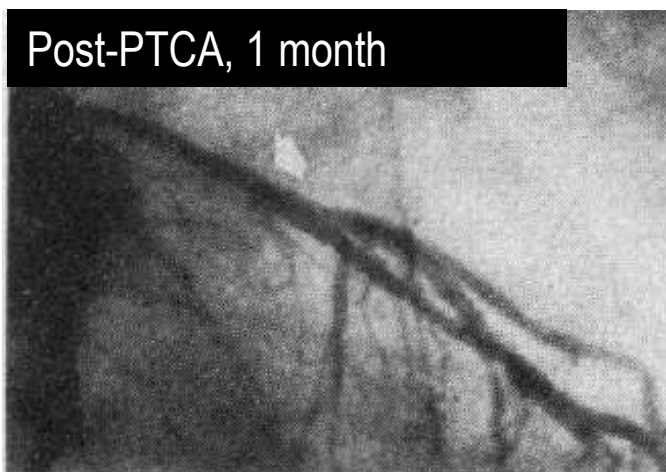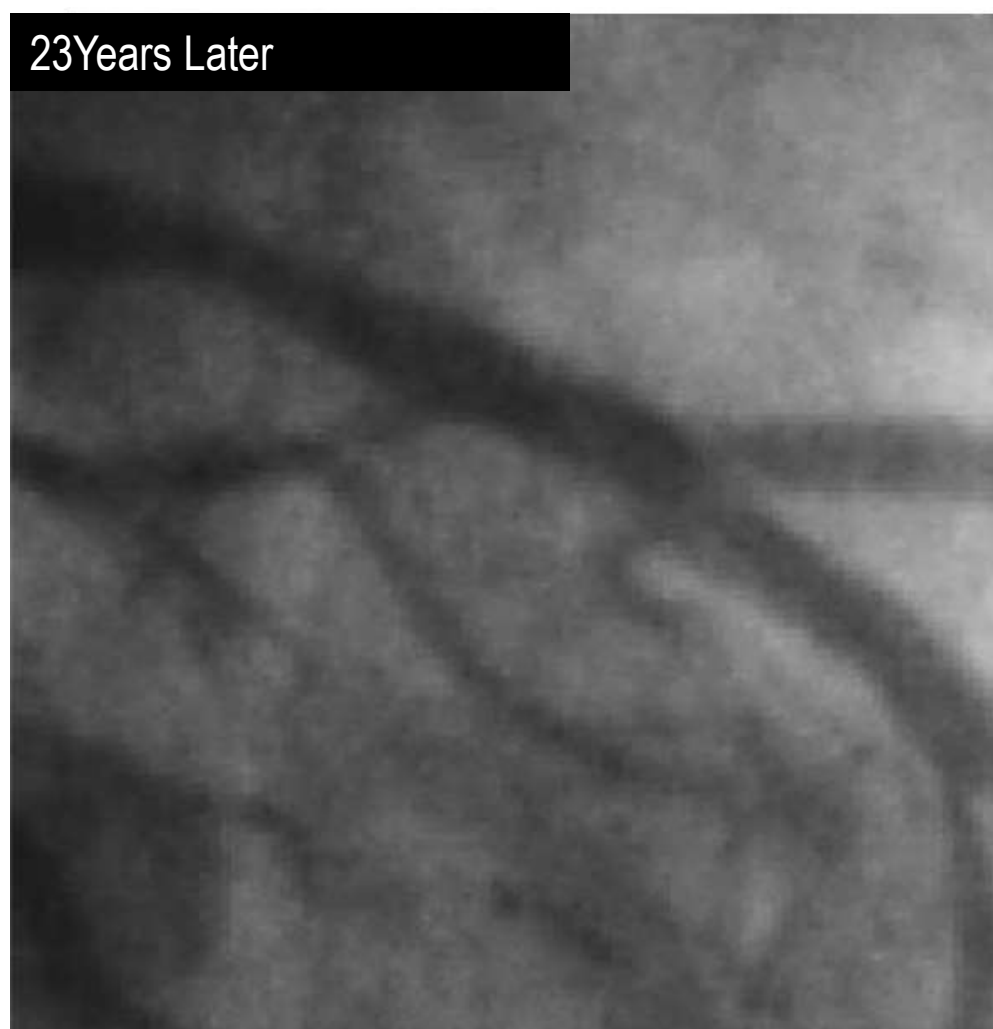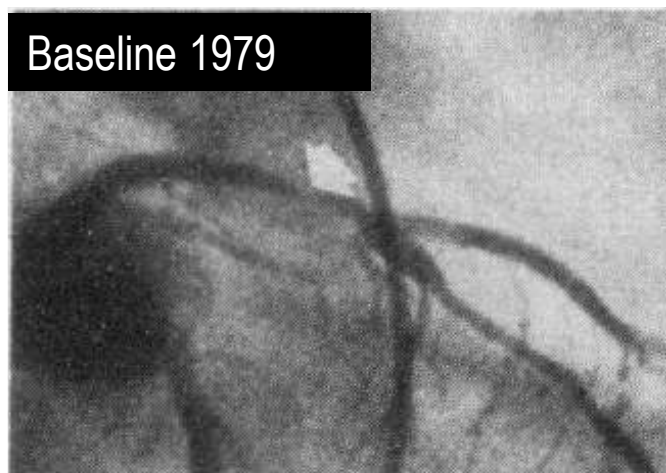# Procedural Optimization for Successful DCB Treatment

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Samsung Medical Center, Seoul, Republic of Korea

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Lessons from First Balloon Angioplasty
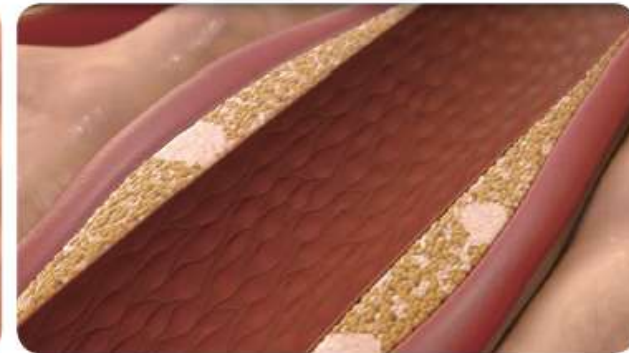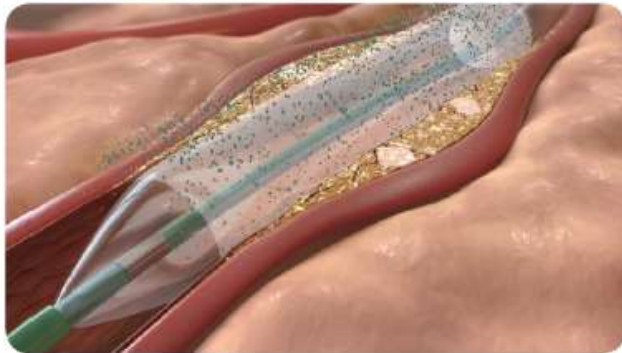

Baseline 1979

23Years Later

Post-PTCA, 1 month

Balloon angioplasty with optimal size, blocking artery with 15-20 seconds.
Post-PTCA pressure gradient was measured

Grunzig A. NEJM 1979;301:61-68
Miere B. N Engl J Med 2001; 344:144-145

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Drug-Coated Balloon Angioplasty

DCB application — Immediate post-PCI — Follow-up

DCB Angioplasty requires essentially same technique with old PTCA

Successful Lesion Preparation
No Immediate Procedural Complication (dissection, recoil, thrombus)

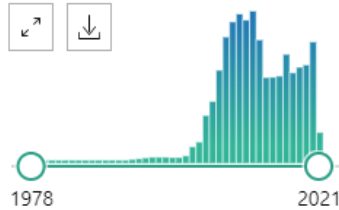**Therefore, Procedural Optimization is the Key!**

DCB Evidence

5,569 Results

Among the numerous evidence of DCB (5,569),
Most studies focused on comparison between DCB vs. DES, various subset of DCB application, or clinical outcome.
Conversely, there has been limited report about how to optimize the procedure.

How Optimize DCB Treatment?
- First report evaluated this issue -

DES ISR
Treated by Paclitaxel-coated DCB (2009.9 ~ 2014.8)
323 Lesions (269 Patients)

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14 Lesions (13 Patients)
Were Excluded d/t BMS ISR

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309 Lesions (256 Patients) of DES ISR
Median Follow-Up Duration of 761.0 Days
8.2% Lost to Follow-Up (21 Patients)
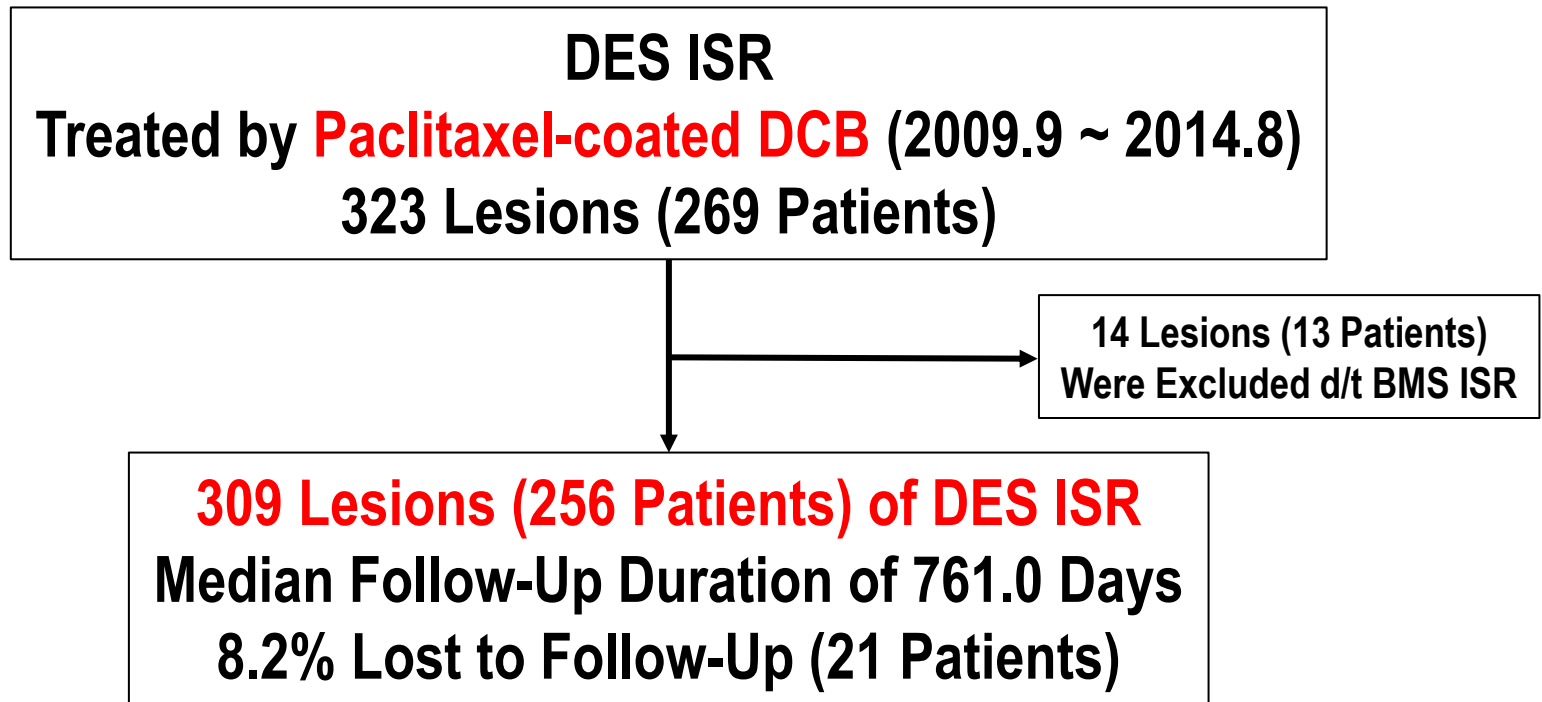
- **Quantitative coronary analysis (QCA) of index DEB procedures**
  - Baseline and final images **+ Images after lesion preparation (POBA)**

* BMS, bare-metal stents

Independent Factors Predicting TLF after DCB

Results of multivariable Cox regression with stepwise selection

	Hazard Ratio (95% CI)	*P*
Procedure-related factors		
Residual %DS after lesion preparation (per 1%↑)	**1.021**	1.014 – 1.028
DCB-to-stent ratio (per 0.1↑)	**0.778**	0.608 – 0.994
Total inflation time of DCB (per 1 second↑)	**0.993**	0.990 – 0.996
Patient-related factors		
Peripheral vascular disease	2.274	1.574 – 3.285
Diabetes mellitus	1.687	1.290 – 2.206
Prior history of myocardial infarction	1.226	1.052 – 1.429
Hypertension	1.184	1.012 – 1.385
Lesion-related factors		
Complex (type B2 or C) lesion	1.737	1.198 – 2.517
Long lesion (≥ 28 mm)	1.272	1.045 – 1.549

**Among Patient, Lesion, and Procedure related factors,
Procedure-related factors are only modifiable factors.**

Optimal Cut-Off Values for Individual Procedure-related Factors

A. Residual %DS after Lesion Preparation

Residual 20% DS

Standardized log-rank statistics

Residual %DS after Lesion Preparation (%)

B. DEB-to-Stent Ratio

Ratio 0.91

Standardized log-rank statistics
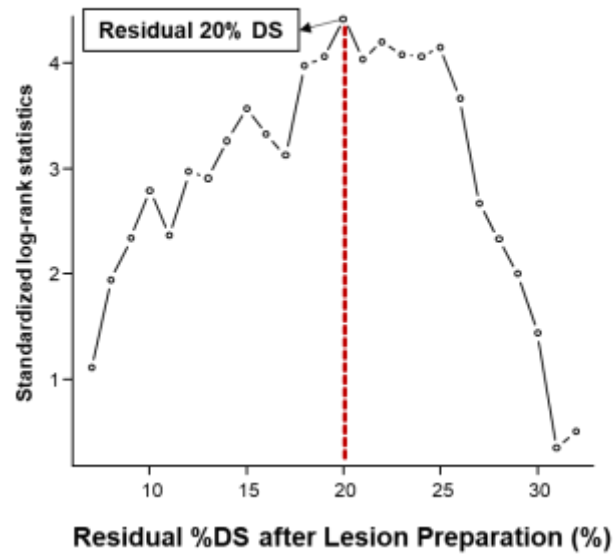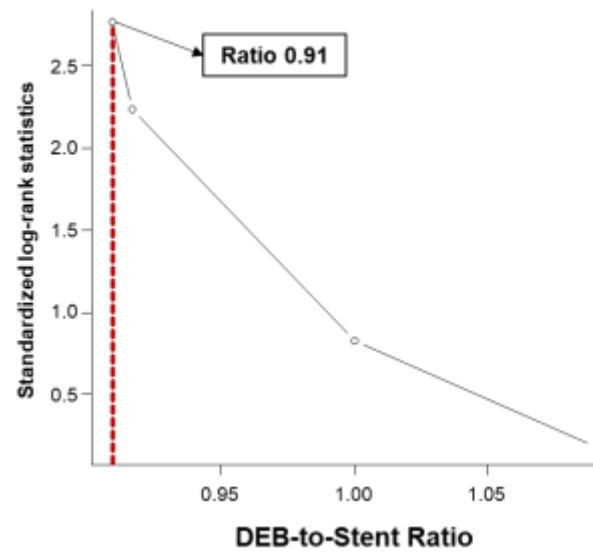
DEB-to-Stent Ratio

C. Total Inflation Time of DEB

Duration 60 seconds

Standardized log-rank statistics

Total Inflation Time of DEB (sec)
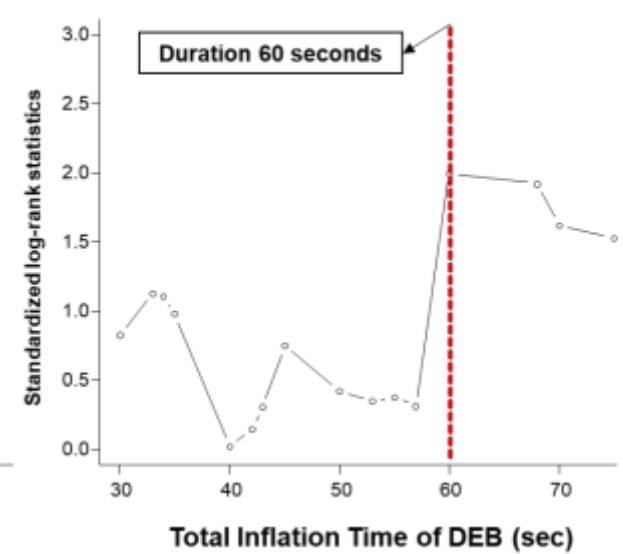
Optimal **residual %DS after lesion preparation** : 20%
Optimal **DCB-to-stent ratio** : 0.91
Optimal **total inflation time of DCB** : 60 sec

Were the best cut-off values to discriminate the occurrence of TLF

Residual %DS after Lesion Preparation
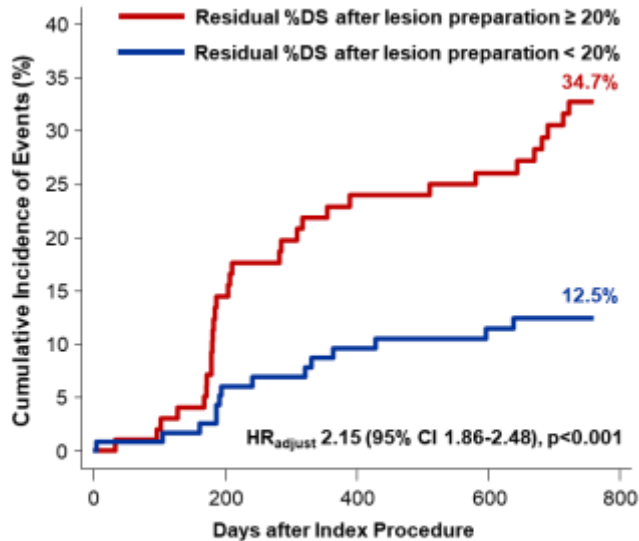
Target Lesion Failure at 2Y

	Residual %DS after lesion preparation		Multivariable-adjusted Hazard ratio (95% CI)	*P* value
	≥ 20% (N = 101)	< 20% (N = 120)		
Target lesion failure	34.7% (31)	12.5% (14)	**2.15 (1.86-2.48)**	**< 0.001**
Target vessel MI	6.4% (5)	0.0% (0)	12.5 (0.53-293.7)	**N/A**
Clinically-driven TVR	31.4% (27)	12.9% (14)	**2.44 (1.84-3.22)**	**< 0.001**
Clinically-driven TLR	30.4% (26)	10.2% (11)	**2.62 (2.04-3.38)**	**< 0.001**

**Superior efficacy outcomes in group with
residual %DS < 20% than with residual %DS ≥ 20%,
Mainly driven by the lower rates of TLR**

**Infers importance of "Proper Lesion Preparation"
until residual %DS < 20%**

Optimal DCB Size Selection

Target Lesion Failure at 2Y

Number at risk
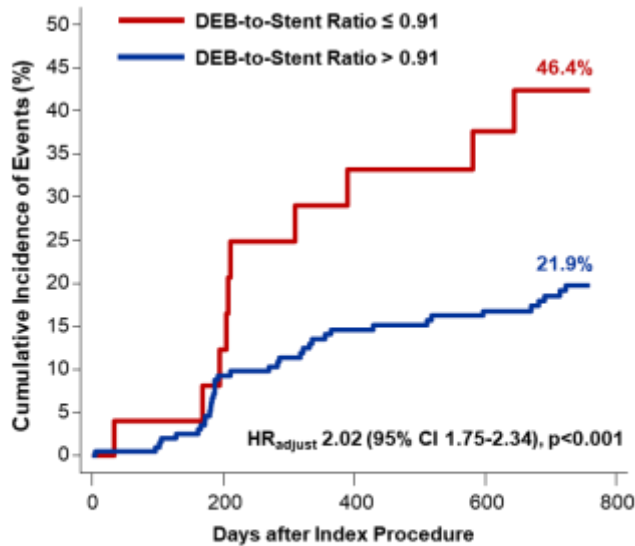
Ratio ≤ 0.91	26	21	16	13	0
Ratio > 0.91	202	174	158	152	0

	DCB-to-stent ratio		Multivariable-adjusted Hazard ratio (95% CI)	*P* value
	≤ 0.91 (N = 26)	> 0.91 (N = 202)		
Target lesion failure	46.4% (10)	21.9% (38)	**2.02 (1.75-2.34)**	**< 0.001**
Target vessel MI	4.0% (1)	3.2% (5)	1.52 (0.18-12.8)	**0.703**
Clinically-driven TVR	46.4% (10)	19.4% (32)	**2.33 (1.95-2.78)**	**< 0.001**
Clinically-driven TLR	42.2% (9)	18.3% (30)	**2.12 (1.76-2.55)**	**< 0.001**

Superior efficacy outcomes in group with DCB-to-stent ratio > 0.91 than with ratio ≤ 0.91, Mainly driven by the lower rates of TLR

Infers importance of "Optimal size selection of DCB" with DEB-to-stent ratio > 0.91

TM Rhee and JM Lee, , HS Kim et al. JACC Cardiovasc Interv 2018;11(10):969-978.

Total Inflation Time of DCB

Target Lesion Failure at 2Y
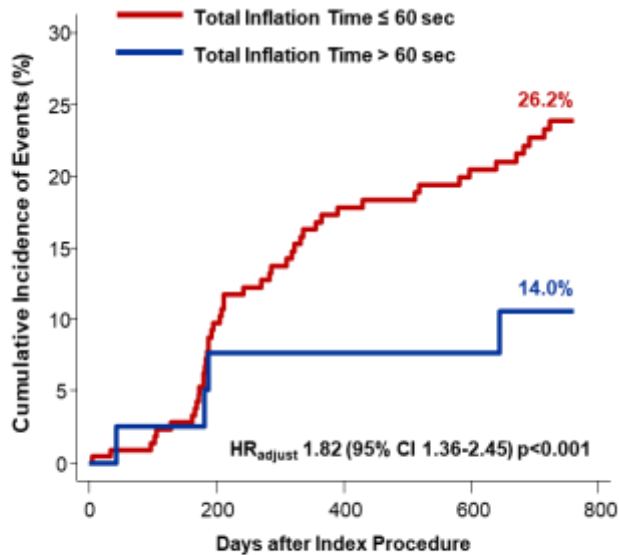
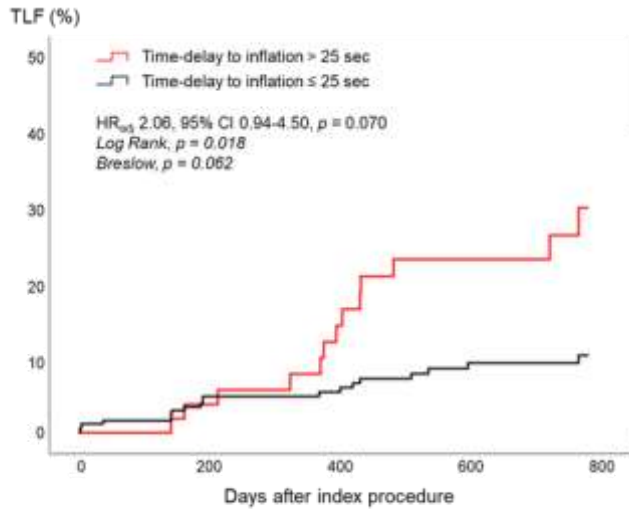|	Total inflation time of DCB		Multivariable-adjusted Hazard ratio (95% CI)	P value
	≤ 60 sec (N = 216)	> 60 sec (N = 37)		
Target lesion failure	26.2% (48)	14.0% (4)	1.82 (1.36-2.45)	< 0.001
Target vessel MI	3.5% (6)	0.0% (0)	1.11 (0.05-26.5)	0.948
Clinically-driven TVR	23.5% (41)	17.4% (5)	1.83 (1.37-2.45)	< 0.001
Clinically-driven TLR	22.5% (39)	11.5% (3)	2.33 (1.87-2.90)	< 0.001

**Superior efficacy outcomes in group with
total inflation time > 60s than with inflation time ≤ 60s,
mainly driven by the lower rates of TLR**

**Infers importance of "Sufficient Inflation of DCB"
until total inflation time > 60 seconds**

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TM Rhee and JM Lee, , HS Kim et al. JACC Cardiovasc Interv 2018;11(10):969-978.

Delivery Time of DCB

259 patients treated with DCB angioplasty
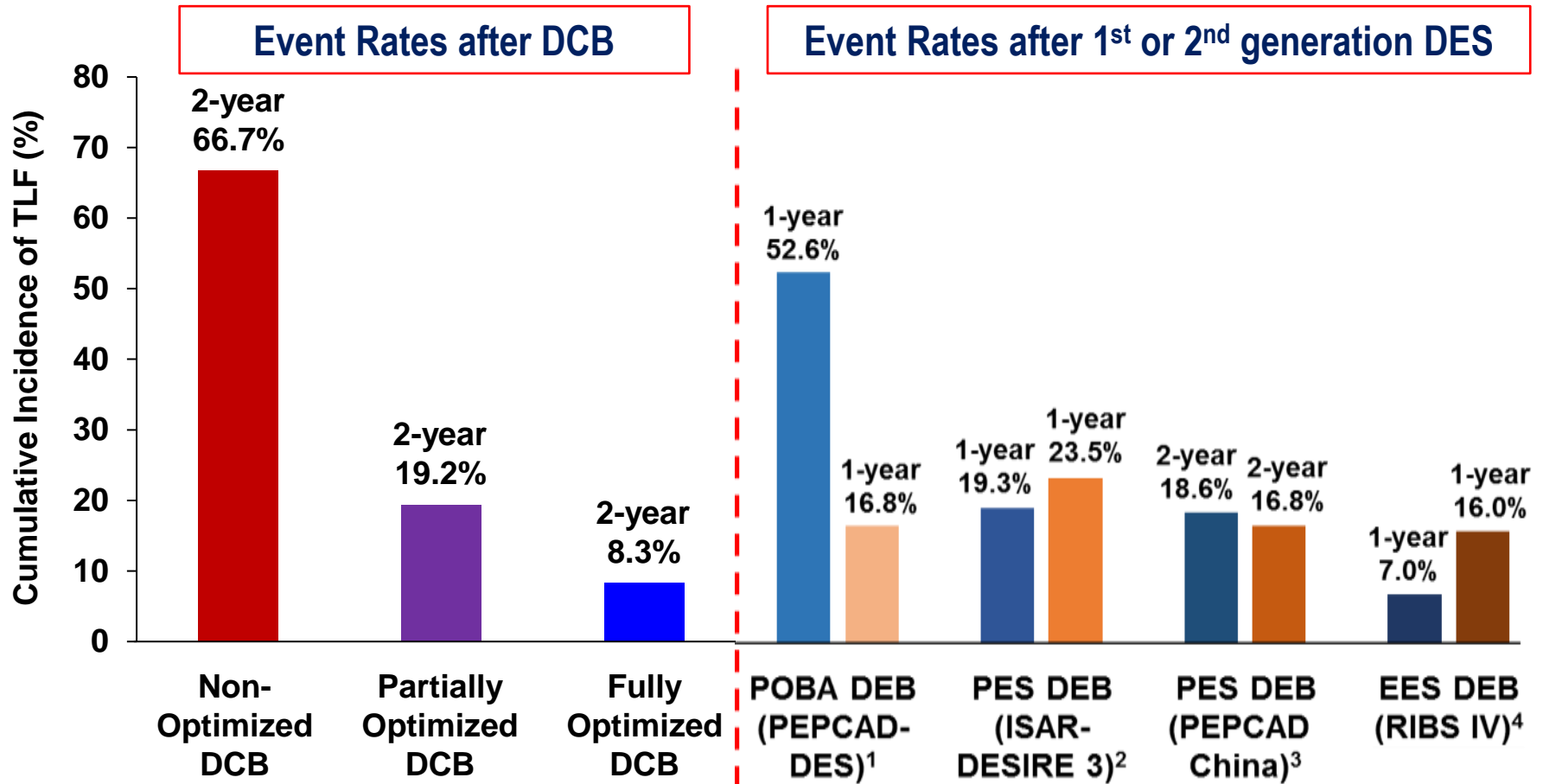## Second report to expand the concept

Target Lesion Failure at 2Y

TLF (%)

Time-delay to inflation > 25 sec
Time-delay to inflation ≤ 25 sec

HR$_{adj}$ 2.06, 95% CI 0.94-4.50, p = 0.070
Log Rank, p = 0.018
Breslow, p = 0.062

Days after index procedure

Number at risk

Duration > 23	55	50	38	29	18
Duration ≤ 23	254	198	158	122	84

	Delivery Time of DCB		Multivariable-adjusted Hazard ratio (95% CI)	*P* value
	≤ 25 sec (N = 254)	> 25 sec (N = 55)		
Target lesion failure	7.1% (18)	20.0% (11)	2.06 (0.94-4.50)	0.070
Target vessel MI	2.4% (6)	1.8% (1)	NR	NR
Clinically-driven TVR	8.3% (21)	20.0% (11)	NR	NR
Clinically-driven TLR	6.7% (17)	16.4% (9)	NR	NR

Strong trends of shorter delivery time and lower the risk of TLF

Infers importance of "Rapid Delivery of DCB"
To minimize loss of the coated drug

Incidence of Target Lesion Failure by Combined Procedure-related Factors

Event Rates after DCB

Event Rates after 1st or 2nd generation DES

Cumulative Incidence of TLF (%)

- **Non-Optimized DCB**: 2-year 66.7%
- **Partially Optimized DCB**: 2-year 19.2%
- **Fully Optimized DCB**: 2-year 8.3%
- **POBA DEB (PEPCAD-DES)[1]**: 1-year 52.6% / 1-year 16.8%
- **PES DEB (ISAR-DESIRE 3)[2]**: 1-year 19.3% / 1-year 23.5%
- **PES DEB (PEPCAD China)[3]**: 2-year 18.6% / 2-year 16.8%
- **EES DEB (RIBS IV)[4]**: 1-year 7.0% / 1-year 16.0%

Fully Optimized DCB Angioplasty showed similar TLF rates with DES in previous ISR trials.

H Rittger et al. JACC 2012, RA Byrne et al. Lancet 2013
B Xu et al. JACC Intervention 2014, F Alfonso et al. JACC 2015
TM Rhee and JM Lee, , HS Kim et al. JACC Cardiovasc Interv 2018;11(10):969-978.

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"Four Major Procedural factors" to Enhance Clinical Outcomes after DCB treatment

1) **Perfect lesion preparation before DCB treatment: Residual %DS < 20%**
   Makes the lesion easy to be coated with drug

2) **DCB-to-stent ratio : at least 0.9**
   Increases the contact area to maximize drug delivery
   Also warrants the optimal lesion preparation

3) **Rapid delivery of DCB device : delivery time < 25-30 seconds**
   Minimizes the amount of drug lost during delivery
   May need additional supporting devices

4) **Total Inflation Time of DCB : at least 60 seconds**
   Increases the time and chance for drug to be delivered
   Needs the ischemic preconditioning before DCB treatment

TM Rhee and JM Lee, , HS Kim et al. JACC Cardiovasc Interv 2018;11(10):969-978.
JM Lee, Rhee TM et al. Int J Cardiol. 2017 Sep 1;242:5.

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Additional Techniques in Lesion Preparation

Benefit of Scoring Balloon in Lesion Preparation
ISAR-DESIRE 4 - 252 patients with DES ISR
Scoring balloon vs. Conventional balloon

FIGURE 1 Cumulative Frequency Distribution Curves for Primary Endpoint According to Treatment Group

Percentage diameter stenosis on 6- to 8-month follow-up angiography; data shown for scoring balloon group **(green)** and control group **(gray)**.
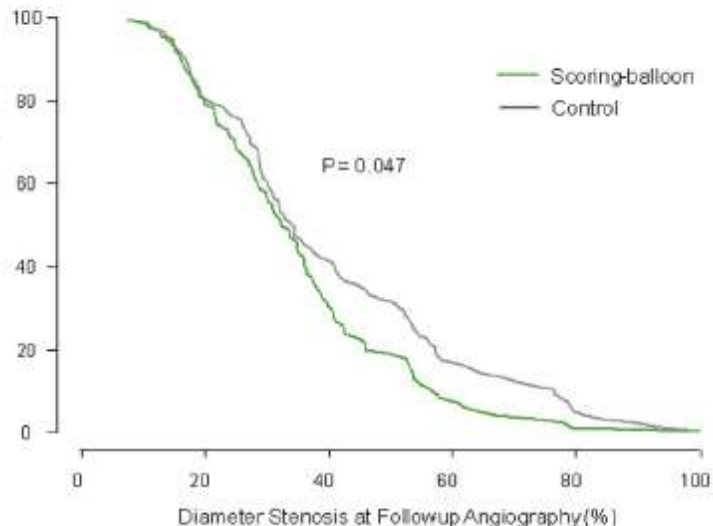
TABLE 3 Angiographic Follow-Up at 6 to 8 Months

	Scoring Balloon (n = 103)	Control (n = 100)	p Value
Diameter stenosis (%), in segment	35.0 ± 16.8	40.4 ± 21.4	0.047
Minimal luminal diameter (mm), in segment	1.95 ± 0.55	1.77 ± 0.68	0.032
Late lumen loss (mm)	0.31 ± 0.59	0.41 ± 0.74	0.27
Recurrent binary restenosis	19 (18.5)	32 (32.0)	0.026
Characteristics of recurrent restenotic lesions	(n = 19)	(n = 32)	
Diameter stenosis (%), in segment	62.5 ± 12.4	66.8 ± 14.0	0.28
Lesion length	10.7 ± 4.6	9.9 ± 5.5	0.58
Restenosis morphology			0.22
Focal margin	1 (5.3)	1 (3.1)	
Focal body	12 (63.2)	18 (56.3)	
Multifocal	2 (10.5)	1 (3.1)	
Diffuse	3 (15.8)	10 (31.3)	
Proliferative	0 (0.0)	1 (3.1)	
Occlusive	1 (5.3)	1 (3.1)	

Values are mean ± SD or n (%) on the basis of in-segment analysis.

Modification of neointima using scoring balloon showed
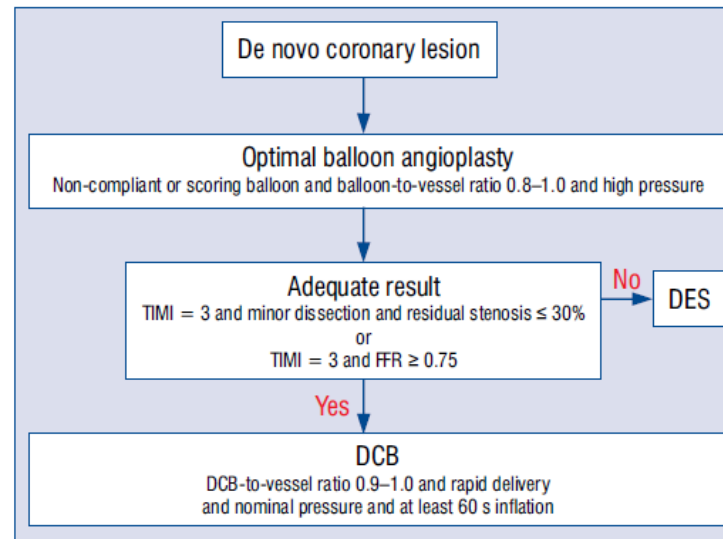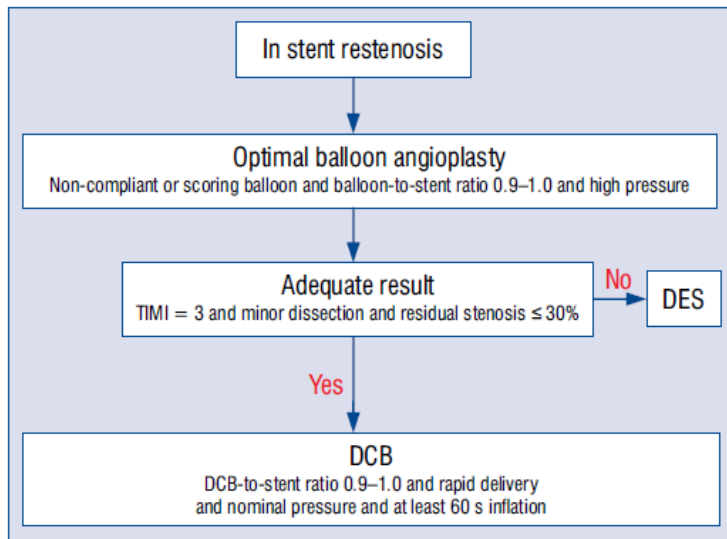## Lower binary restenosis and Higher follow-up %DS

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Consensus Documents

International Consensus
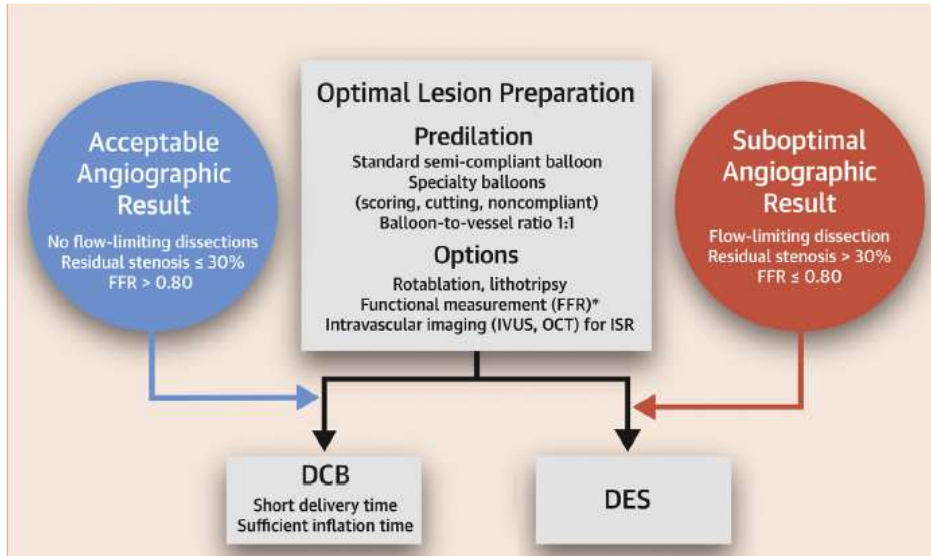
Optimal Lesion Preparation if the most important step before DCB application

Asian-Pacific Consensus

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Case Example of Optimized DCB Procedure
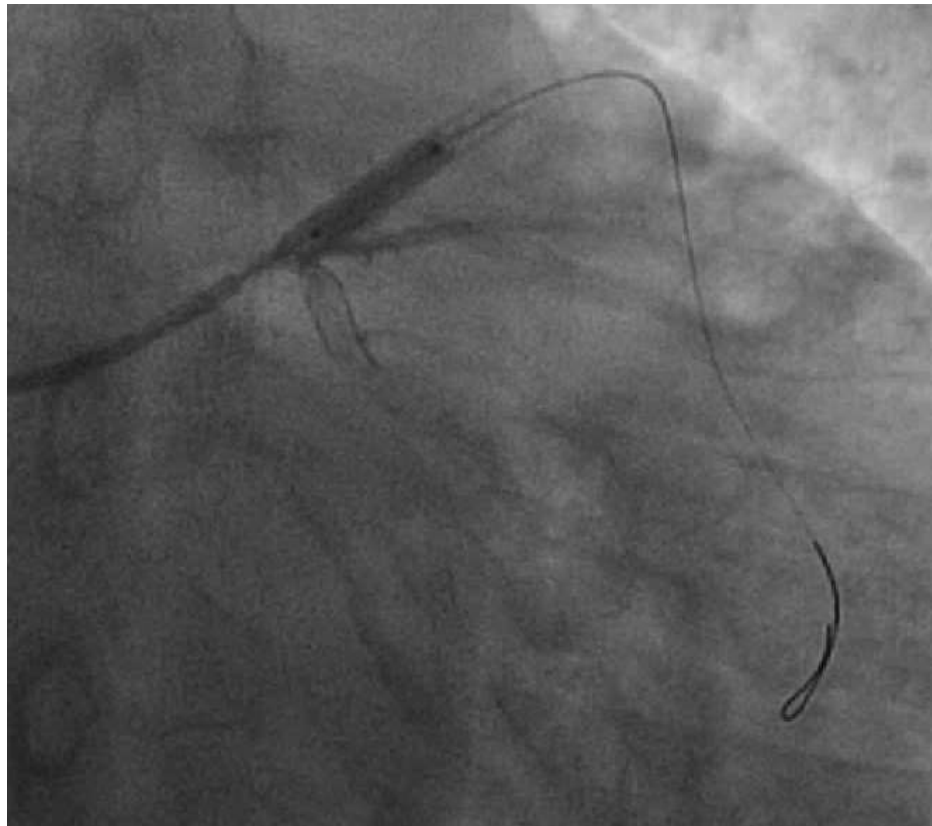## - Baseline Angiography -

42/Female

s/p PCI to pLAD (4 years ago) at Outside hospital
- **PCI indication unknown**
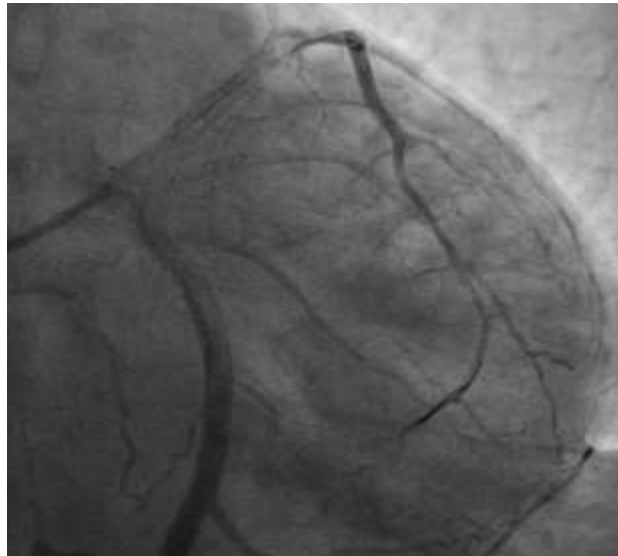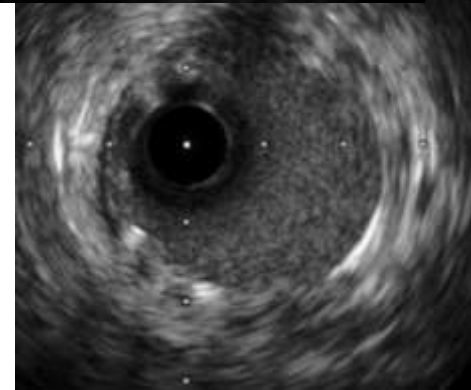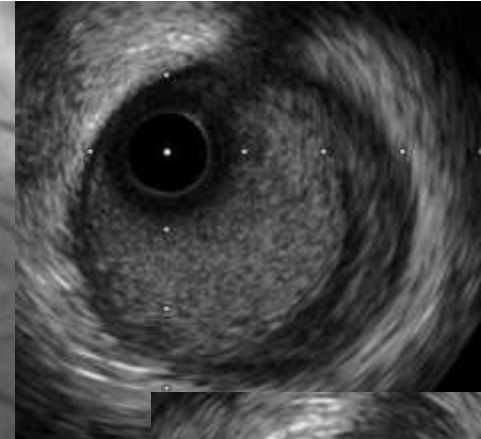- **Stent size and length unknown**

Presented with Unstable Angina with Resting Chest pain

Case Example of Optimized DCB Procedure
- Repeated Pre-Dilatation -

Total 4 times of Pre-dilatation with 30 seconds duration
➔ Ischemic Pre-Conditioning

Case Example of Optimized DCB Procedure
- Post Pre-Dilatation -
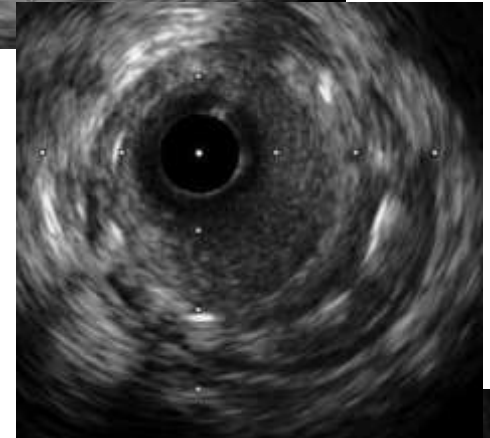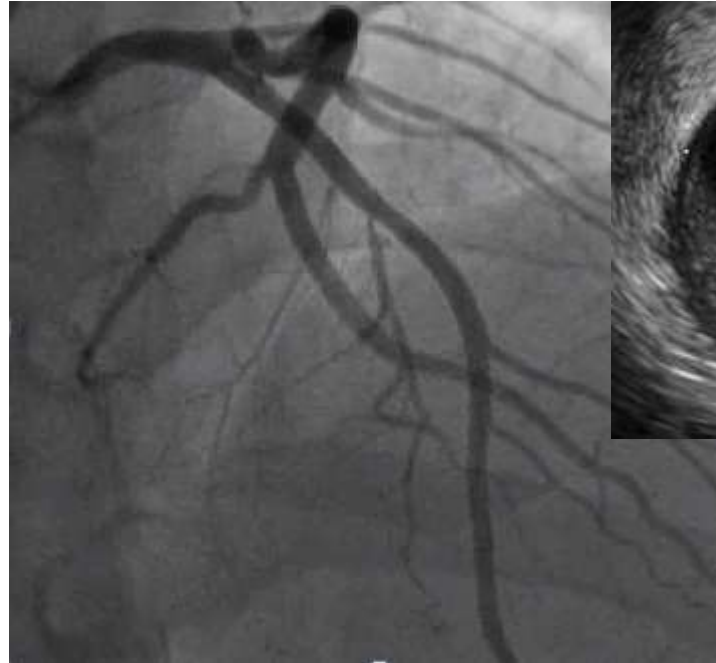
- **Percent Diameter Stenosis After Pre-Dilatation 17%**

- **No Significant Dissection**

- **TIMI 3 Flow**

- **Intravascular Imaging is Key!!**

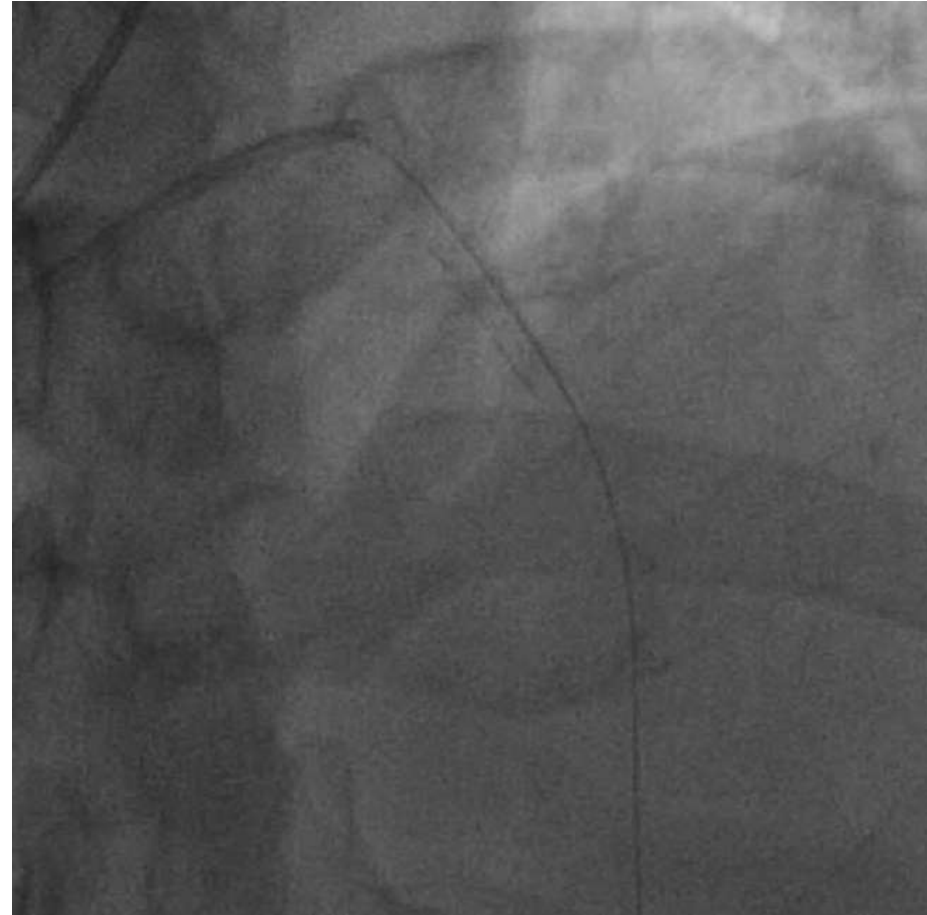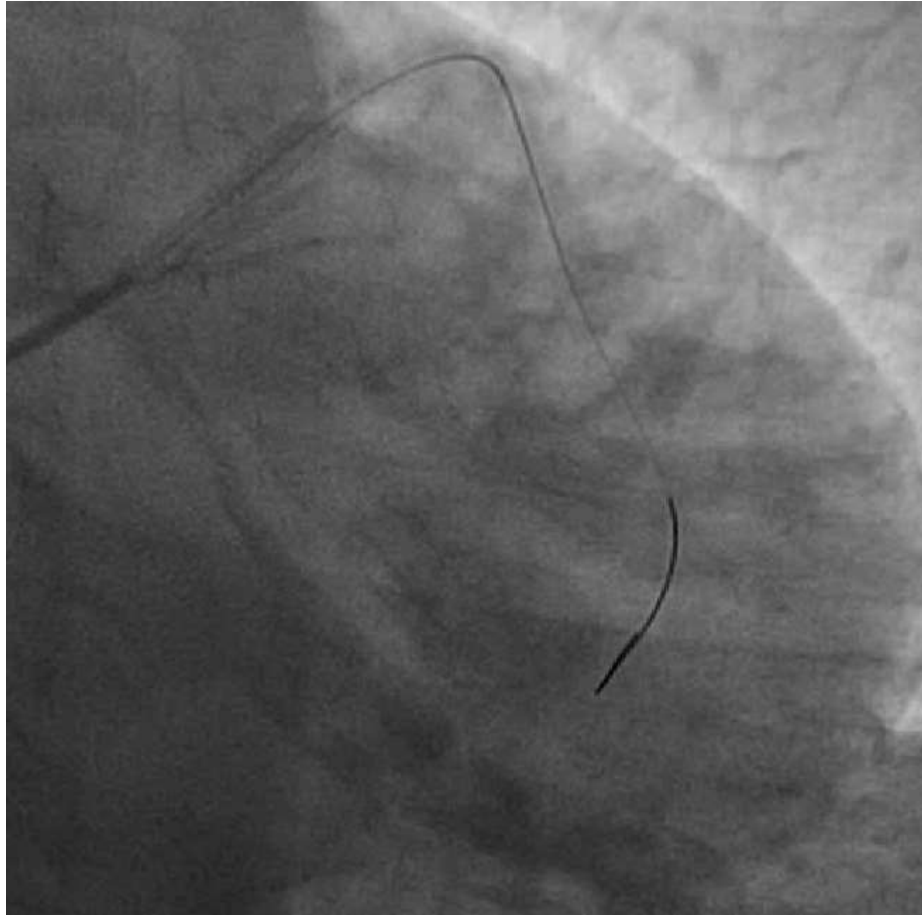# Case Example of Optimized DCB Procedure
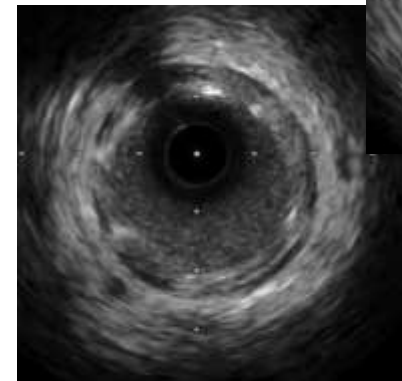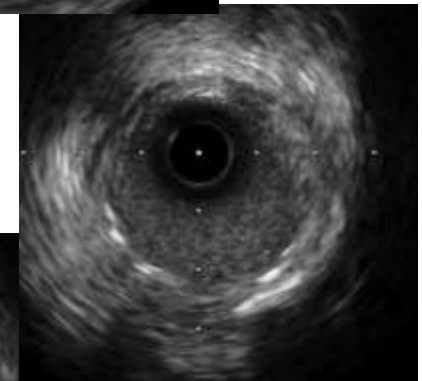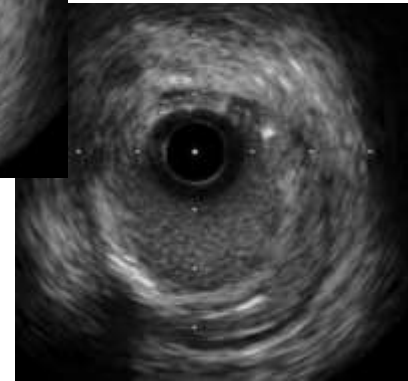## - DCB Application -
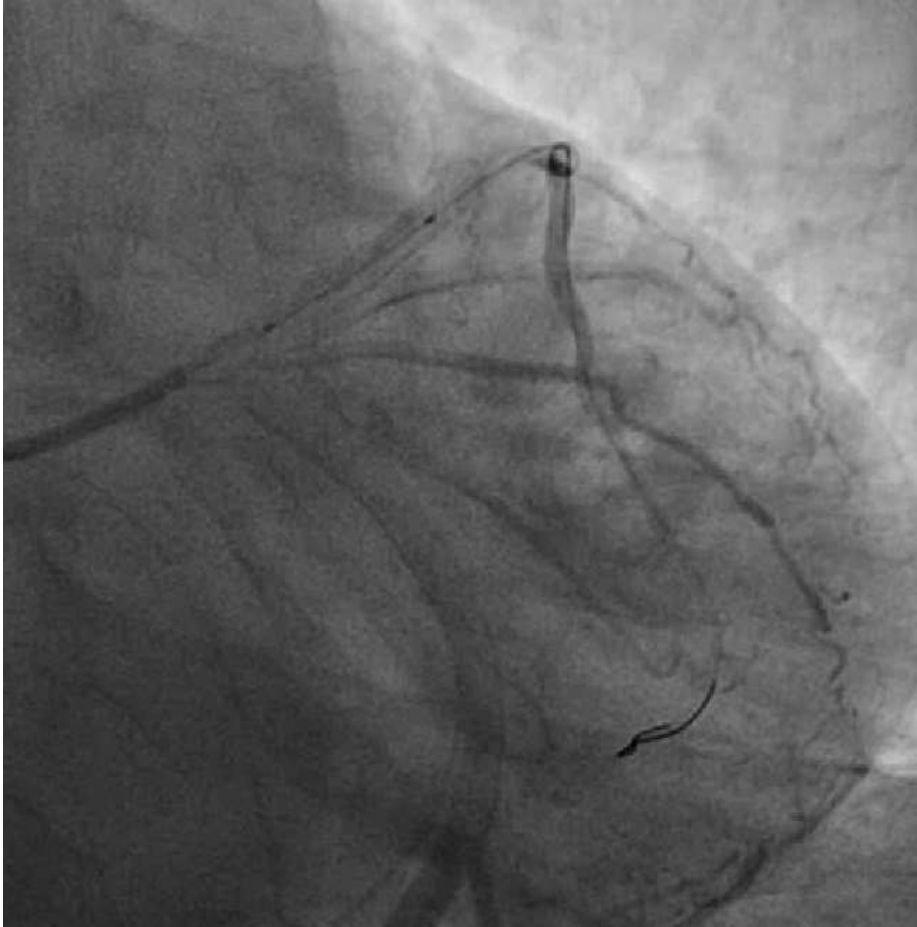
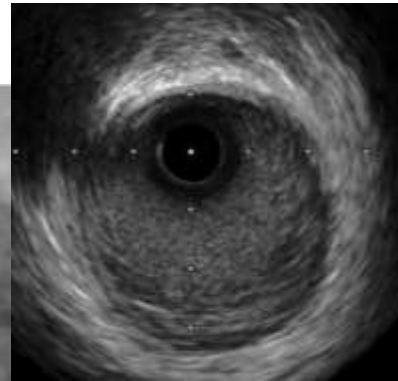**Delivery Time : 25 seconds**

Total Inflation Time : 80 seconds

Patient was well tolerated.

Case Example of Optimized DCB Procedure
- Final Angiogram -

Case Example of Optimized DCB Procedure
- Final IVUS -

Summary and Conclusions

- **DCB is fundamentally different treatment with stent.**

- **Optimal lesion preparation is the key process before DCB application**

- **Procedural optimization of DCB is more important than that of DES.**

- **In order to maximize DCB results, 4 major procedural factors should be considered.**
  - **Perfect lesion preparation (residual %DS<20%)**
  - **Optimal selection of DCB size (at least >0.9 of reference)**
  - **Rapid delivery of the DCB into target lesion (≤25-30 seconds)**
  - **Sufficient total inflation time (>60 seconds)**