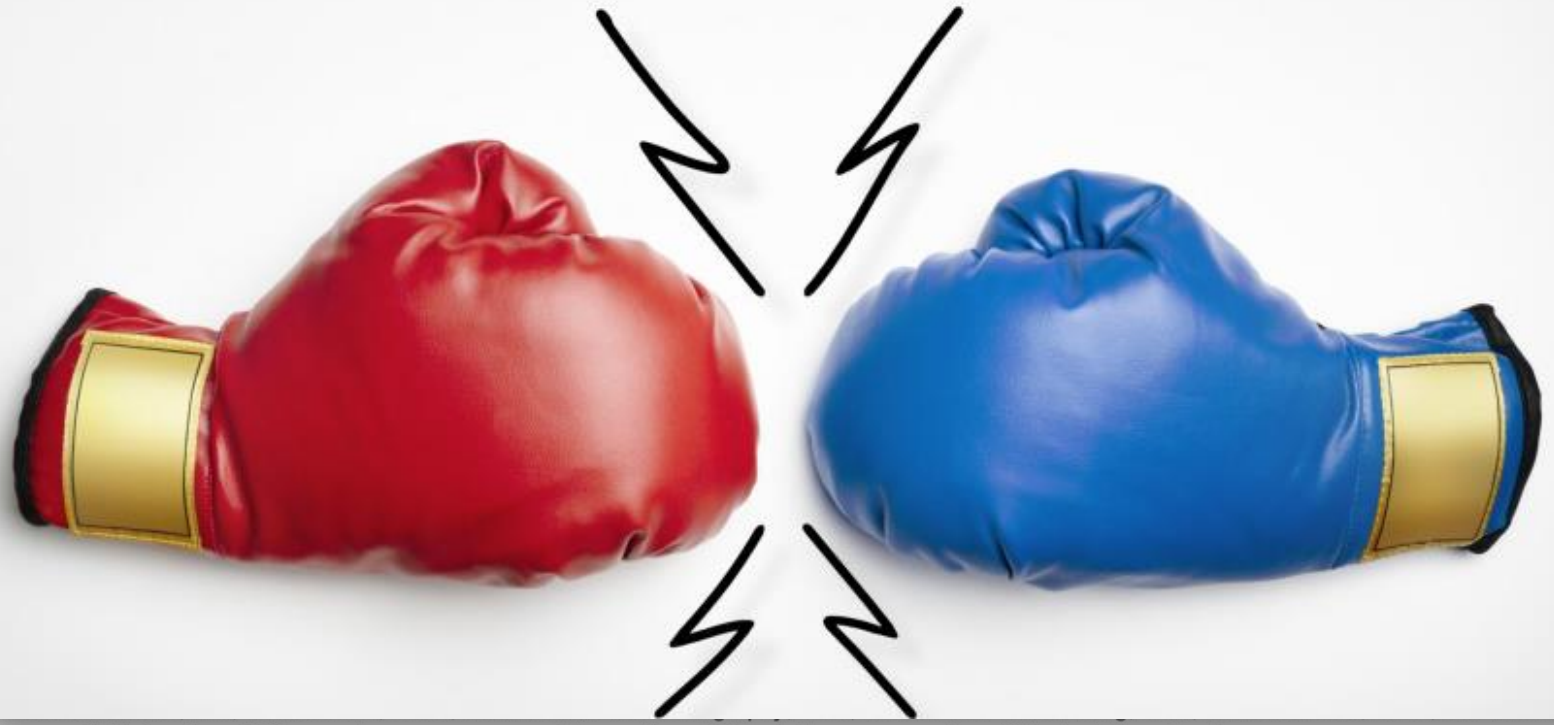
2. Types of DESs could affect the outcomes?



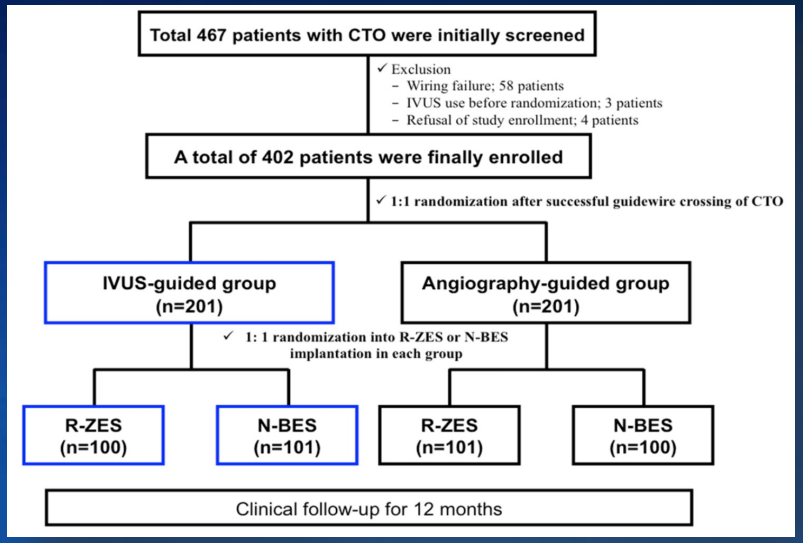
First-generation vs Second-generation DESs in CTO?

- After successful CTO intervention, New-generation DESs showed

New-generation vs. Newer-generation ?



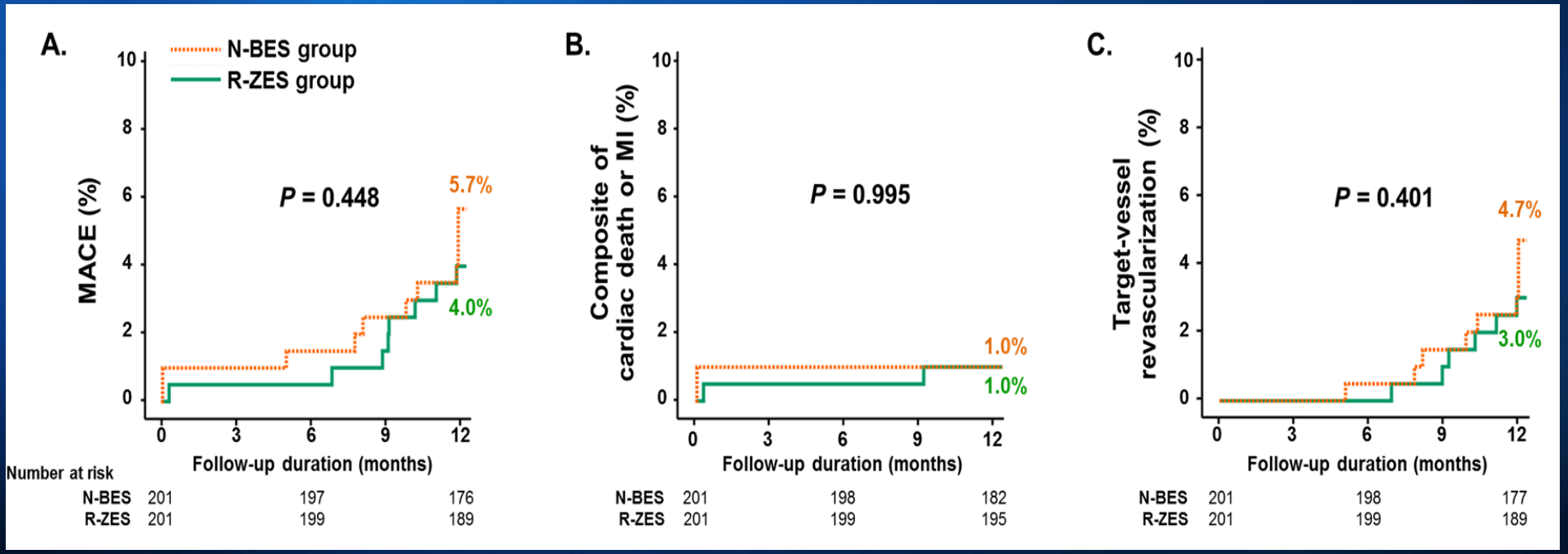
Kim, et al. CAD 2017;28:381-86.



From the randomized CTO-IVUS trial

Comparison between new-generation DESs;

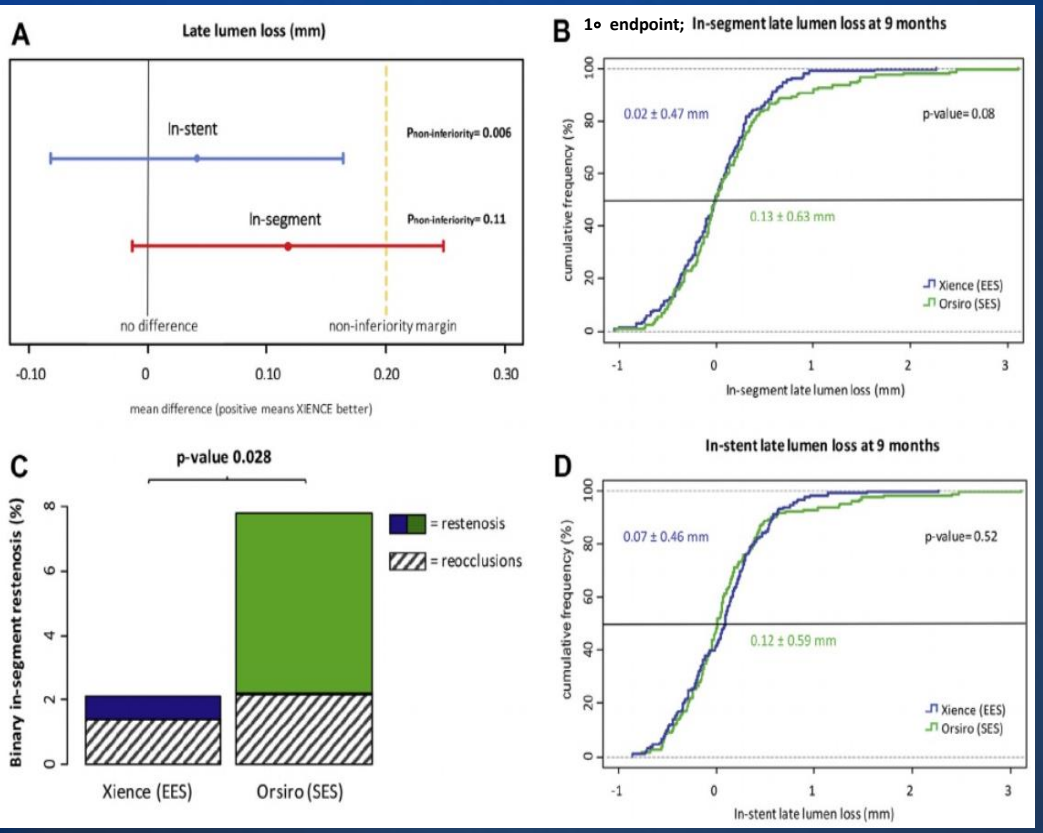
N-BES vs. R-ZES ?



Kim BK, et al. Circ Interv 2015

Randomized PRISON IV trial

Outcomes between EES vs Hybrid SES in CTO ?



	Hybrid SES (n = 165)	EES (n = 165)	p Value
TLR	16 (10.5)	6 (4)	0.04
Clinically driven	14 (9.2)	6 (4)	0.08
OCT driven	2 (1.4)	0	0.16
Target vessel revascularization, non-TLR	0	3 (2)	0.08
Non-target vessel revascularization	20 (12.3)	18 (11.1)	0.75
Planned	13 (7.9)	12 (7.3)	0.82
Unplanned	5 (3.5)	8 (5.3)	0.39
Myocardial infarction*	1	1	
Stent thrombosis			
Definite or probable	1	1	
Possible		1	
Timing			
Late†	1	2	
Death			
Cardiac	1	2	
Noncardiac	0	1	
Composite endpoints			
Target vessel failure	15 (9.9)	10 (6.6)	0.35
Major adverse cardiac events	15 (9.9)	8 (5.3)	0.16

- ✓ This randomized trial failed to show noninferiority of hybrid SES relative to EES in terms of in-segment late lumen loss in successfully recanalized CTOs.
- ✓ Clinical endpoints were comparable.

JACC Cardiovasc Interv. 2017;10:133-143

BRS for CTO ? BRS may exhibit obvious potential advantages …

- ✓ Improvement in endothelial and vascular functions of the coronary segment treated, eliminating the metallic caging
- ✓ Good for late lumen enlargement after CTO-PCI
- ✓ Vasomotion restoration
- ✓ Overcome the weakness of full metal jacket & PCI-failure

Contents lists available at ScienceDirect

International Journal of Cardiology

journal homepage: www.elsevier.com/locate/ijcard

Feasibility of everolimus-eluting bioresorbable vascular scaffolds in patients with chronic total occlusion

Jens Wiebe [a], Christoph Liebetrau [a,b], Oliver Dörr [a], Astrid Most [a], Kay Weipert [a], Johannes Rixe [a], Timm Bauer [a], Helge Möllmann [b], Albrecht Elsässer [c], Christian W. Hamm [a,b], Holger M. Nef [a,*]

[a] University of Giessen, Medizinische Klinik I, Department of Cardiology, Klinikstrasse 33, 35392 Giessen, Germany
[b] Kerckhoff Heart and Thorax Center, Department of Cardiology, Benekestrasse 2-8, 61231 Bad Nauheim, Germany
[c] Klinikum Oldenburg, Department of Cardiology, Rahel-Straus-Strasse 10, 26133 Oldenburg, Germany

ARTICLE INFO

Article history:
Received 24 March 2014
Received in revised form 30 September 2014
Accepted 18 October 2014
Available online 7 November 2014

Keywords:
Biodegradable
Stent
Percutaneous coronary intervention
Chronic total coronary occlusion
Coronary artery disease
Bioresorbable vascular scaffold

ABSTRACT

Table 4
Follow-up. **23 patients with CTO**

Median follow-up (days, IR[a])	108 (79.5–214.5)
Total MACE[b]	4.3% (1/23)
– Death	0.0% (0/23)
– Myocardial infarction	0.0% (0/23)
– TLR[d]	4.3% (1/23)
TVF[e]	4.3% (1/23)
TLF[c]	4.3% (1/23)

One-Year Results of Bioresorbable Vascular Scaffolds for Coronary Chronic Total Occlusions

- **35 patients with CTO**

Beatriz Vaquerizo, MD, PhD[a,b,*], Antonio Barros, MD[a], Sandra Pujadas, MD[a], Ester Bajo, MD[a], Marcelo Jiménez, MD[a], José Gomez-Lara, MD[c], Francisco Jacobi, MD[c], Neus Salvatella, MD[b], Guillem Pons, MD[a], Juan Cinca, MD[a], and Antonio Serra, MD, PhD[a]

The potential of bioresorbable vascular scaffold (BVS) technology has been demonstrated in first-in-man studies with up to 5-year follow-up. This study sought to investigate the 1-year outcomes of the BVS, for the treatment of chronic total occlusions (CTOs), using various imaging techniques. Thirty-five true CTO lesions treated with BVS were included in this prospective study. Scaffolds were deployed after mandatory predilation and intravascular ultrasound analysis. Optical coherence tomography was performed after BVS implantation and at 10 to 12 months. Multislice computed tomography was performed at 6 months. Clinical follow-up was confirmed by angiography. At 12 months, no scaffold thrombosis or major adverse cardiac events were reported. The optical coherence tomography at follow-up showed that 94% of struts were well apposed and covered (5% of uncovered struts and 1% of nonapposed struts), and only 0.6% of struts were nonapposed and uncovered. In conclusion, 1-year results suggest that BVS for CTO is associated with excellent clinical and imaging outcomes. Accurate percutaneous coronary BVS technique might have enabled these promising results.
(Am J Cardiol 2016;117:906–917)

Percutaneous coronary intervention for chronic total occlusion of the coronary artery with the implantation of bioresorbable everolimus-eluting scaffolds. Poznan CTO-Absorb Pilot Registry

Maciej Lesiak*, MD, PhD; Magdalena Łanocha, MD, PhD; Aleksander Araszkiewicz, MD, PhD; Andrzej Siniawski, MD; Marek Grygier, MD, PhD; Małgorzata Pyda, MD, PhD; Anna Olasińska-Wiśniewska, MD, PhD; Sylwia Iwanczyk, MD; Włodzimierz Skorupski, MD, PhD; Przemysław Mitkowski, MD, PhD; Michal Bartosz Lesiak, MD; Stefan Grajek, MD, PhD

1st Department of Cardiology, University of Medical Sciences, Poznan, Poland

- **40 CTO patients with 63 BVSs**

KEYWORDS
- bioresorbable scaffolds
- CTO lesion

Table 5. Clinical outcomes.

Variable	30 days	9 months
Death	0 (0.0%)	0 (0.0%)
Any MI	1 (2.5%)	2 (5.0%)
Target vessel MI	1 (2.5%)	2 (5.0%)
TVR	1 (2.5%)	3 (7.5%)
TVF	1 (2.5%)	3 (7.5%)
Any scaffold thrombosis	1 (2.5%)	2 (5.0%)

Conclusions: CTO stenting with BVS is feasible with good acute performance, and good early and mid-term clinical outcomes.

Coronary Interventions

Bioresorbable Vascular Scaffolds for the Treatment of Chronic Total Occlusions

An International Multicenter Registry

Satoru Mitomo, MD; Toru Naganuma, MD; Yusuke Fujino, MD, PhD; Hiroyoshi Kawamoto, MD; Sandeep Basavarajaiah, MD; Michael Pitt, MD; Wei-Hsian Yin, MD, PhD; Damras Tresukosol, MD, PhD; Antonio Colombo, MD, PhD; Sunao Nakamura, MD, PhD

Background—There are only limited studies reporting clinical outcomes after bioresorbable vascular scaffold (BVS; Absorb; Abbott Vascular, Santa Clara, CA) implantation for coronary chronic total occlusions (CTO). The aim of this study was to evaluate the real-world feasibility and safety of BVS implantation for the treatment of CTO.

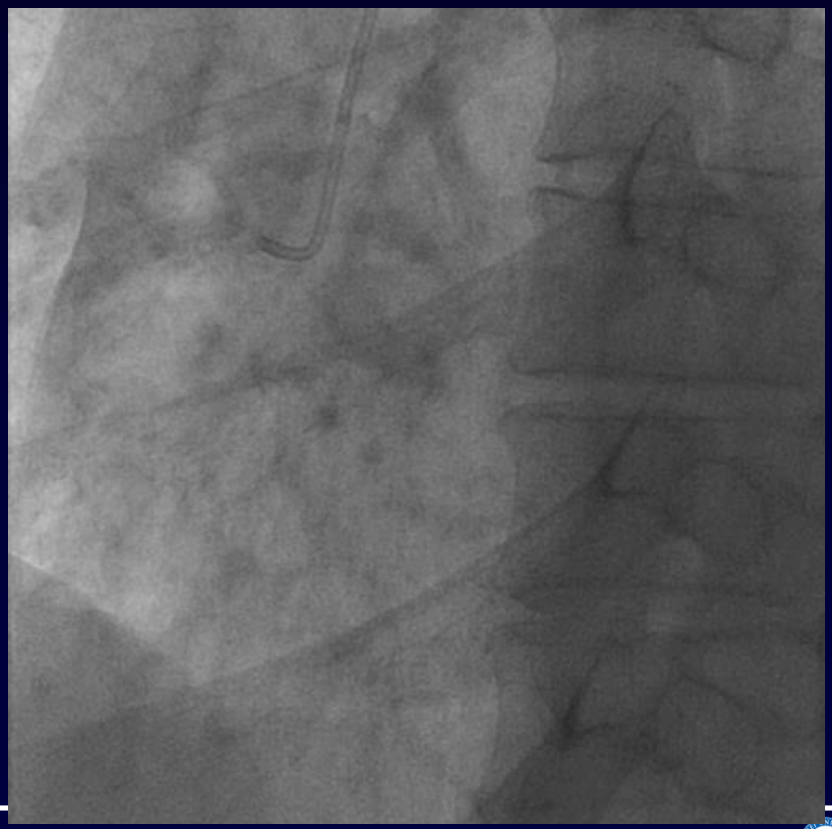
Methods and Results—We retrospectively evaluated CTO cases treated with BVS from a multicenter registry. The primary end point was target lesion failure defined as a composite of cardiac death, target vessel myocardial infarction, and clinically driven target lesion revascularization. From September 2012 to November 2015, 65 patients with CTO were successfully treated with BVS. The mean age of patients was 60.8±11.0 years; 89.2% were male and 40.0% diabetic. The mean ejection fraction was 57.7±10.8%. The mean reference vessel diameter and CTO lesion length were 3.0±0.4 and 20.2±3.0 mm, respectively. The mean number of BVS deployed per patient was 1.8±0.7, of which mean diameter and total length were 3.0±0.4 and 47.6±19.9 mm, respectively. Postdilatation with noncompliant balloons (mean diameter 3.3±0.3 mm) was performed at high pressures (18.6±5.3 atm) in all cases. Intravascular ultrasound (n=34) or optical coherence tomography (n=31) was performed in all cases. During the follow-up period (median: 453 days, 25th and 75th percentiles: 230 and 703), there were no occurrences of target lesion failure or scaffold thrombosis.

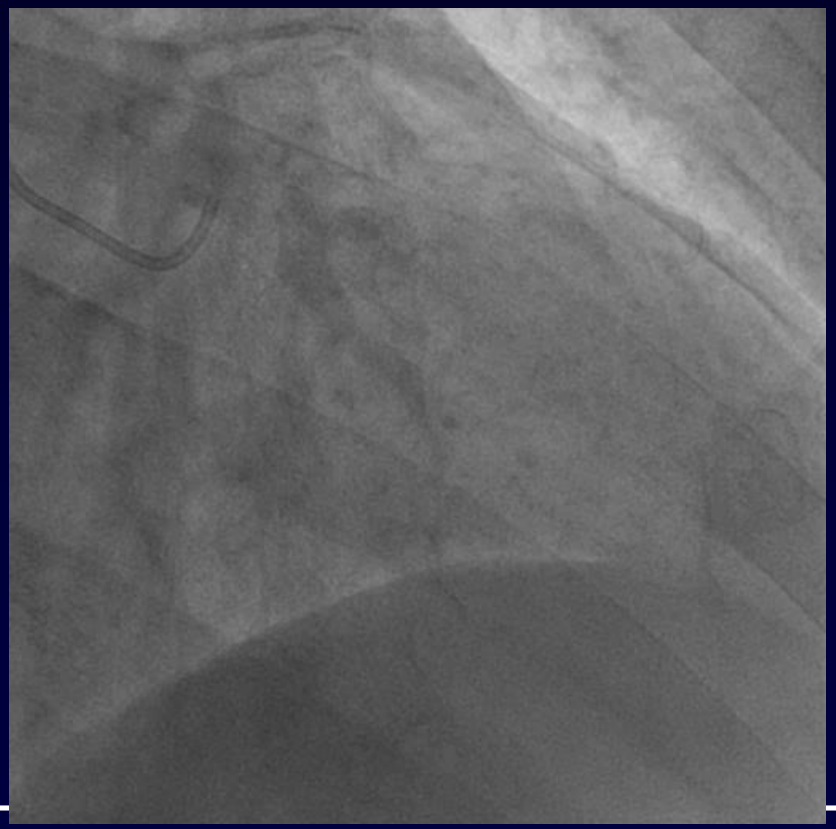
Conclusions—BVS implantation for the treatment of CTO seems feasible and safe. Appropriate lesion preparation, high-pressure postdilatation, and the use of intravascular imaging are recommended to obtain the best possible final result. (***Circ Cardiovasc Interv***. 2017;10:e004265. DOI: 10.1161/CIRCINTERVENTIONS.116.004265.)

CASE

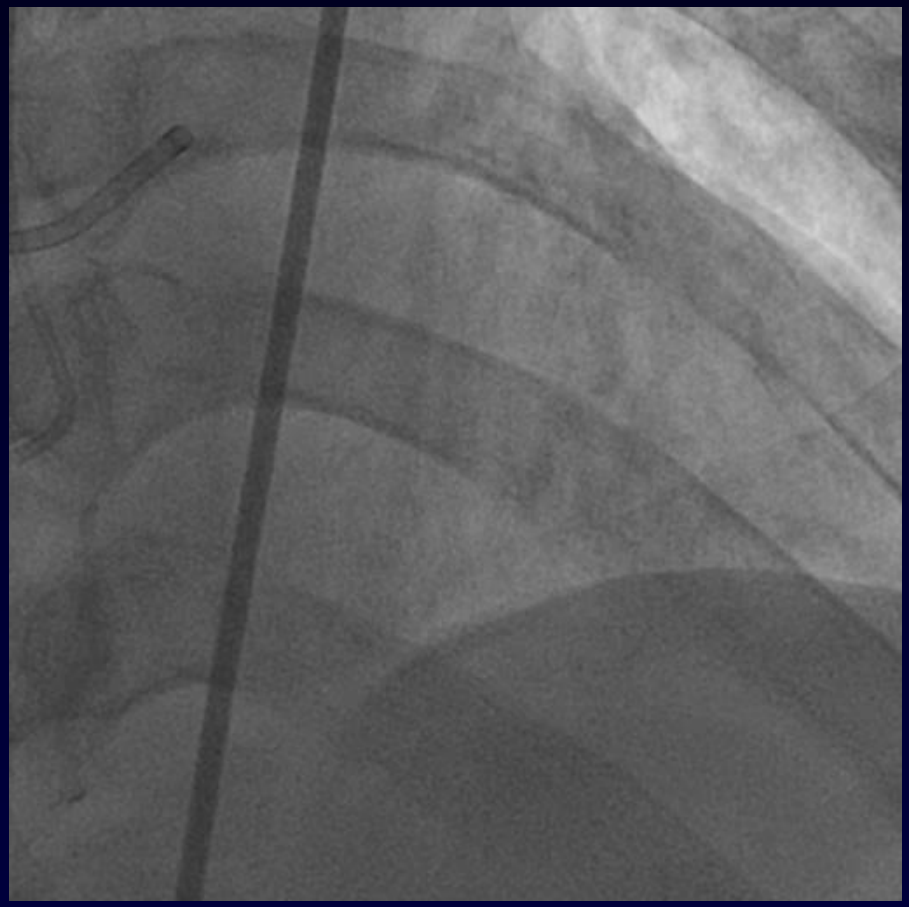
M/53 Retried LAD-CTO

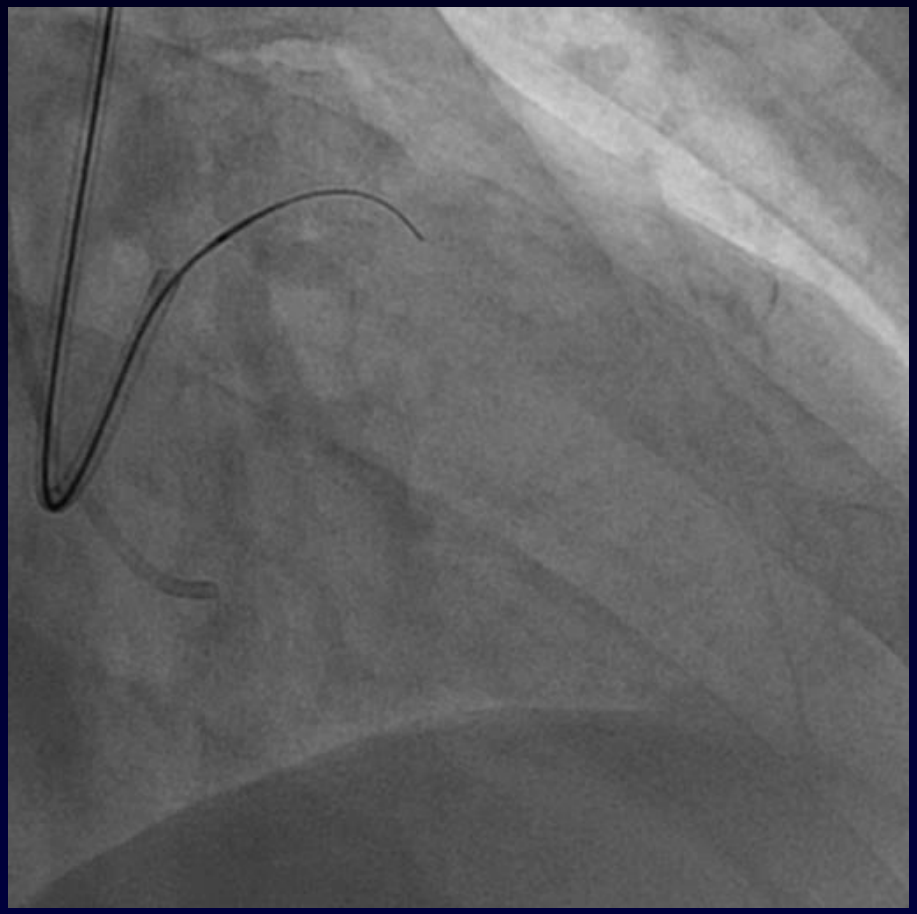
- **CC:** Intermittent Chest pain
- **TMT :** Positive
  Echocardiography : No RWMA, LVEF 71%
- **Coronary CT :** m-LAD 90% stenosis
- **Dx :** Stable angina (failed LAD-CTO)





LAD-CTO; Prior attempt

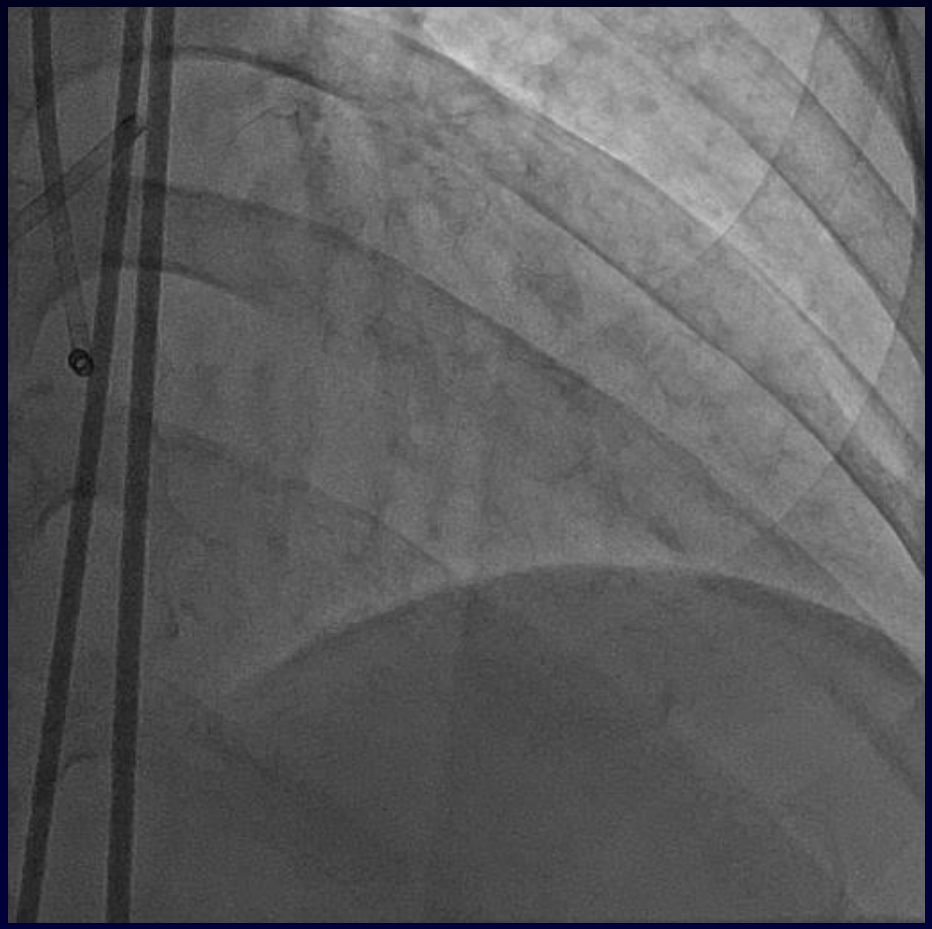


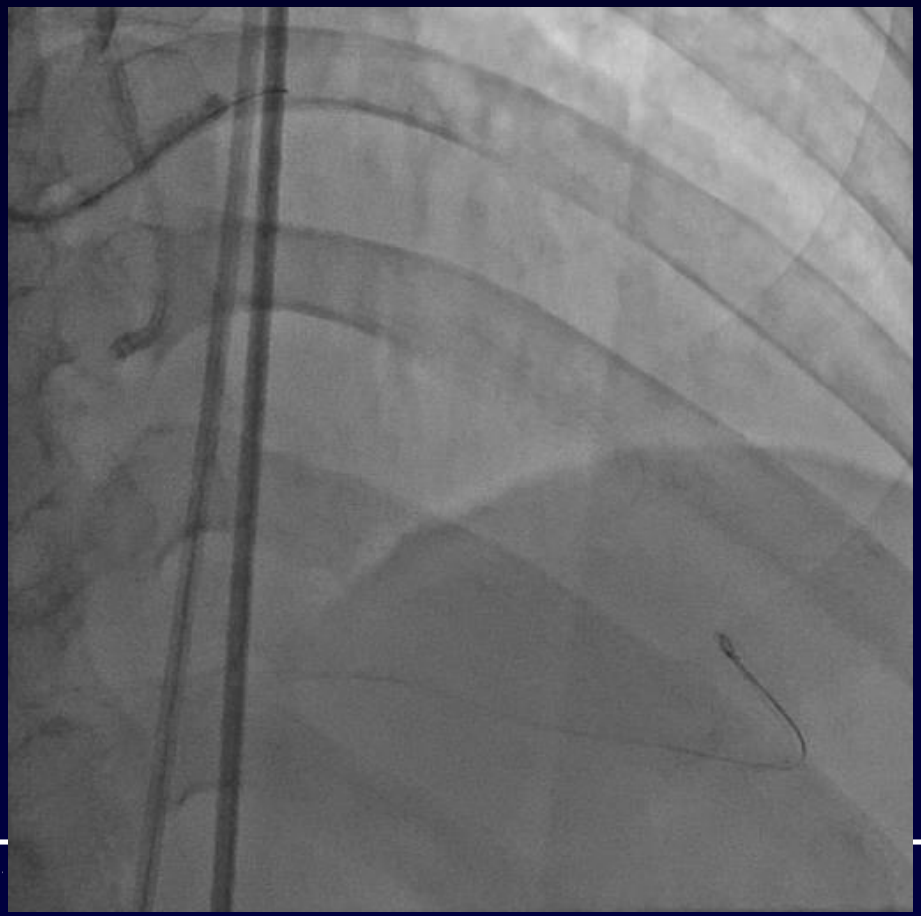


Antegrade approach

Corsair + (Pilot → Gaia 2nd → Conquest pro → **cross X**)

Retry by using retrograde epicardial collateral



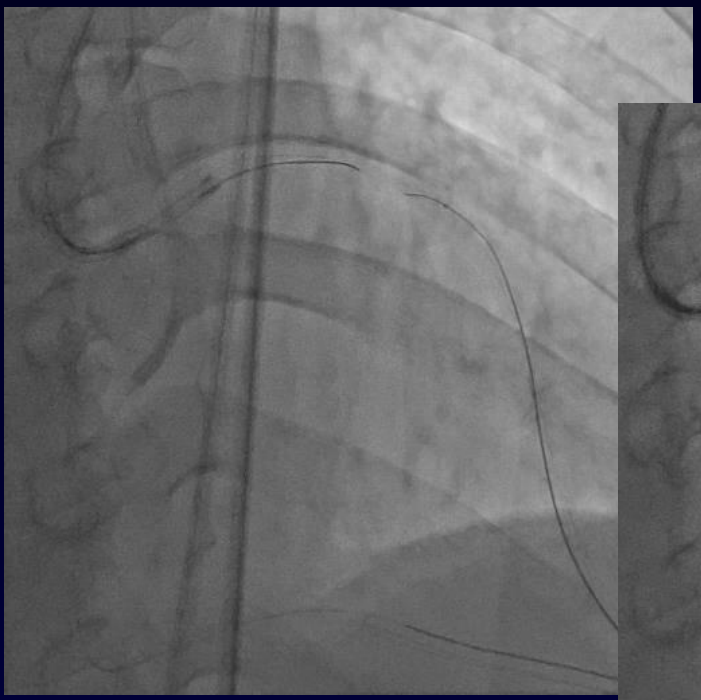


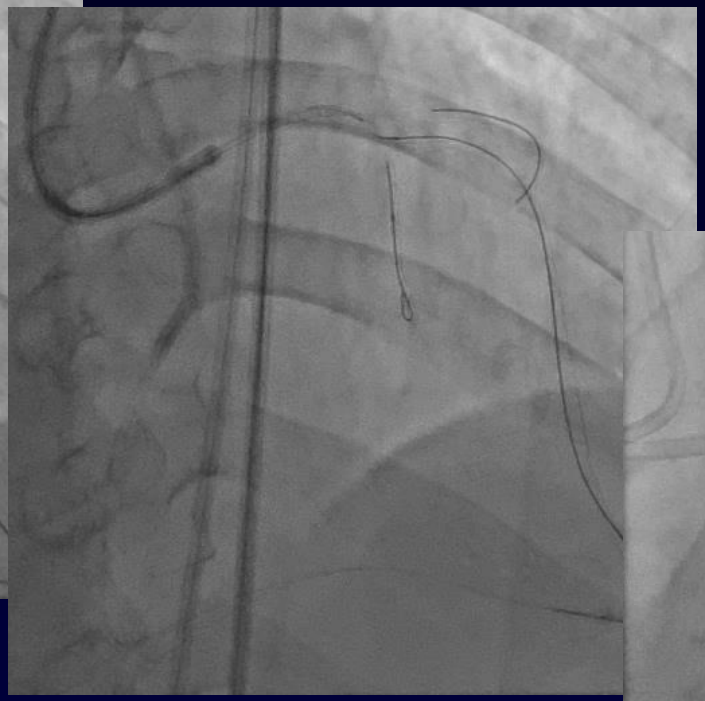
Retrograde approach

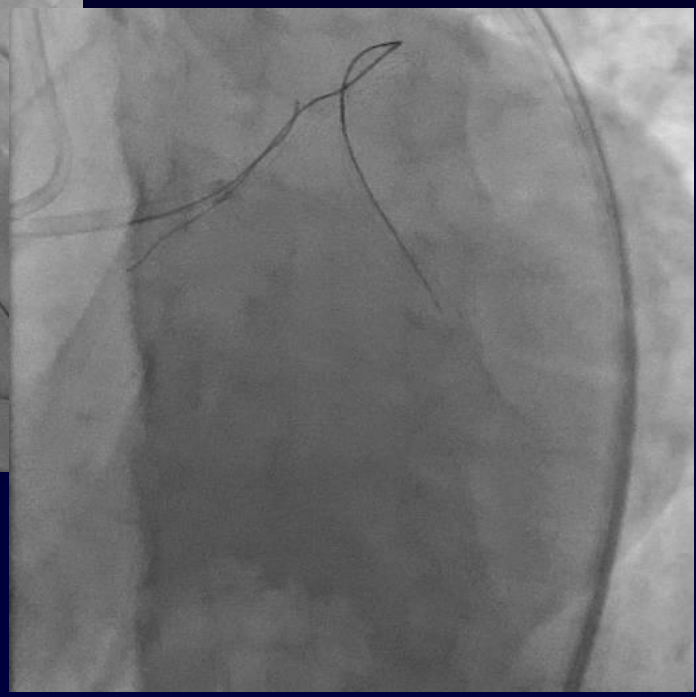
XBG 8-3.5 (SH)

Finecross + 014" G/W : Runthrough → Sion

PCI of retried LAD-CTO



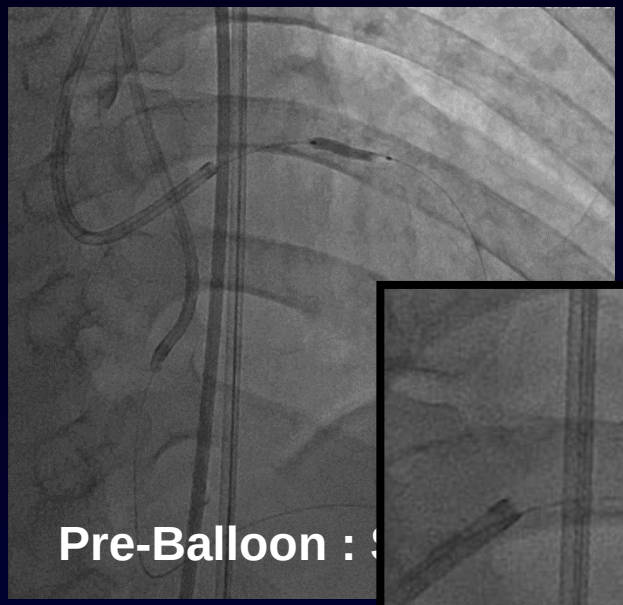


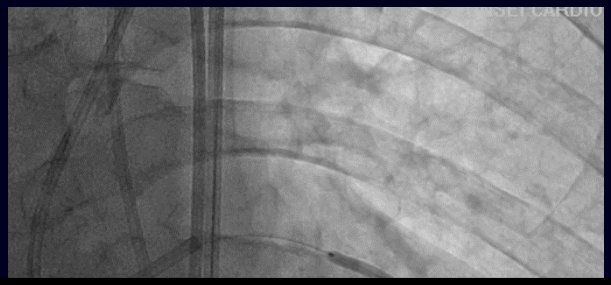


Antegrade approach SAL 7-1 (SH)
Corsair + 014" G/W : Runthrough → XT-R

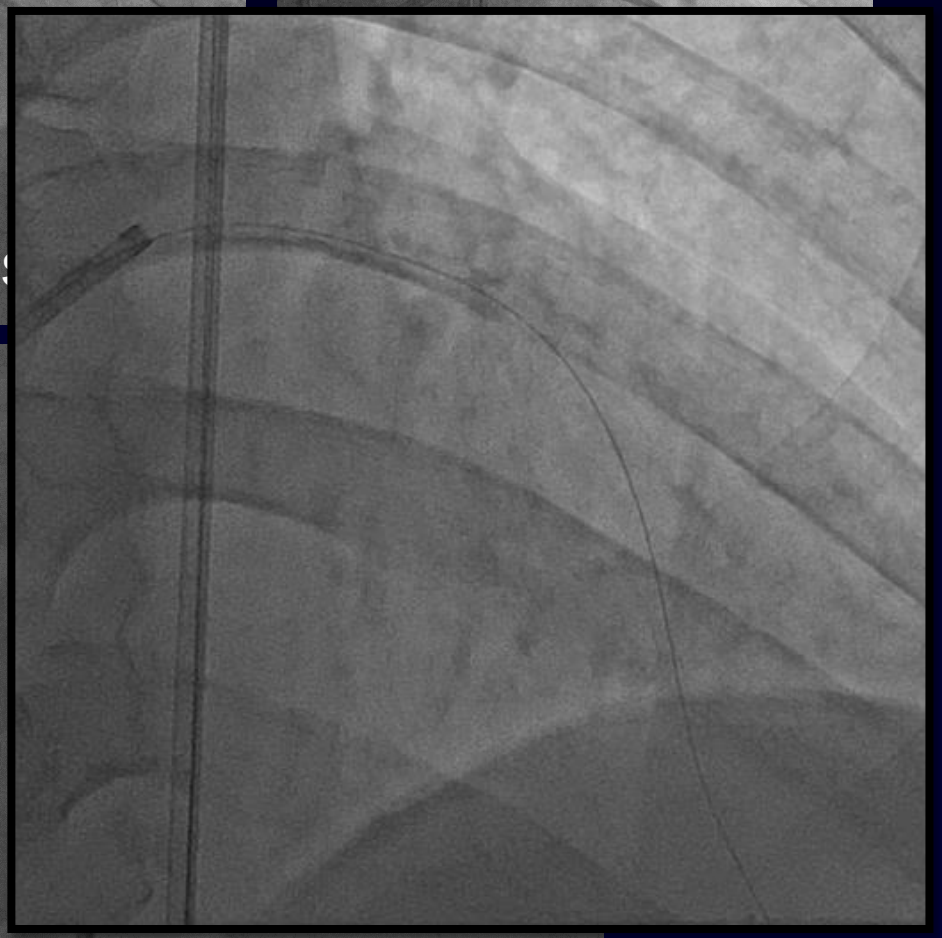
Retrograde approach
Corsair + 014" G/W : Gaia 1st → lesion passed !

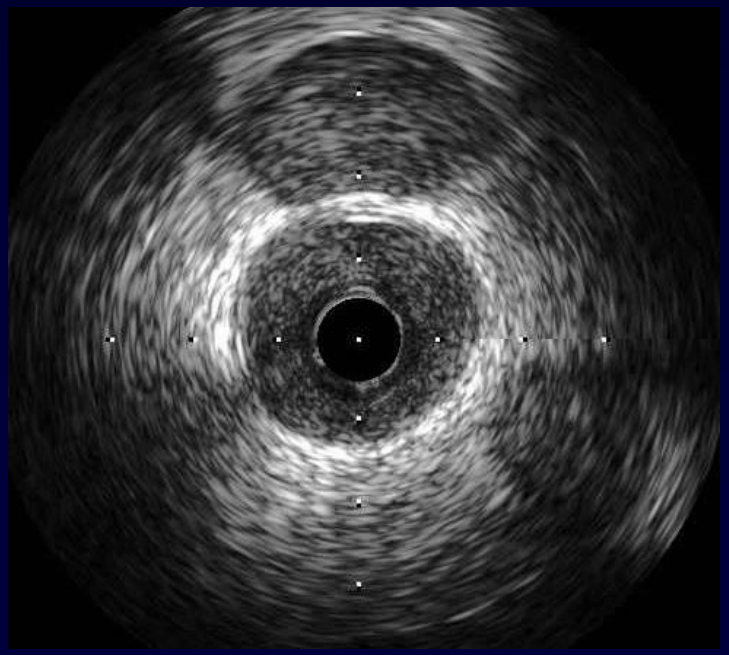
Pre-dilation





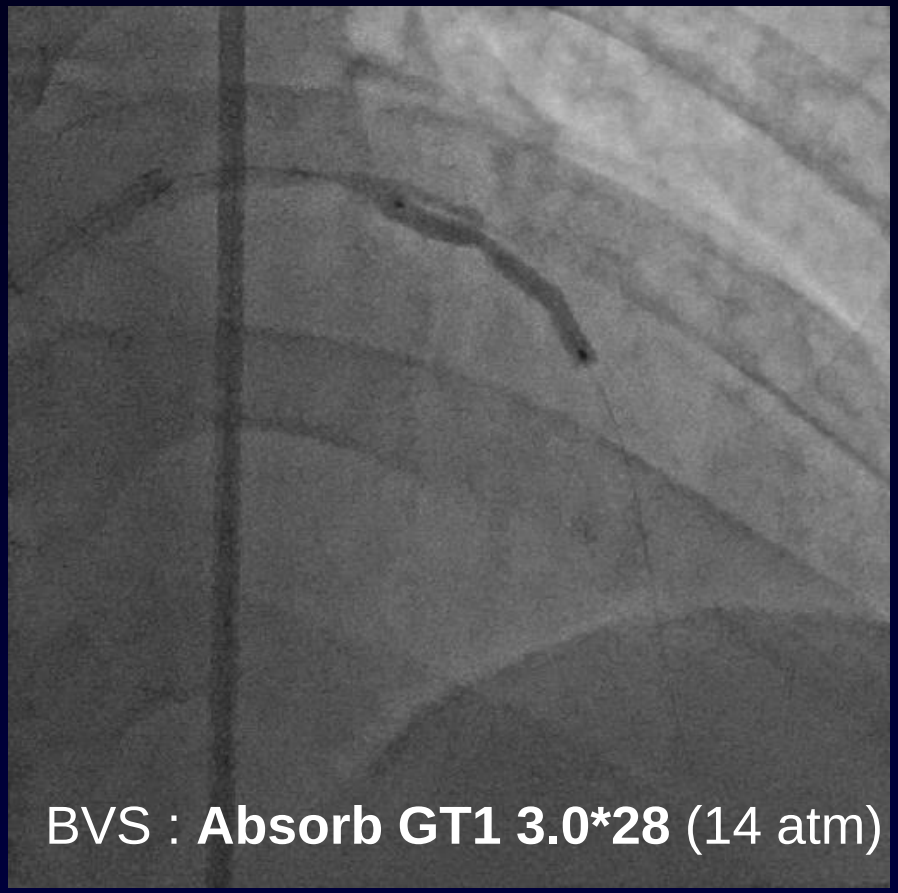
Pre-Balloon : S



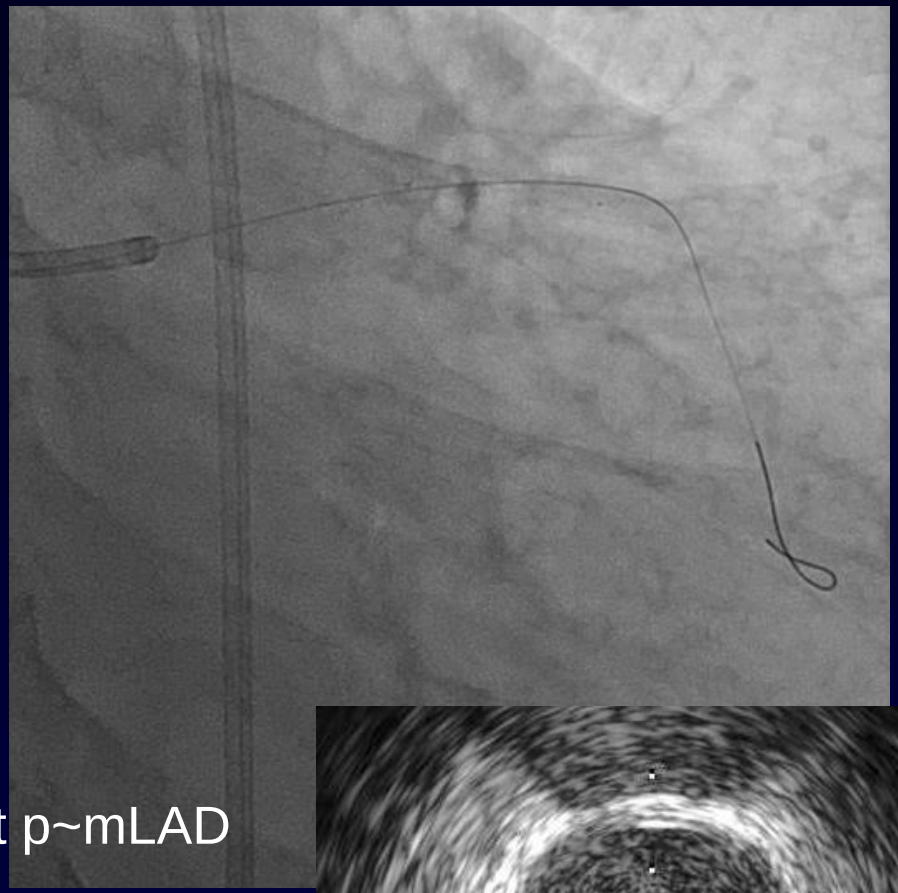


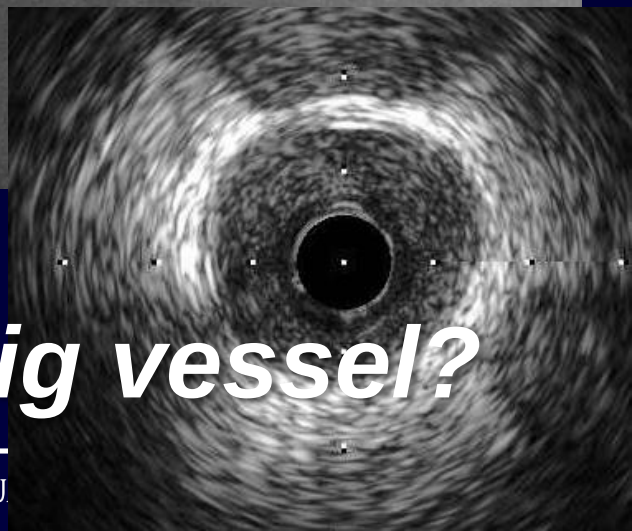
Pre-Balloon : NC balloon 3.5*12

BRS @ LAD-CTO



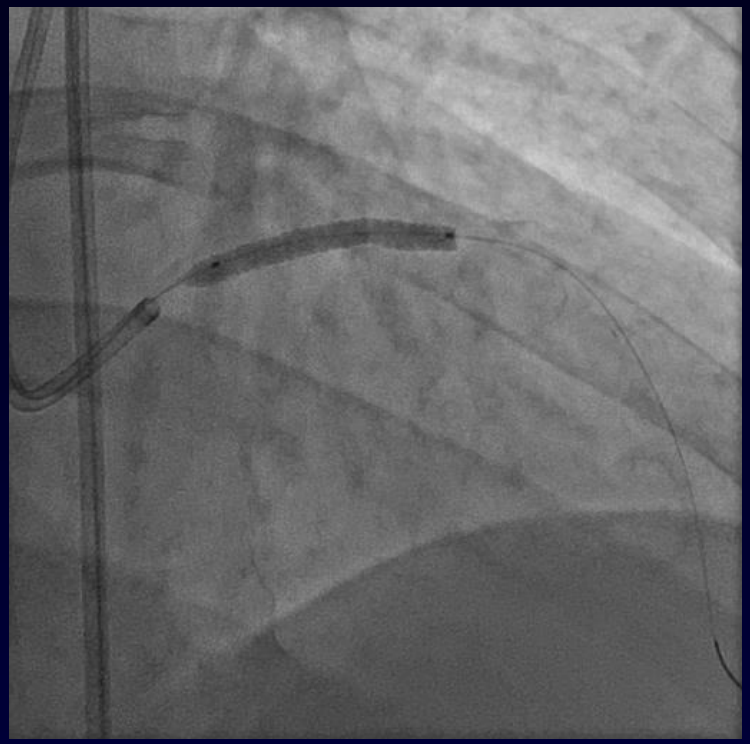
BVS : **Absorb GT1 3.0*28** (14 atm) at p~mLAD

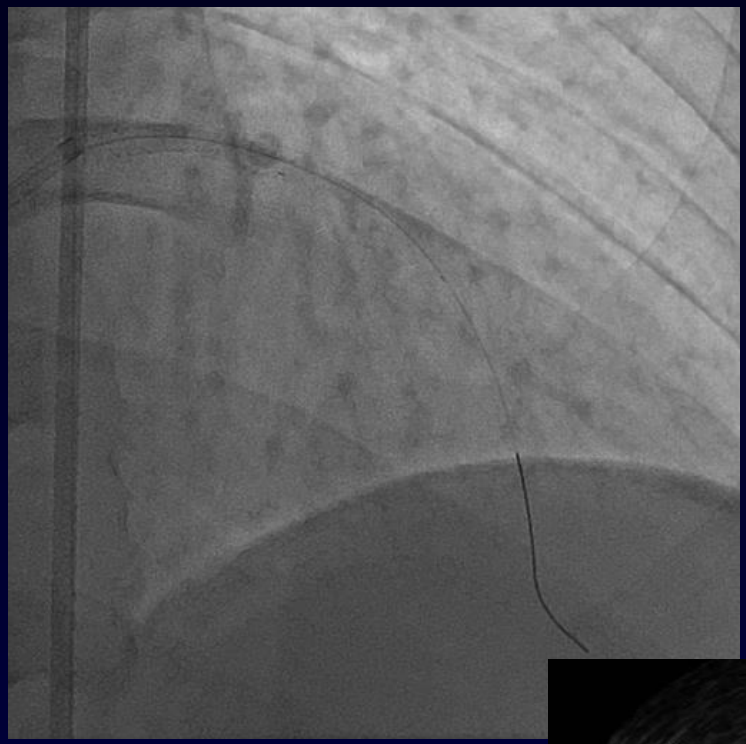




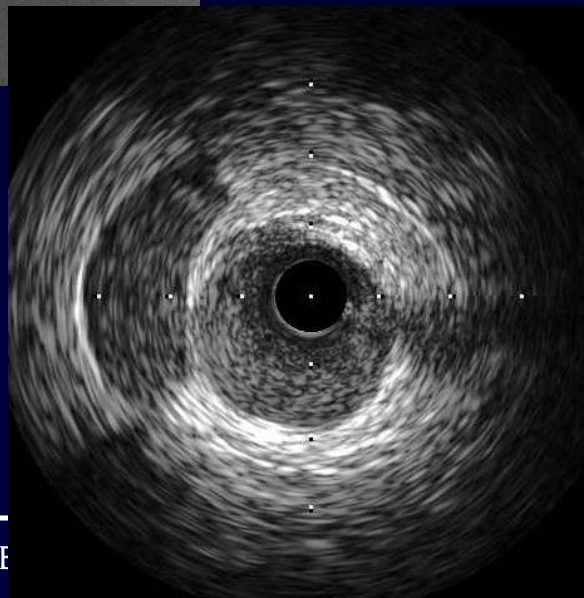
✓ ***How to treat p-LAD, big vessel?***

Hybrid PCI using metal stent and BRS

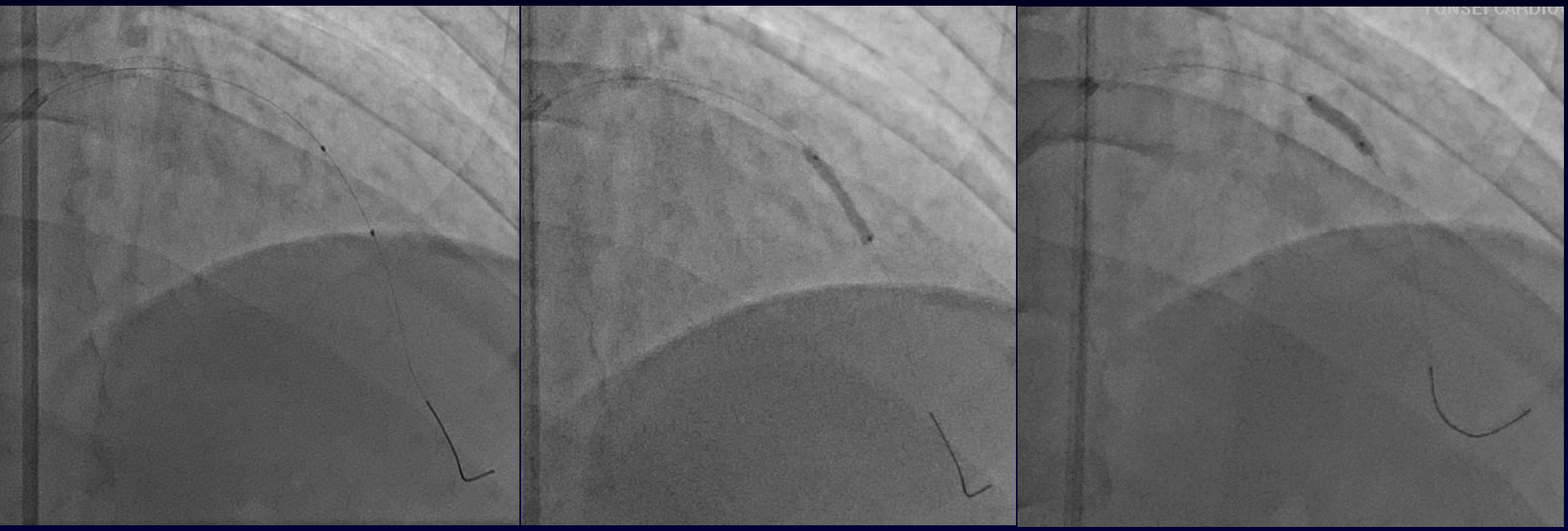




Hybrid stenting: Xience alpine 3.5*28 (18atm) at LM~pLAD



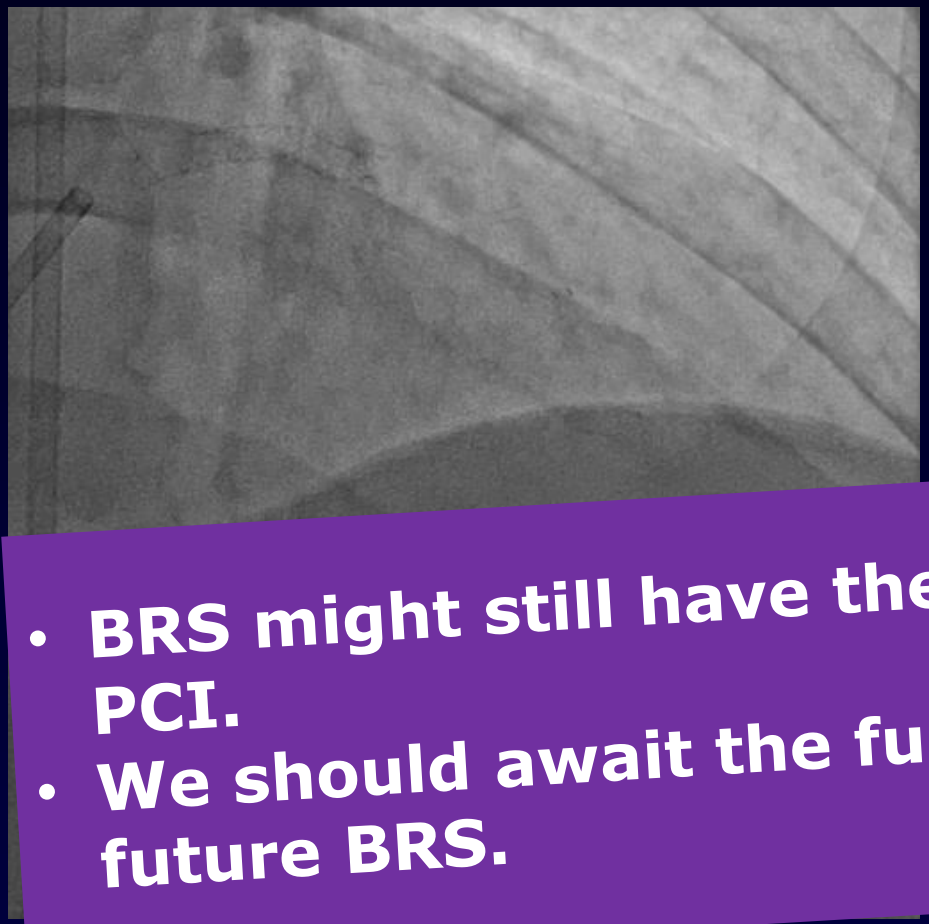
Hybrid PCI using metal stent and BRS



Absorb GT1 3.0*18 (14atm) at m-dLAD
(in case of stent failure & saving for CABG)

- Adjuvant balloon : NC 3.5*12
  (up to 26 atm) at LM-m-dLAD

Final angiography



- **BRS might still have their own benefits in CTO PCI.**
- **We should await the further roles in updated future BRS.**

Successful **Hybrid PCI of LAD-CTO**: (Xience 3.5*28, Absorb GT1 3.0*28, 3.0*18)

How to improve clinical outcomes after successful CTO PCI ?

3. Procedural factors affecting the clinical outcomes after successful CTO-PCI?

Clinical Impact of Intravascular Ultrasound–Guided Chronic Total Occlusion Intervention With Zotarolimus-Eluting Versus Biolimus-Eluting Stent Implantation

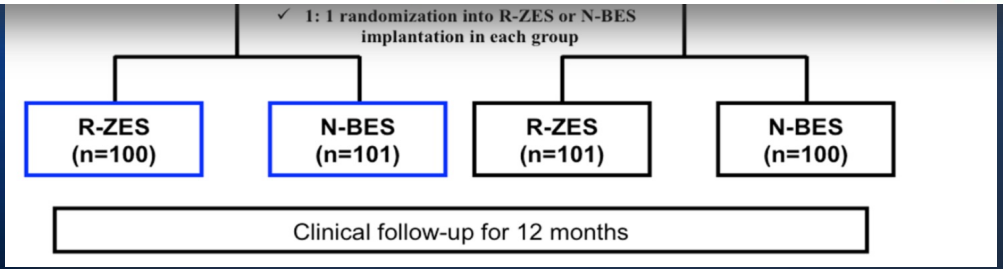
Randomized Study

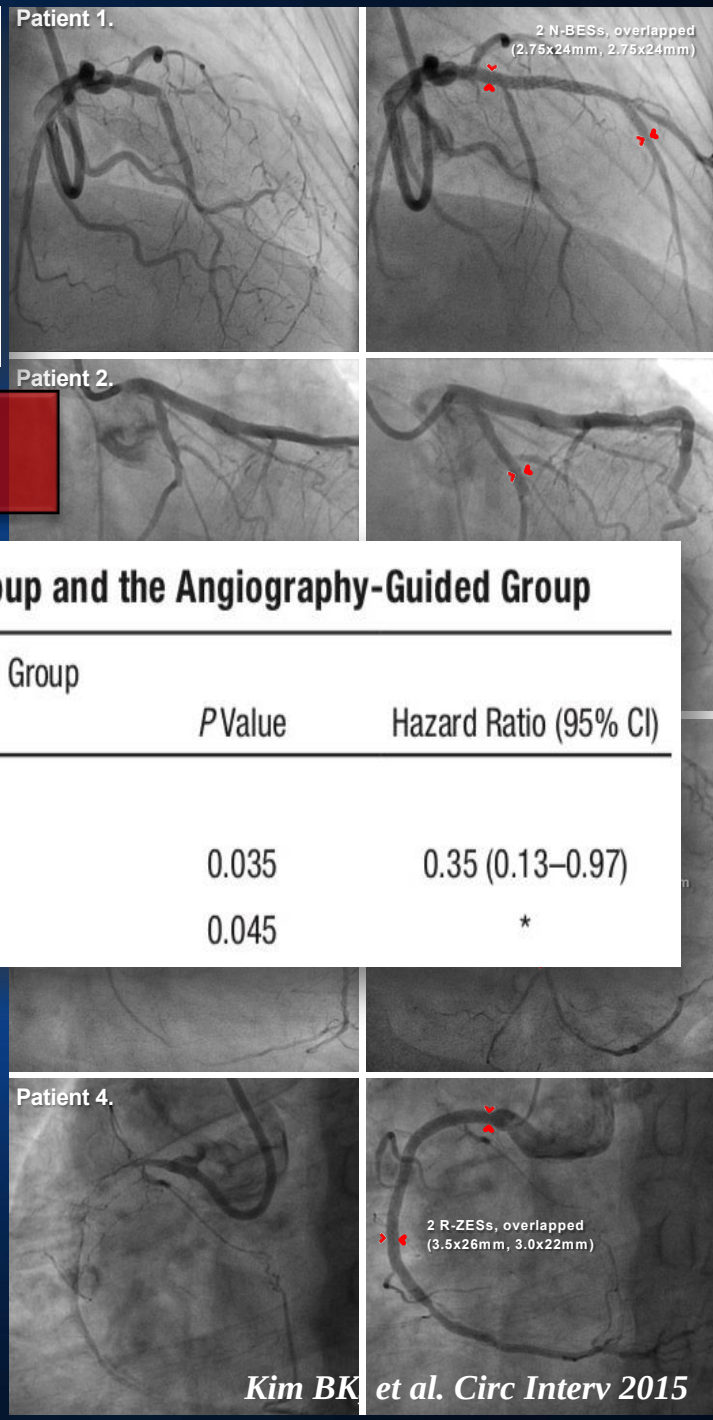
Byeong-Keuk Kim, MD; Dong-Ho Shin, MD; Myeong-Ki Hong, MD; Hun Sik Park, MD; Seung-Woon Rha, MD; Gary S. Mintz, MD; Jung-Sun Kim, MD; Je Sang Kim, MD; Seung-Jin Lee, MD; Hee-Yeol Kim, MD; Bum-Kee Hong, MD; Woong-Chol Kang, MD; Jin-Ho Choi, MD; Yangsoo Jang, MD; for the CTO-IVUS Study Investigators*

Cases either with cardiac death or MI

Table 3. Comparison of the Clinical Outcomes Between the IVUS-Guided Group and the Angiography-Guided Group

	IVUS-Guided Group (n=201)	Angiography-Guided Group (n=201)	*P* Value	Hazard Ratio (95% CI)
Composite events				
MACE	5 (2.6)	14 (7.1)	0.035	0.35 (0.13–0.97)
Cardiac death or MI	0 (0.0)	4 (2.0)	0.045	*





Kim BK et al. Circ Interv 2015

Clinical Impact of Intravascular Ultrasound–Guided Chronic Total Occlusion Intervention With Zotarolimus-Eluting Versus Biolimus-Eluting Stent Implantation

Randomized Study

Randomized CTO-IVUS study

A prospective, multi-center (20 centers in Korea), randomized trial

Total 467 patients with CTO were initially screened

✓ Exclusion
- Wiring failure ; 61 patients
- Refusal of study enrollment ; 4 patients

A total of 402 patients were finally enrolled after successful guidewire-crossing

1:1 randomization

IVUS-guided group (n=201)

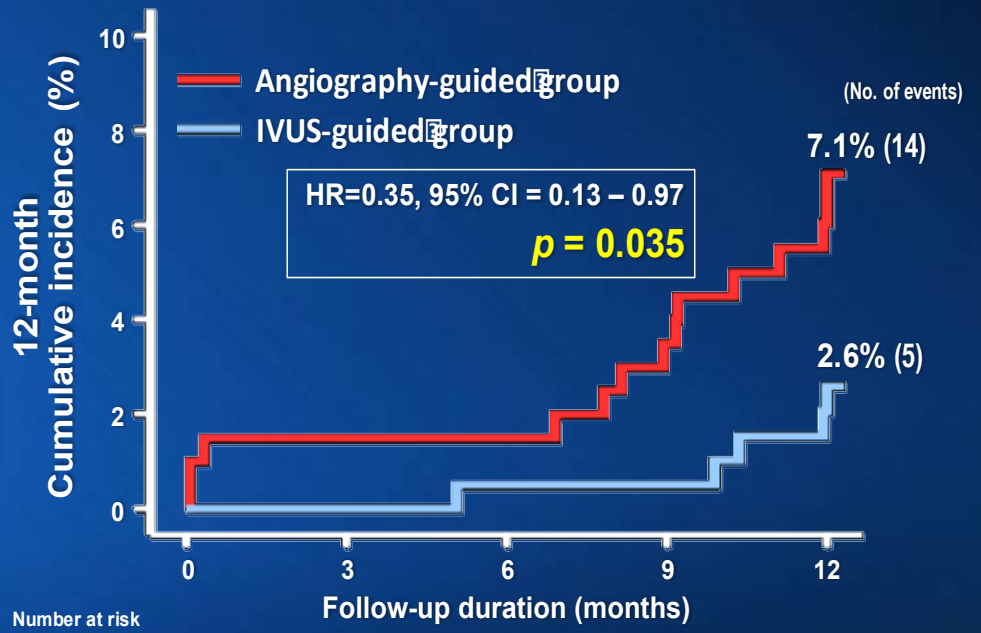
Angiography-guided group (n=201)

1:1 randomization
R-ZES vs. N-BES

Clinical follow-up for 12 months

Recommendation in the IVUS-guided group: 1) EMSA ≥ distal reference LA; 2) EMSA at CTO segment ≥ 5 mm² as far as vessel area permits; and 3) complete stent apposition.

 # Primary endpoint; Composite of Cardiac death, MI, ST, & TVR at 12 months



Kim BK, et al. Circ Interv 2015

How to improve clinical outcomes by imaging guidance ?

How to improve clinical outcomes by imaging guidance ?

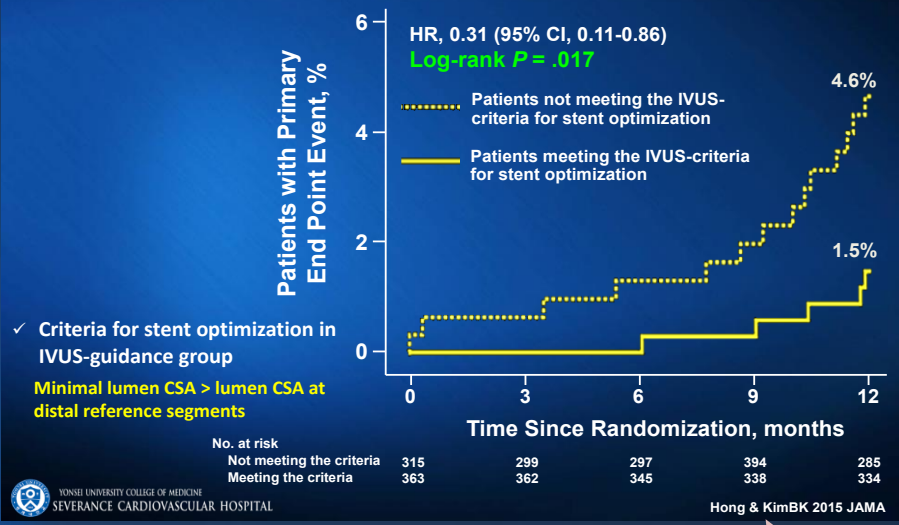
QCA outcomes from CTO-IVUS & IVUS-XPL trials

Randomized CTO-IVUS study	IVUS-guided (n=201)	Angiography-guided (n=201)	p value
Total number of stents, n	1.7 ± 0.8	1.6 ± 0.7	0.198
Total stented length, mm	43.6 ± 18.7	41.5 ± 17.6	0.245
High-pressure post-stent dilation	103 (51.2%)	83 (41.3%)	0.045
Maximum post-stent balloon pressure, atm	14.6 ± 3.7	13.8 ± 3.8	0.040
Post-procedural MLD, mm	2.64 ± 0.35	2.56 ± 0.41	0.025

IVUS-XPL Randomized Clinical Trial	IVUS-guidance (n=700)	Angiography-guidance (n=700)	P value
No. of stents per lesions	1.3 (0.5)	1.3 (0.5)	.48
Adjunct post-dilatation	534 (76)	402 (57)	<.001
Final balloon size, mm	3.14 ± 0.43	3.04 ± 0.42	<.001
Maximal inflation pressure, atm	16.5 ± 4.1	15.9 ± 4.1	.052
Post-procedural MLD, mm	2.64 ± 0.42	2.56 ± 0.39	<.001

How to improve clinical outcomes by imaging guidance ?

Comparison of the outcomes according to the meeting of IVUS-criteria



✓ Criteria for stent optimization in IVUS-guidance group

Minimal lumen CSA > lumen CSA at distal reference segments

YONSEI UNIVERSITY COLLEGE OF MEDICINE
SEVERANCE CARDIOVASCULAR HOSPITAL

Hong & KimBK 2015 JAMA

IVUS criteria from **CTO-IVUS trial**

1) MSA ≥ distal reference LA
2) SA at CTO segment ≥5 mm^2 as far as vessel area permits

Stent optimization

Adequate expansion by imaging tool

Improved clinical outcomes

YONSEI UNIVERSITY COLLEGE OF MEDICINE
SEVERANCE CARDIOVASCULAR HOSPITAL

How to improve clinical outcomes after successful CTO PCI ?

4. Any parameters affecting the clinical outcomes to monitor ?

   Check-up of post-procedure enzymes !

Received: 2 July 2017 | Revised: 15 October 2017 | Accepted: 30 October 2017
DOI: 10.1002/ccd.27420

ORIGINAL STUDIES

WILEY

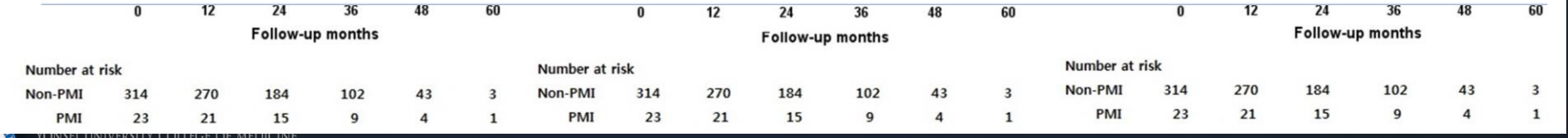
Incidence, predicting factors, and clinical outcomes of periprocedural myocardial infarction after percutaneous coronary intervention for chronic total occlusion in the era of new-generation drug-eluting stents

Jin-Ho Kim, MD[1] | Byeong-Keuk Kim, MD[1] | Seunghwan Kim, MD[1] | Chul-Min Ahn, MD[1] | Jung-Sun Kim, MD[1] | Young-Guk Ko, MD[1] | Donghoon Choi, MD[1] | Myeong-Ki Hong, MD[1,2] | Yangsoo Jang, MD[1,2]

- Between 2012 and 2015, a total of 337 patients who underwent CTO-PCI and met the study criteria were consecutively enrolled from the YONSEI CTO registry.

- Primary endpoints; MACCE (the composite of cardiac death, MI, stent thrombosis, TVR, and CVA)

Individual events	PMI ($n = 23$)	Non-PMI ($n = 314$)	P-value[a]	HR (95%CI)
All-cause death	2 (13.9%)	6 (2.4%)	0.048	4.35 (0.87–21.57)
Cardiac death	2 (13.9%)	2 (0.7%)	0.001	13.33 (1.87–94.66)
MI	1 (4.3%)	0 (0%)	<0.001	
Stent thrombosis	1 (4.3%)	1 (0.4%)	0.015	13.52 (0.84–216.17)
Target-vessel revascularization	2 (11.3%)	8 (4.0%)	0.118	3.21 (0.68–15.15)
Repeat PCI	1 (4.3%)	8 (2.5%)		
Bypass surgery	1 (4.3%)	0 (0.0%)		
Cerebrovascular accident	0 (0.0%)	3 (1.0%)	0.639	
In-hospital MACCE	0 (0.0%)	1 (0.3%)	0.787	



Kim, et al. Catheter Cardiovasc Interv. 2017 Dec 20.

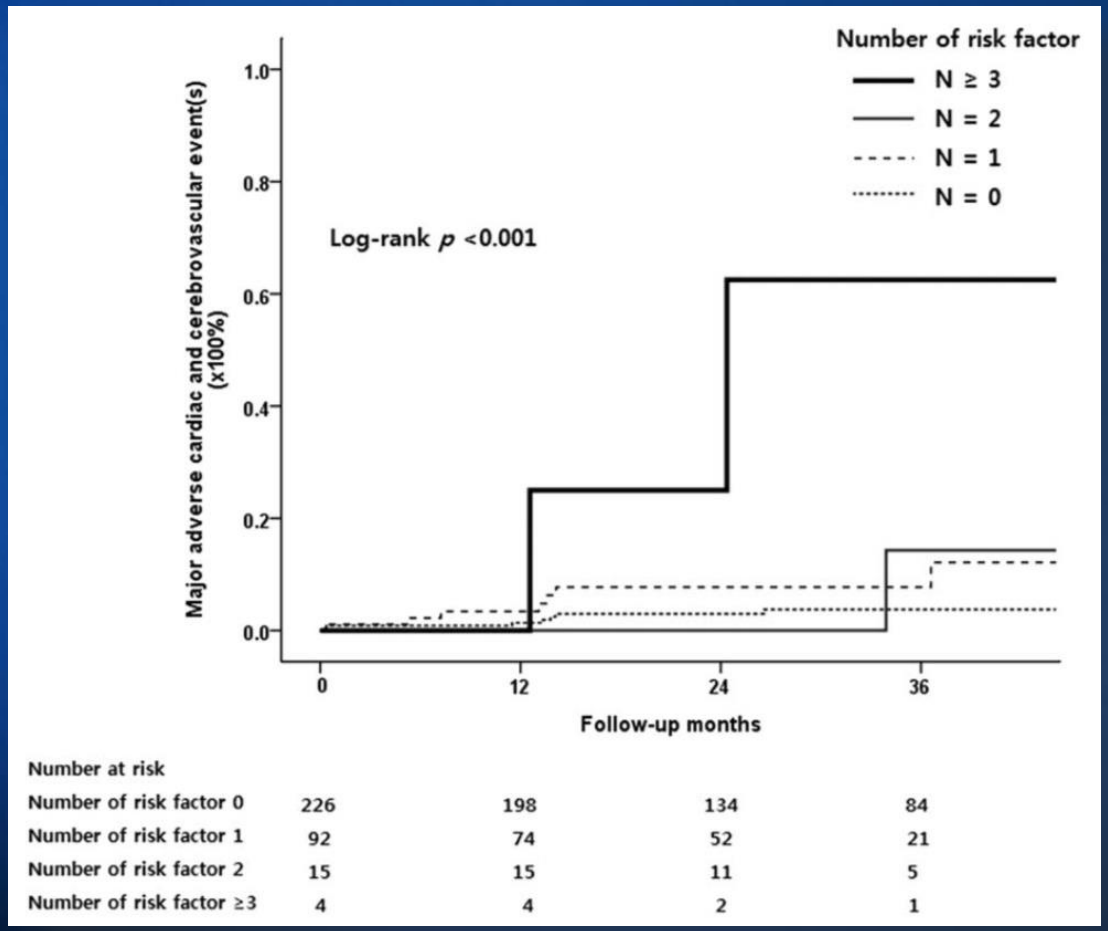
Risk factors for PPMI after CTO intervention

- PPMI in CTO might be strongly related to the fatal worse clinical outcomes.
- However, the specific treatment strategy for the patients with PPMI

	Univariate		Multivariate	
	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value
Clinical variables				
Previous CABG	9.41 (2.85–31.0)	<0.001	5.52 (1.17–25.92)	0.03
LVEF	0.96 (0.93–0.99)	0.03	0.97 (0.93–1.01)	0.16
Angiographic variables				
J-CTO score ≥3	6.70 (2.78–16.11)	<0.001	7.06 (2.57–19.39)	< 0.001
Side branch occlusion	3.87 (1.30–11.47)	0.01	4.21 (1.13–15.66)	0.03
Blunt stump	3.34 (1.22-9.11)	0.02	1.94 (0.54-6.88)	0.30
Procedural variables				
Procedure success	0.61 (0.23–1.63)	0.32	0.87 (0.25–3.01)	0.82
Retrograde approach	2.06 (0.80–5.24)	0.13	0.84 (0.22–3.20)	0.80
Longer procedure time (>90th percentile)	6.35 (2.42–16.62)	<0.001	4.18 (1.35–12.99)	0.01

Kim, et al. Catheter Cardiovasc Interv. 2017 Dec 20.

Cumulative Event Rates according to the No. of Risk Factors for PMI



Number at risk				
Number of risk factor 0	226	198	134	84
Number of risk factor 1	92	74	52	21
Number of risk factor 2	15	15	11	5
Number of risk factor ≥3	4	4	2	1

- 4 main risk factors
  1) Previous CABG,
  2) J-CTO score ≥ 3,
  3) Longer procedure time (>90th percentile),
  4) Side branch occlusion

- The group with **multiple risk factors (No. of risk factors ≥ 3)** had a significantly higher MACCE rate than the other groups (groups with 0, 1, or 2 risk factors).

Kim, et al. CCI 2017 Dec

Take-home message

How to improve clinical outcomes after successful CTO PCI ?

- **Pre-CTO-procedure**

Clinical outcomes after CTO intervention were **worse in patients with multiple risk factors (DM + Age + CHF)**

→ reconsidering the benefits and losses between PCI and CABG

- **During CTO procedure**
  - **Recent DESs showed a favorable clinical outcomes**
  - **A still room for BRS in CTO**
  - **Stent optimization (adequate expansion) by IVUS guidance**

  → essential for the improvement of clinical outcomes

- **Post-procedure**

Clinical parameters (age/DM/CHF), PPMI after CTO-PCI

→ **Predictors of the fatal clinical events.**

→ **A strict management strategy is definitely needed, even after CTO-PCI success.**

With the Love of God, Free Humankind from Disease and Suffering

Severance

Thank you for your attention!