Complex PCI of an LAD/Diagonal bifurcation lesion (Medina 1,1,1) utilizing the DK Crush technique ".

"Σύμπλοκη αγγειοπλαστική βλάβης διχασμού LAD/Diagonal (Medina 1,1,1) με την τεχνική DK crush ".

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Structure of Presentation

1. Detailed description of the individual steps of the DK Crush Technique

2. Focus on the problems and complications arising during its implementation and proposals for their treatment

3. Brief reference to literature on this technique

4. **Conclusions**

Disclosures

None to be declared

Case Presentation

A 64-year-old man was referred to our hospital for cardiac catheterization due to an abnormal stress test, having reported to his doctor post – exertion anginal chest pain which had worsened over the course of the previous 6 months, prompting him to order a myocardial scintigraphy study. The SPECT showed a large reversible anterior wall perfusion defect that indicated LAD ischemia.

Case Presentation

- **Physical examination:** unremarkable
- **Chest X-ray:** normal
- **Electocardiogram (ECG):** anterior T wave changes
- **Transthoracic echo:** normal examination with preserved left ventricular ejection fraction (EF 60%) showing no segmental wall motion abnormalities
- **Routine laboratory evaluation:** unrevealing
- **Cardiovascular risk factors:** heavy smoker, arterial hypertension, hyperlipidaemia
- **Past medical history:** degenerative joint disease.
- **Medication:** atorvastatin, carvedilol.

Case Presentation

- **Vital signs at admission time:** HR 60 beats/min, BP 110/70 mmHg

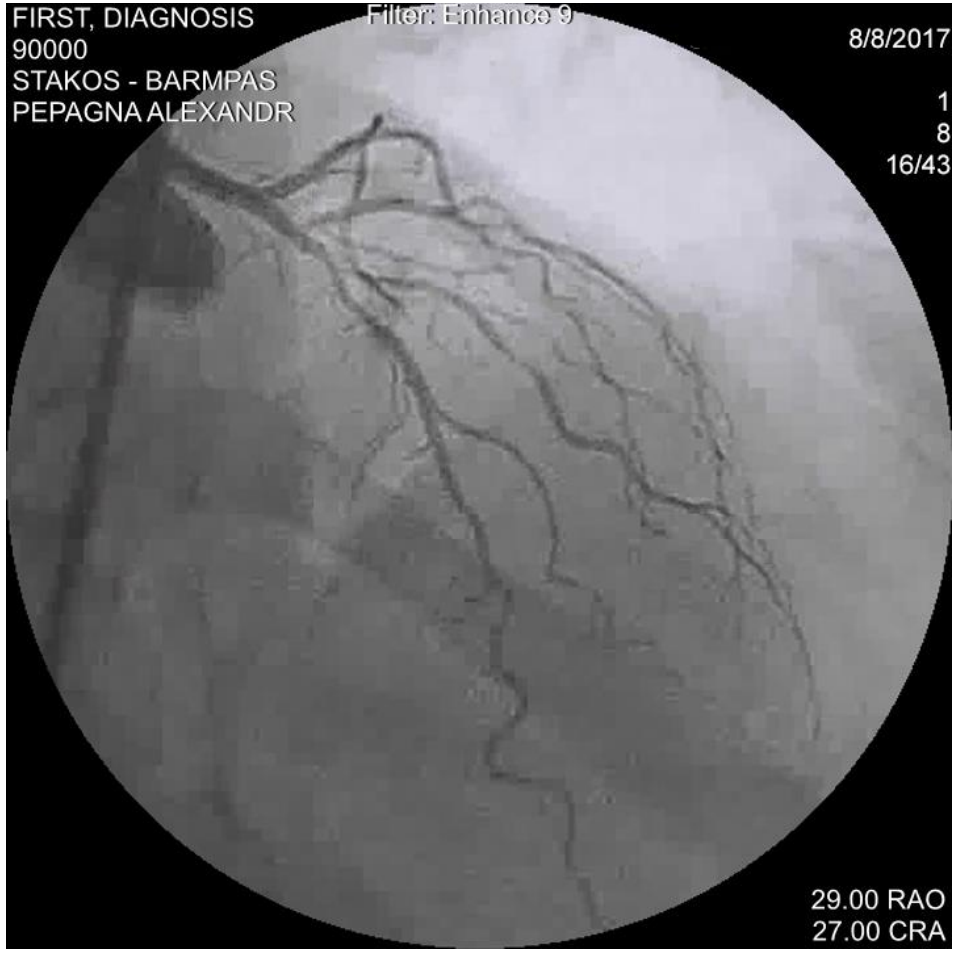
- **Pre procedure medications:**
  - 180 mg Ticagrelor p.o.
  - 300 mg Aspirin p.o.
  - 5000 U Heparin i.v.

Baseline Angiography

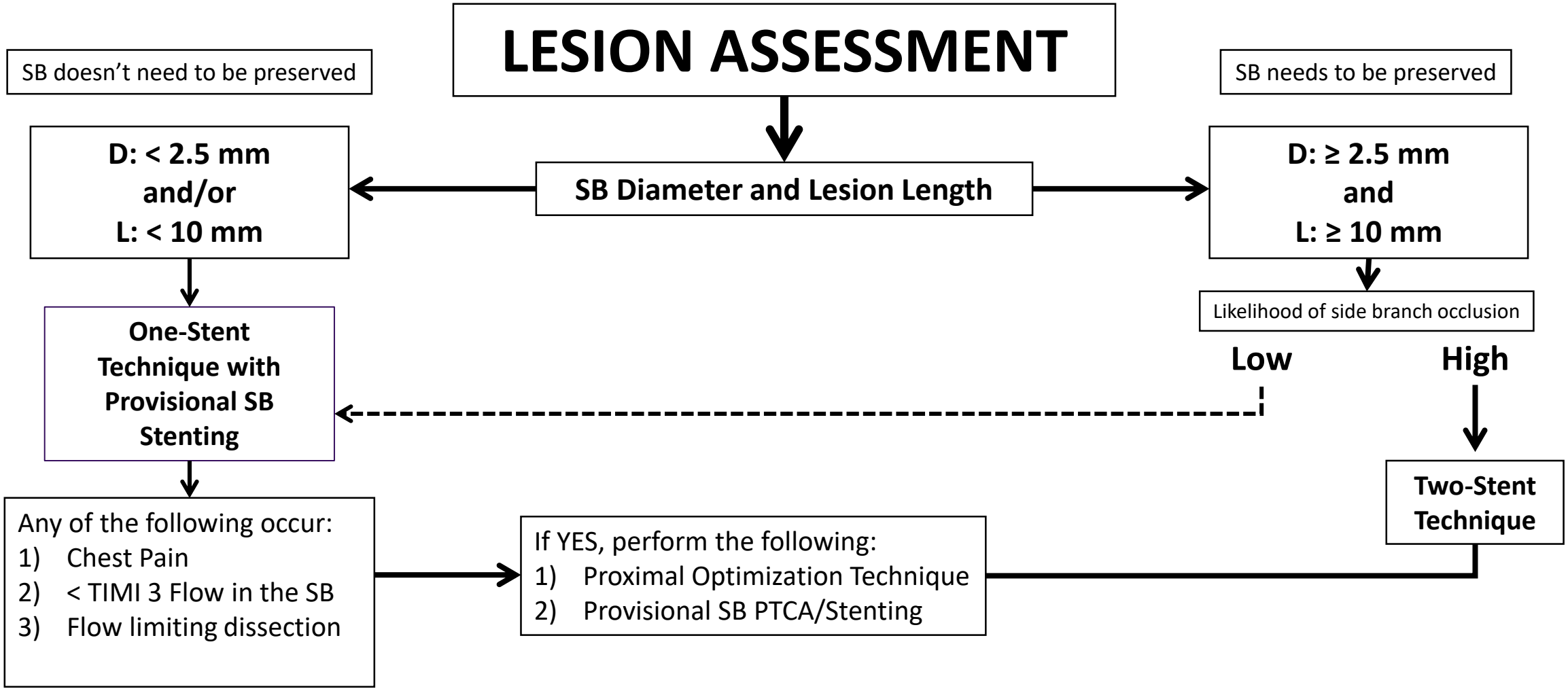
Access: right femoral artery

Sheath: Femoral Introducer Sheath Kit (5F)

Diagnostic catheters: 5F 4,0 JL/4,0 JR



An algorithm to choose between 1 versus 2 stents in the setting of bifurcation lesions, not including the left main



Reasons for choosing a Two-Stent Strategy

- We have a diagonal branch of large diameter around 2.5 mm that supplies blood to a large area of the myocardium
- The stenosis of the diagonal is severe > 70 % and extends over the orifice to a large extent above 10 mm
- Also, in the case of stenting of the main vessel, the diagonal branch due to its morphology would have a particularly increased risk of occlusion, with obvious implications. The calculated Resolve Score was 12, indicating high risk of Side breach occlusion. The calculation of the Resolve Score is detailed in the following slide
- The bifurcation angle was 60 ° which would make it difficult for the guide wire to pass to the SB following implantation of the stent into the main vessel

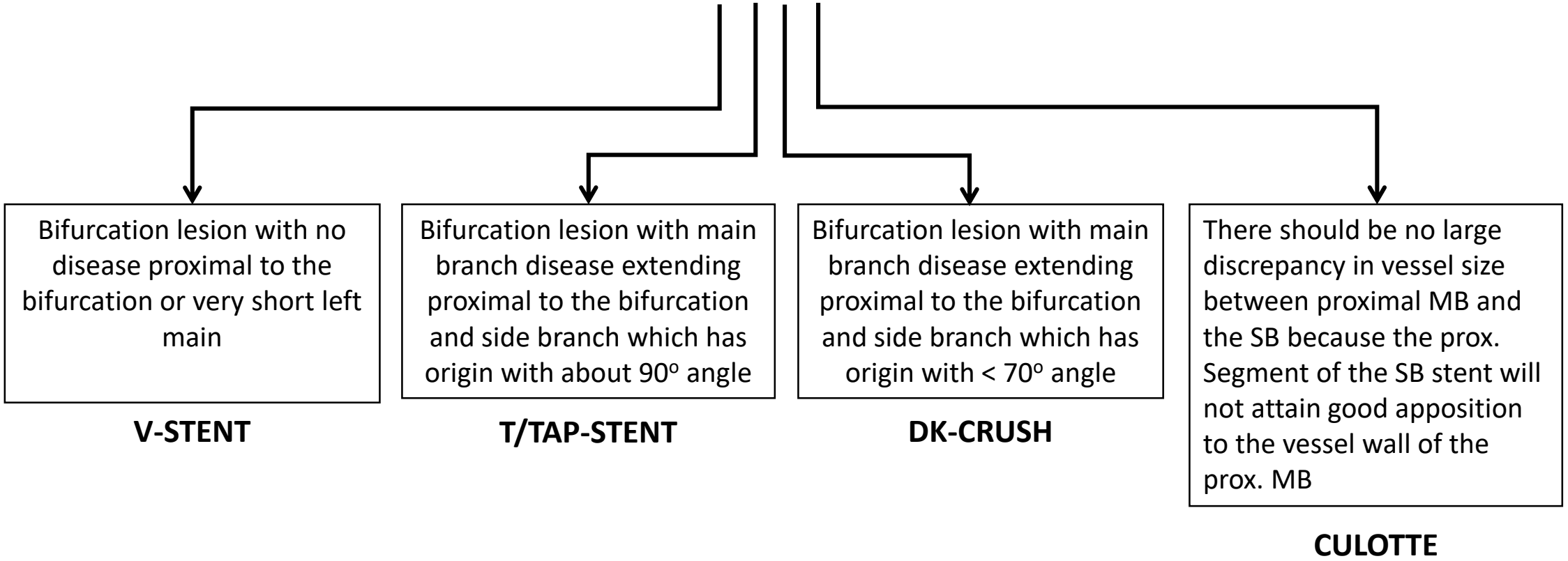
RESOLVE Score

An Angiographic Tool for Risk PrEdiction of Side Branch OccLusion in Coronary Bifurcation InterVEntion

- Plaque distribution---at the same side of SB: 1
- MV TIMI flow grade before stenting---TIMI 3: 0
- Diameter stenosis of bifurcation core--- >70%: 3
- Bifurcation angle--- <70°: 0
- Diameter ratio between MV/SB---[1-1.5): 2
- Diameter stenosis of SB --- 70%-90%: 6

Total score: 12---High risk of SB occlusion

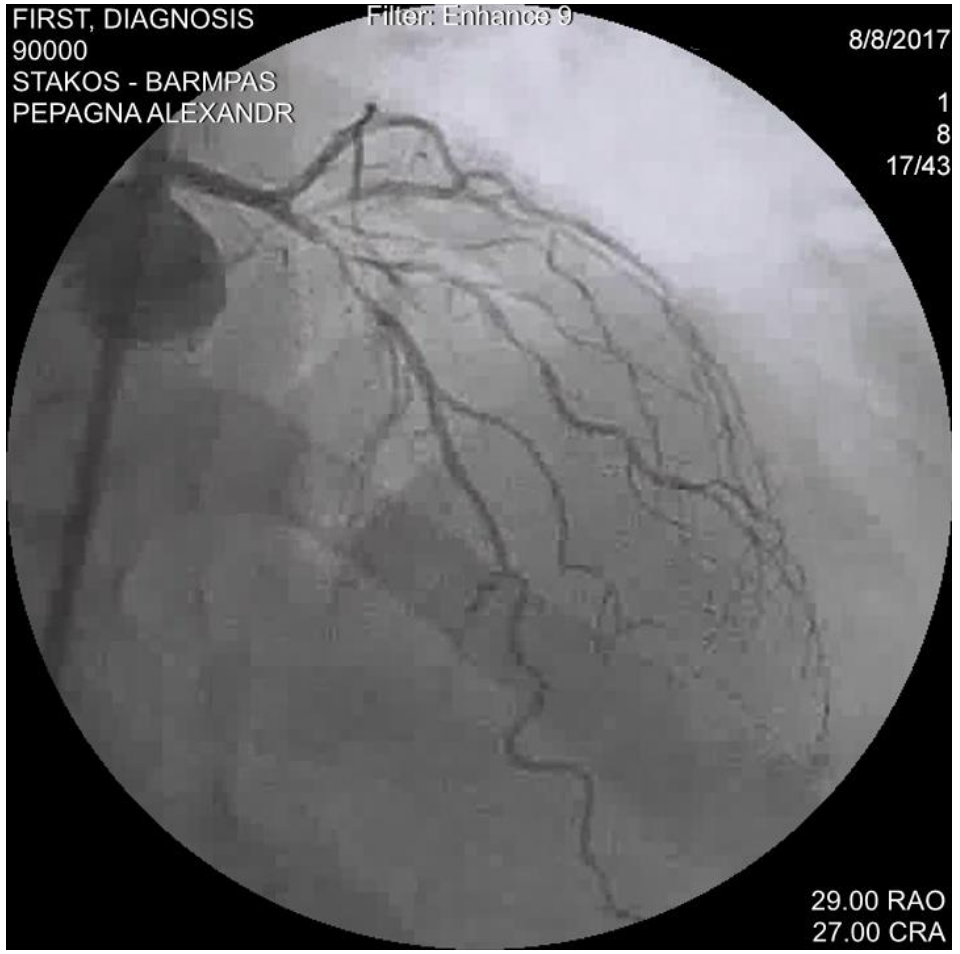
An approach for bifurcation lesions when using 2 stents as intention to treat



Case Presentation

LAD/Diagonal bifurcation lesion -PCI

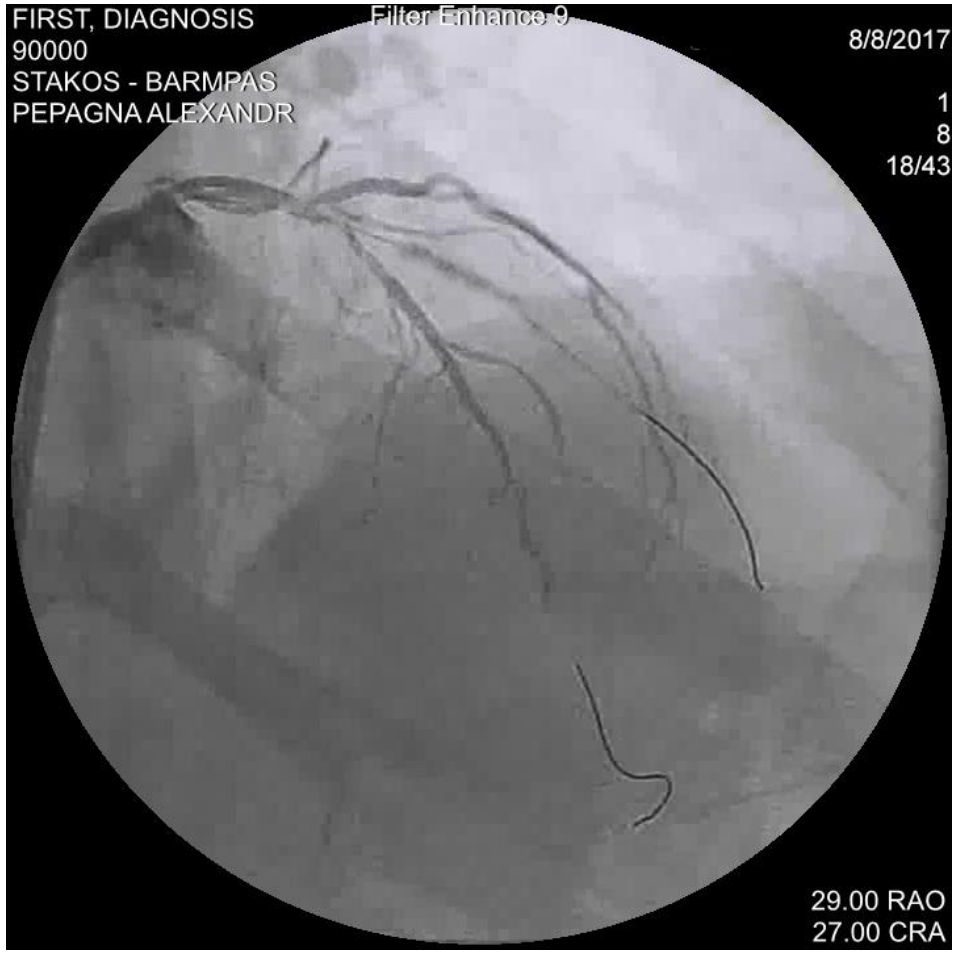
Guiding catheter: 7F EBU 3,5.



Case Presentation

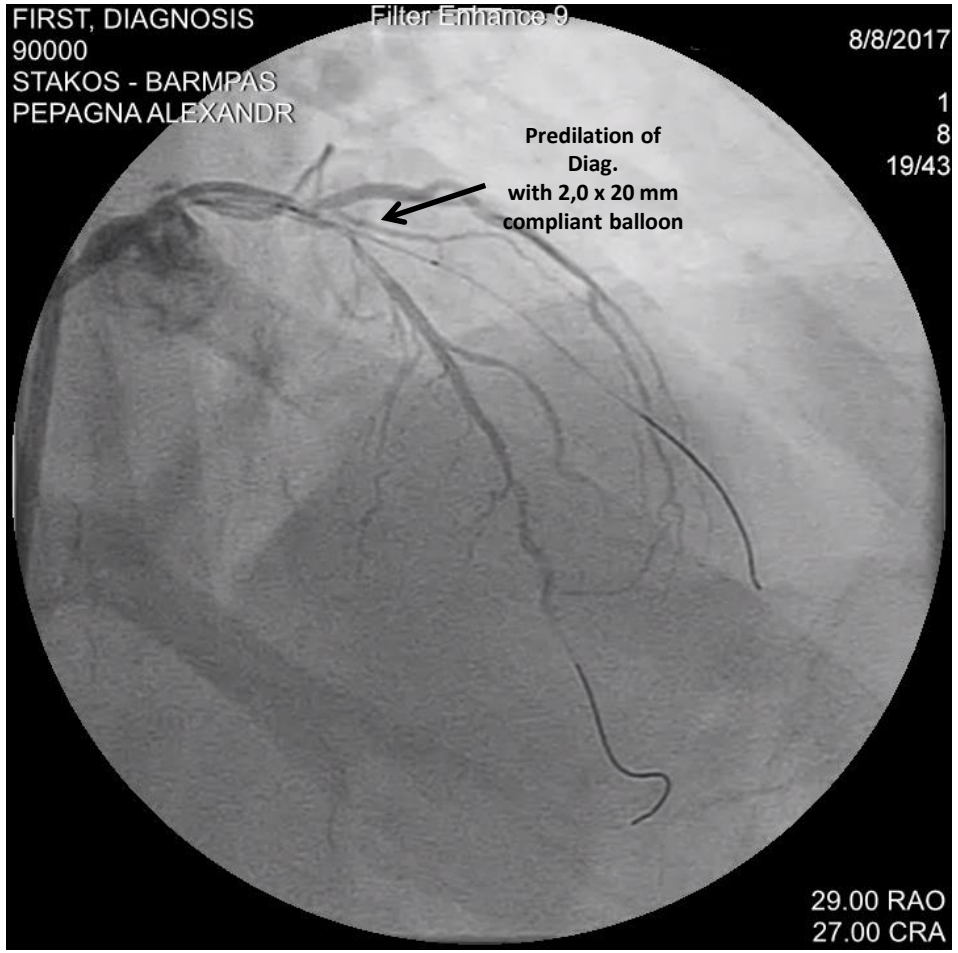
Wiring of both branches

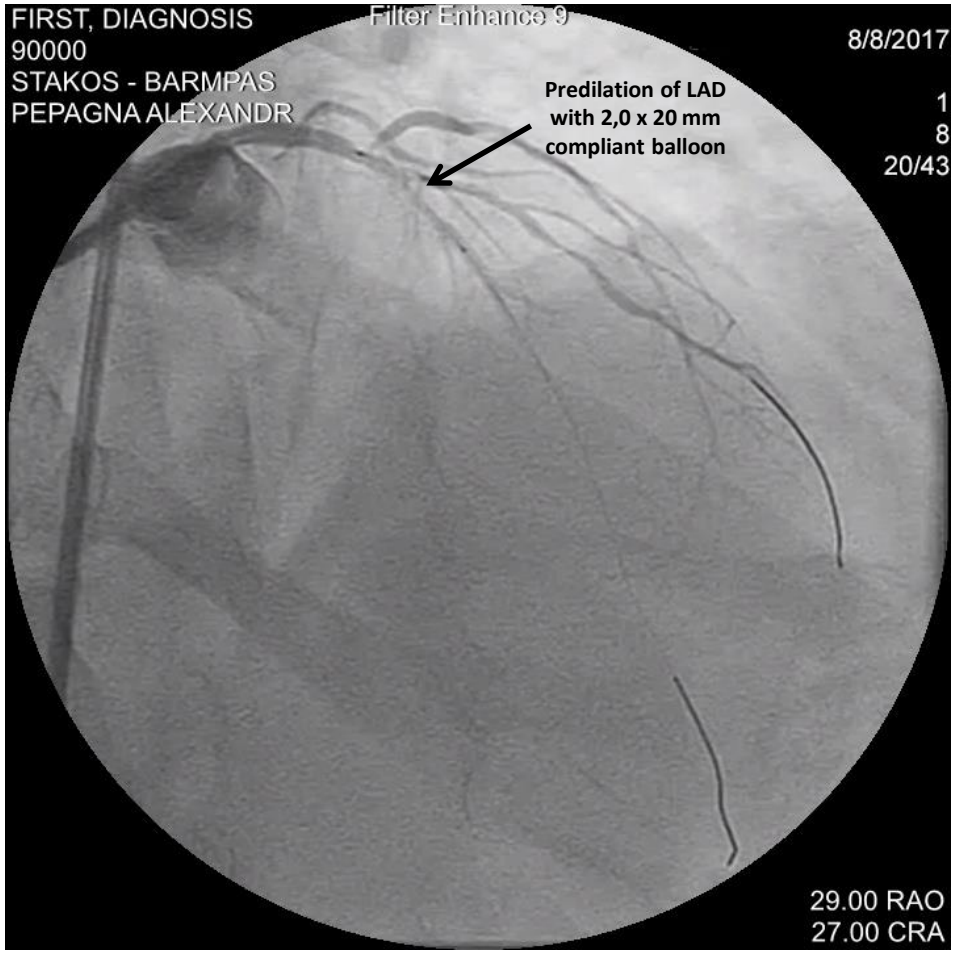
Guiding Wires: Runthrough-LAD, Balance Middleweight-Diagonal



Case Presentation

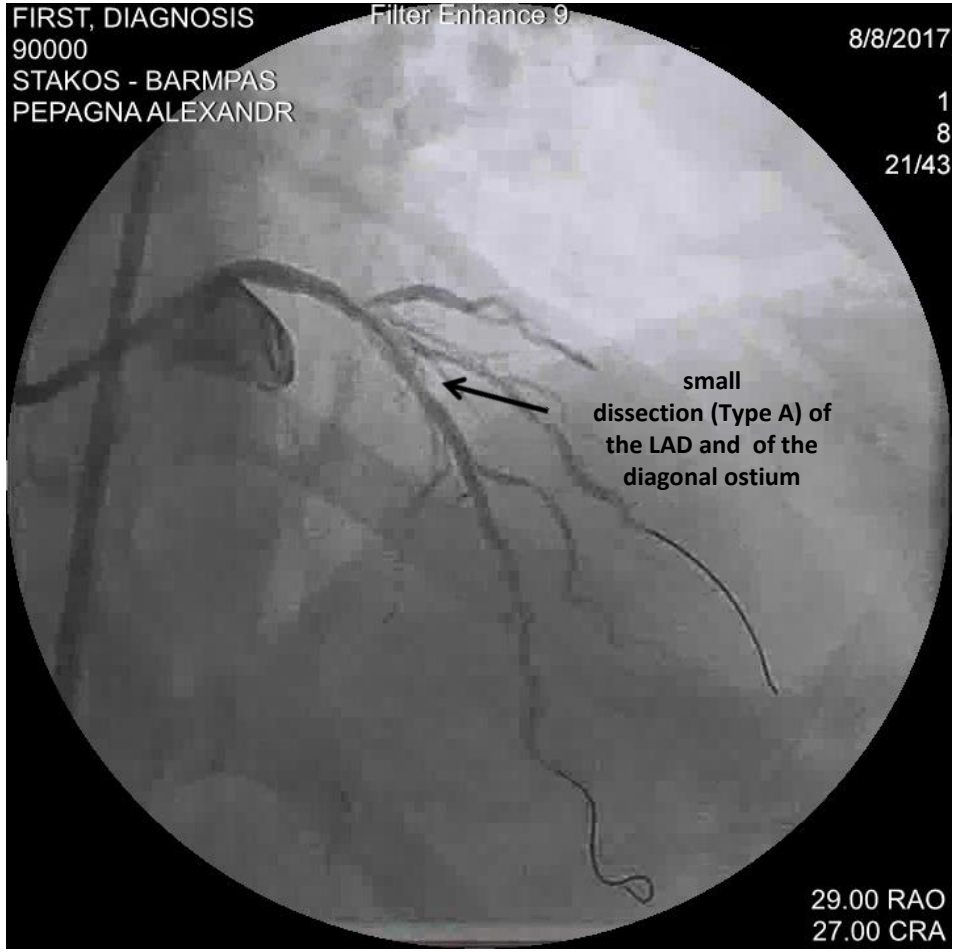
Side branch and main branch predilation with 2,0 x 20 mm compliant balloon



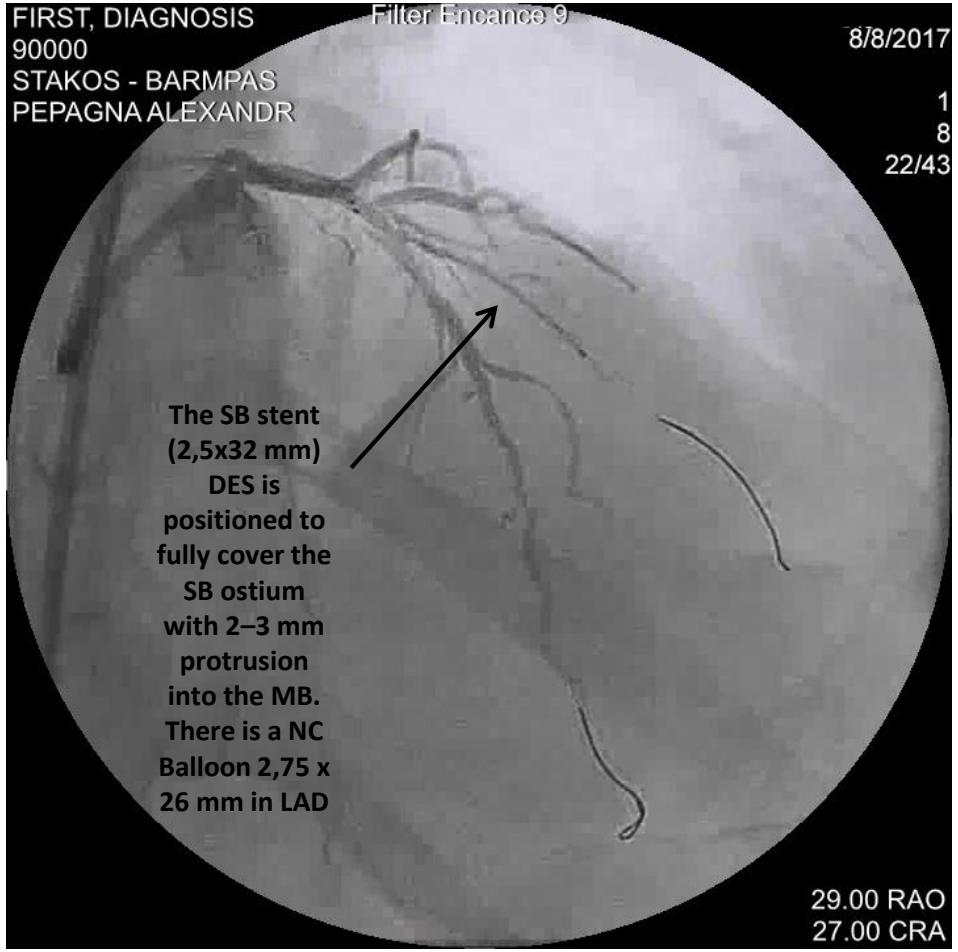


Case Presentation

Coronary angiography revealed a small dissection (Type A) of the LAD and of the diagonal ostium after predilation

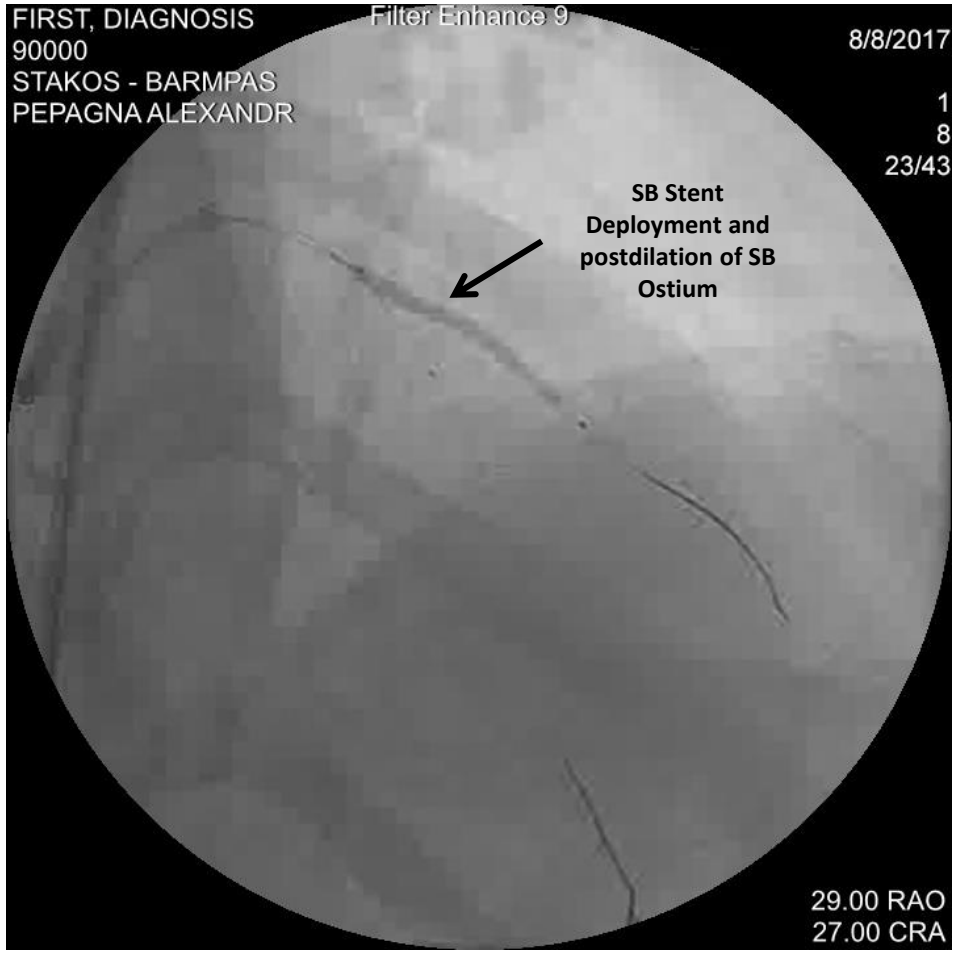


Case Presentation
Side Branch Stent Positioning

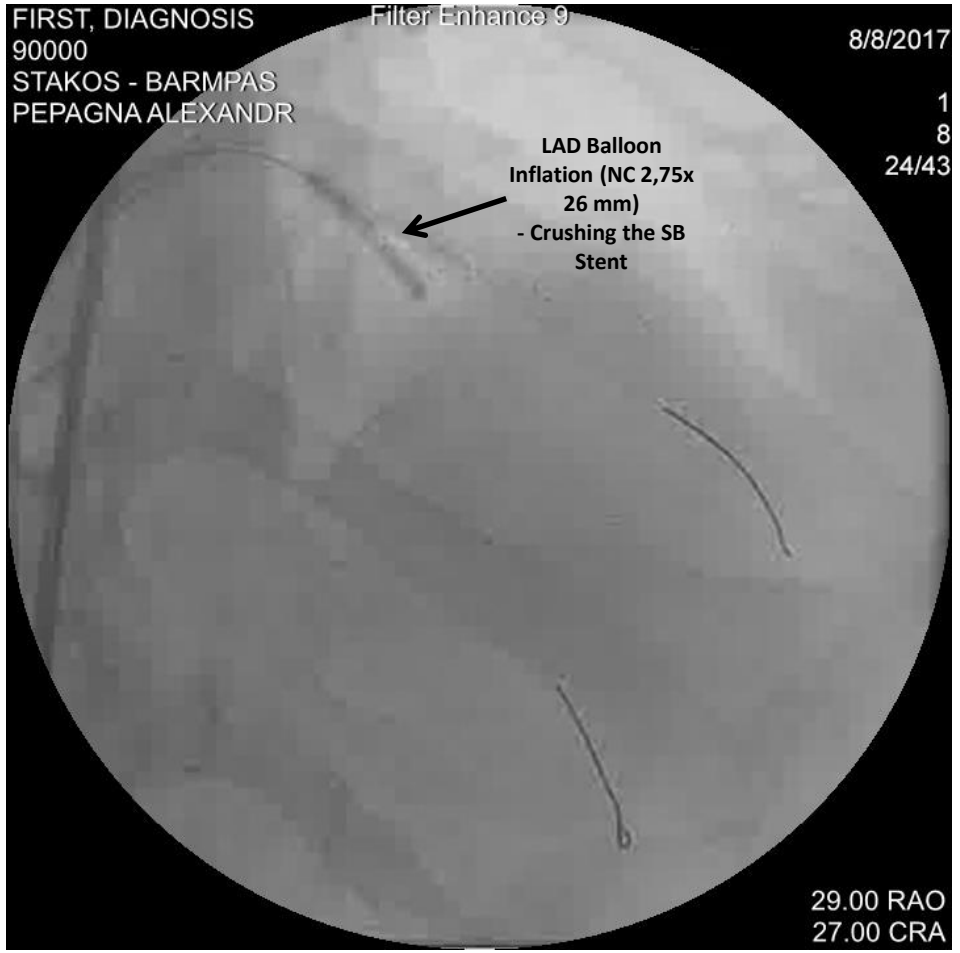


Case Presentation

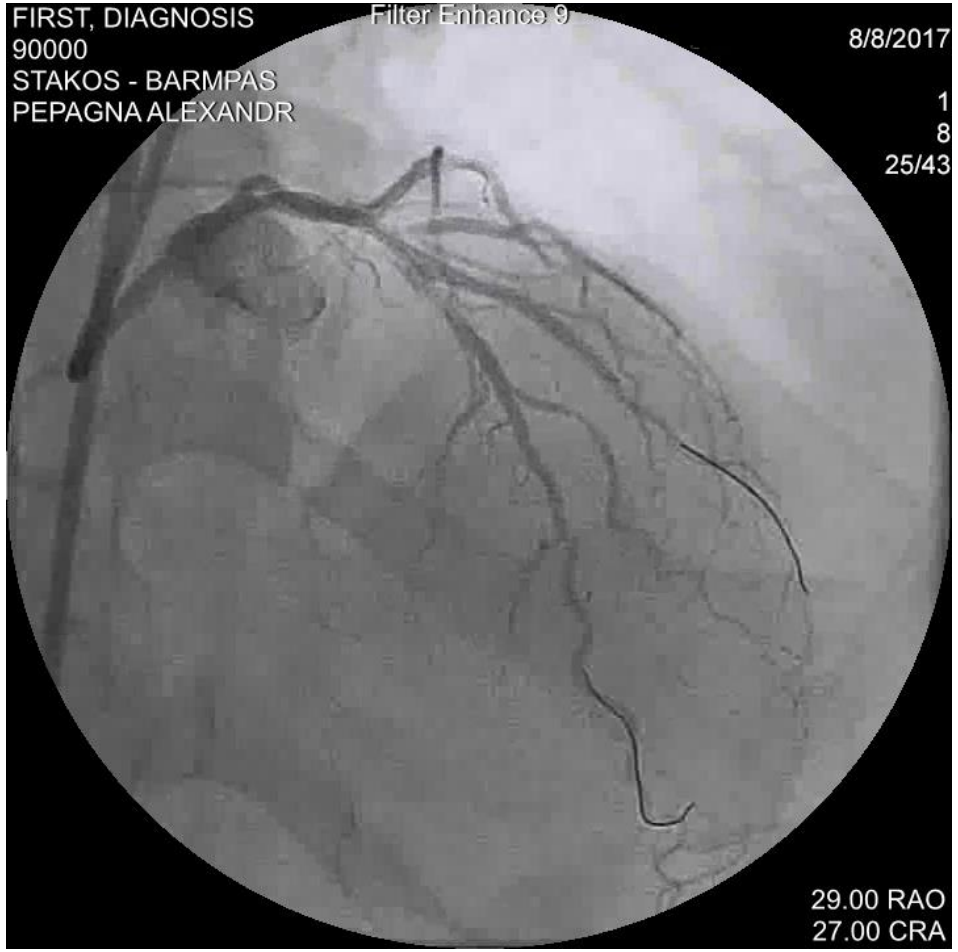
SB stent deployment, postdilation of SB Ostium and control angiography before „crushing“ of the SB Stent



Case Presentation
MB Balloon Inflation- Crushing of the SB Stent

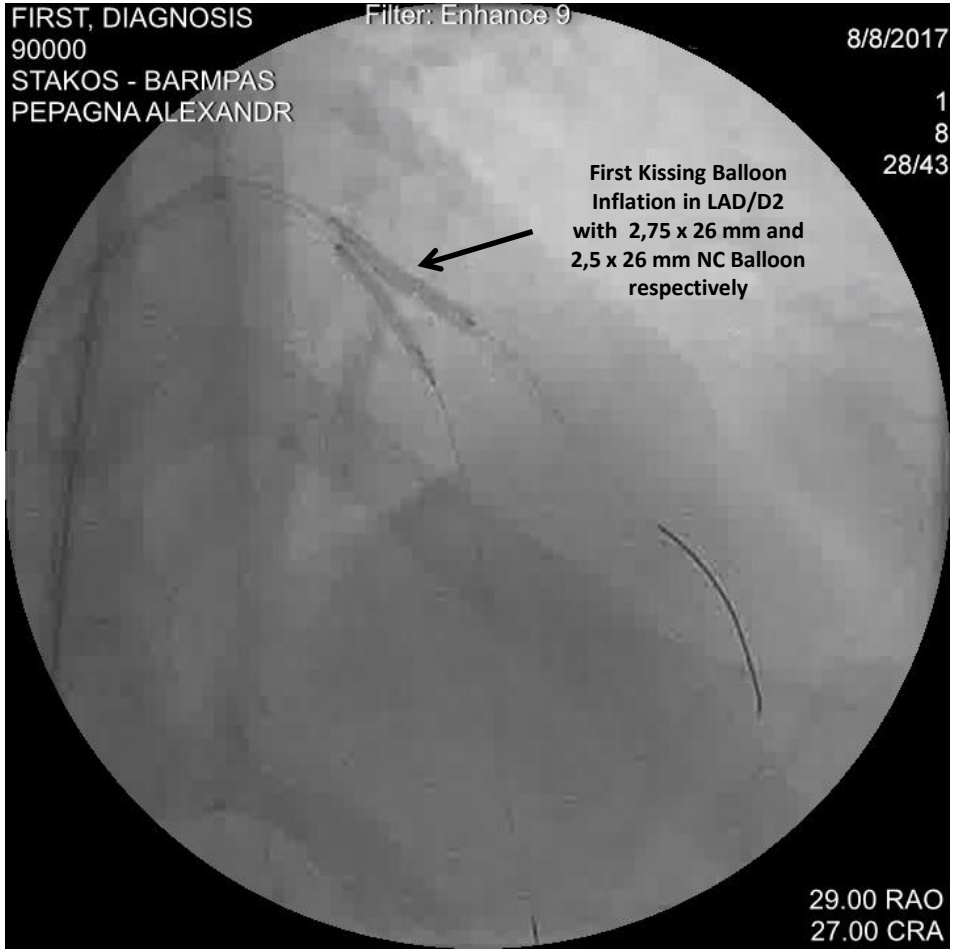


Case Presentation
Post crush Angiography

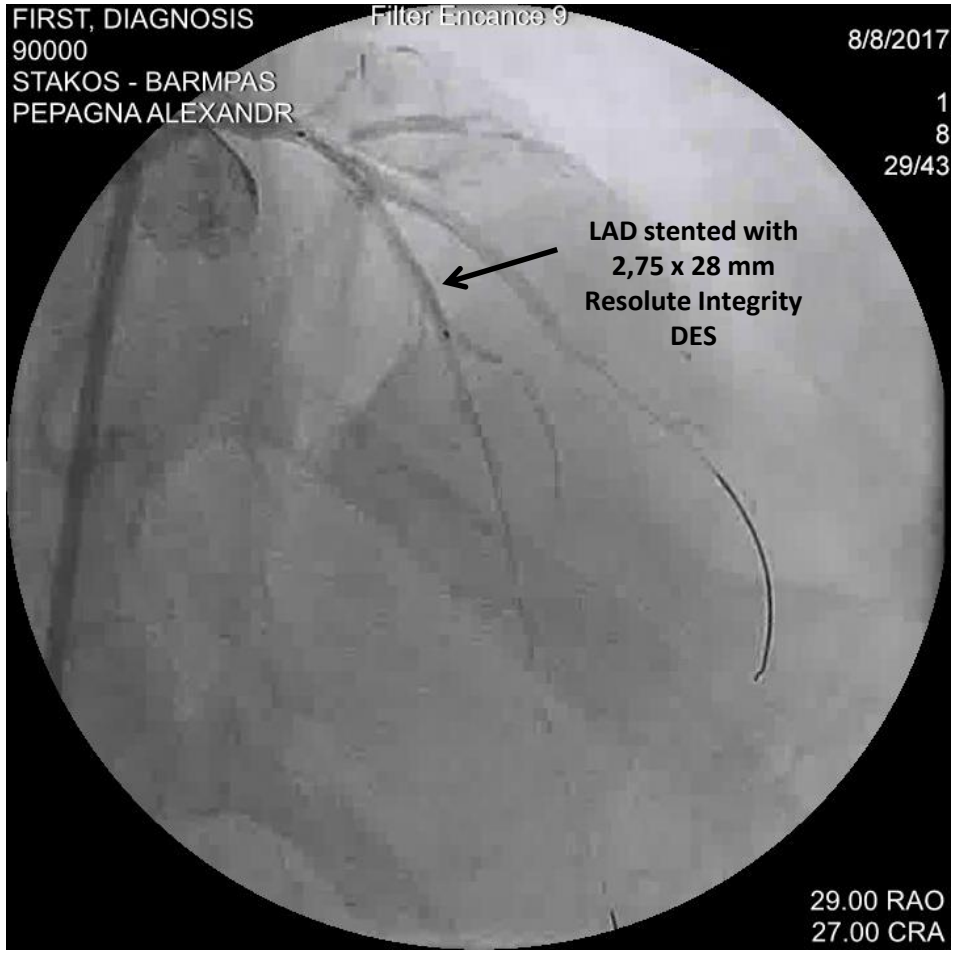


Case Presentation
Diagonal Rewiring

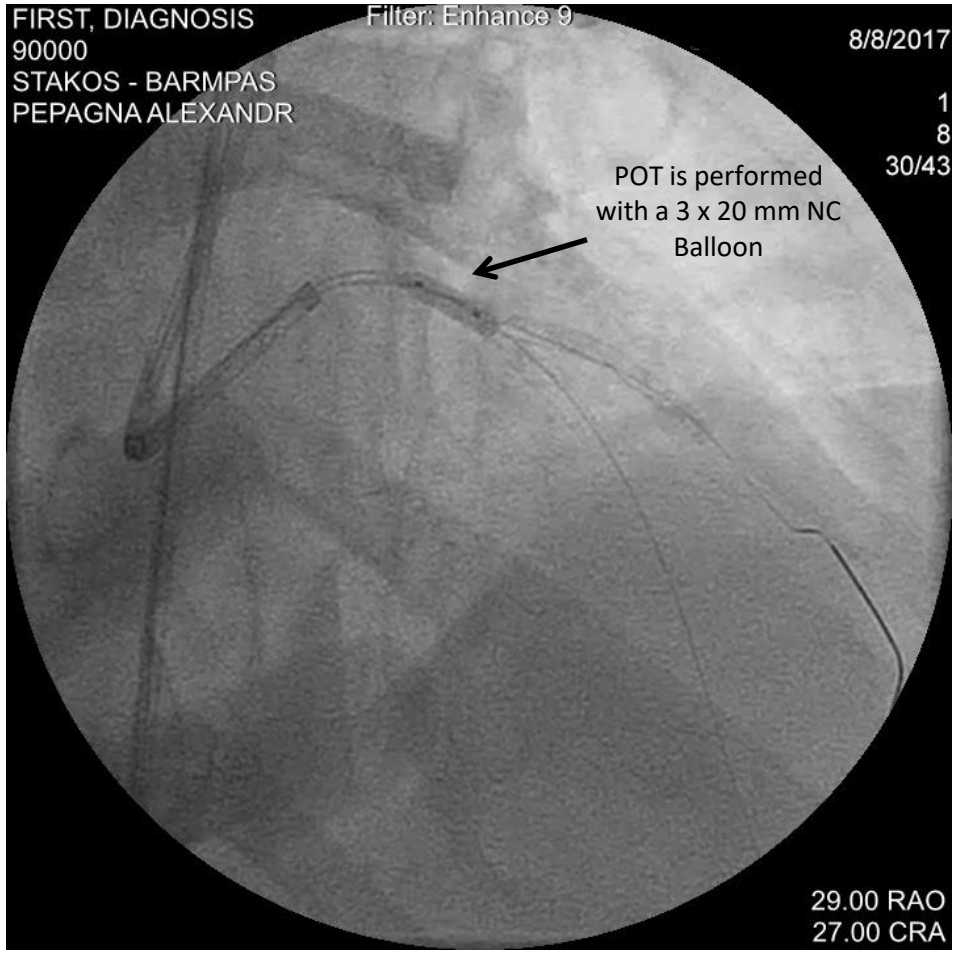
Case Presentation
2-Step First Kissing Balloon Inflation



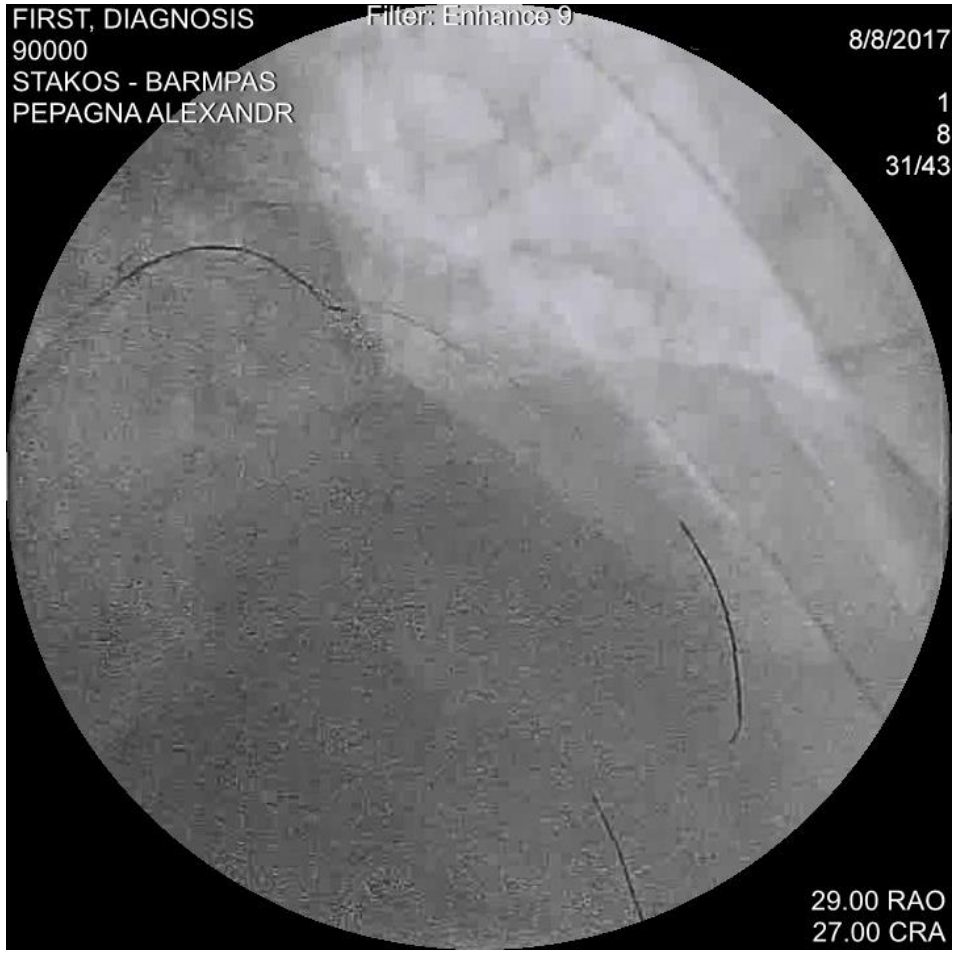
Case Presentation
Main Branch Stent Positioning and Deployment



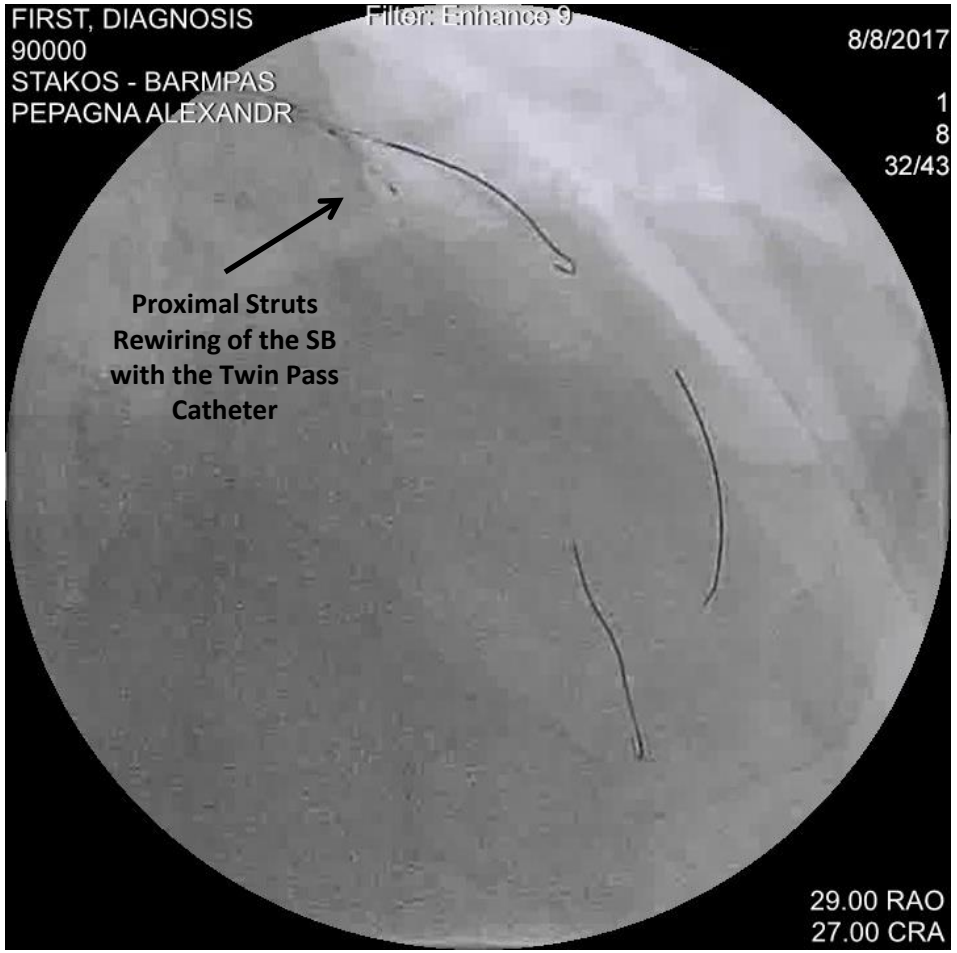
Case Presentation
Proximal Optimization Technique (POT)



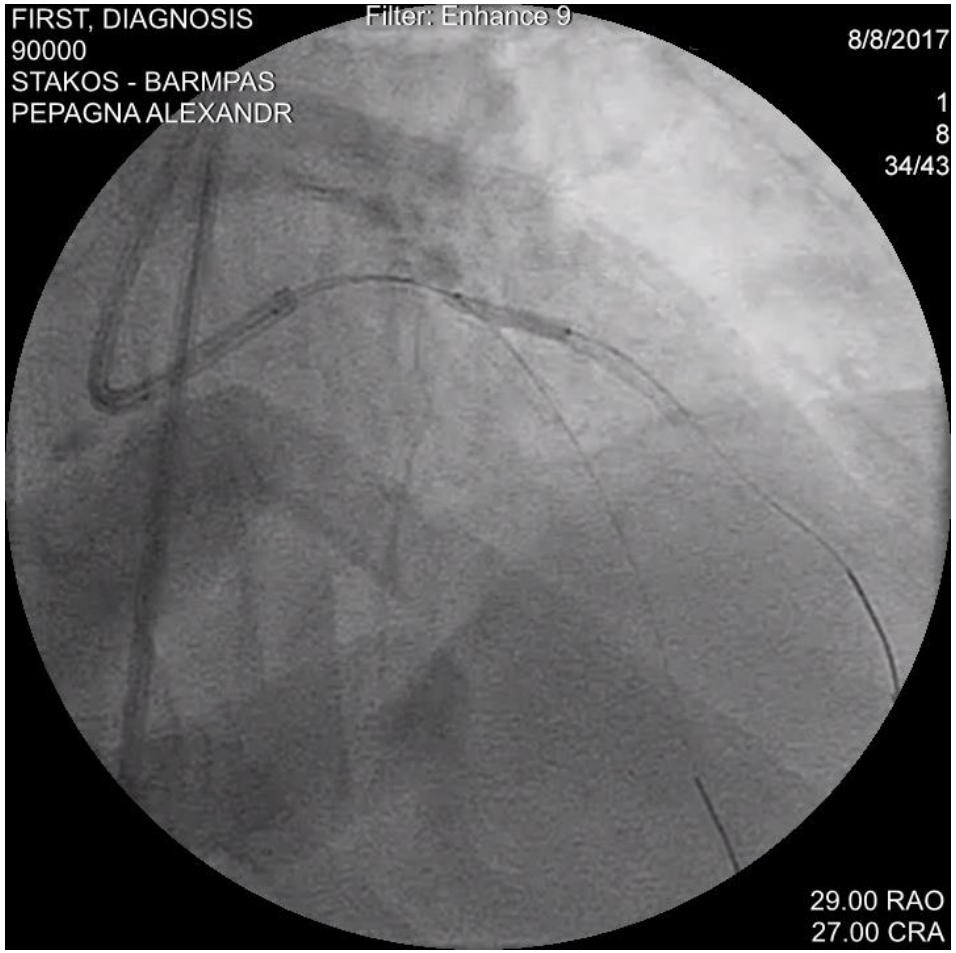
Case Presentation
Difficulty in Rewiring the SB

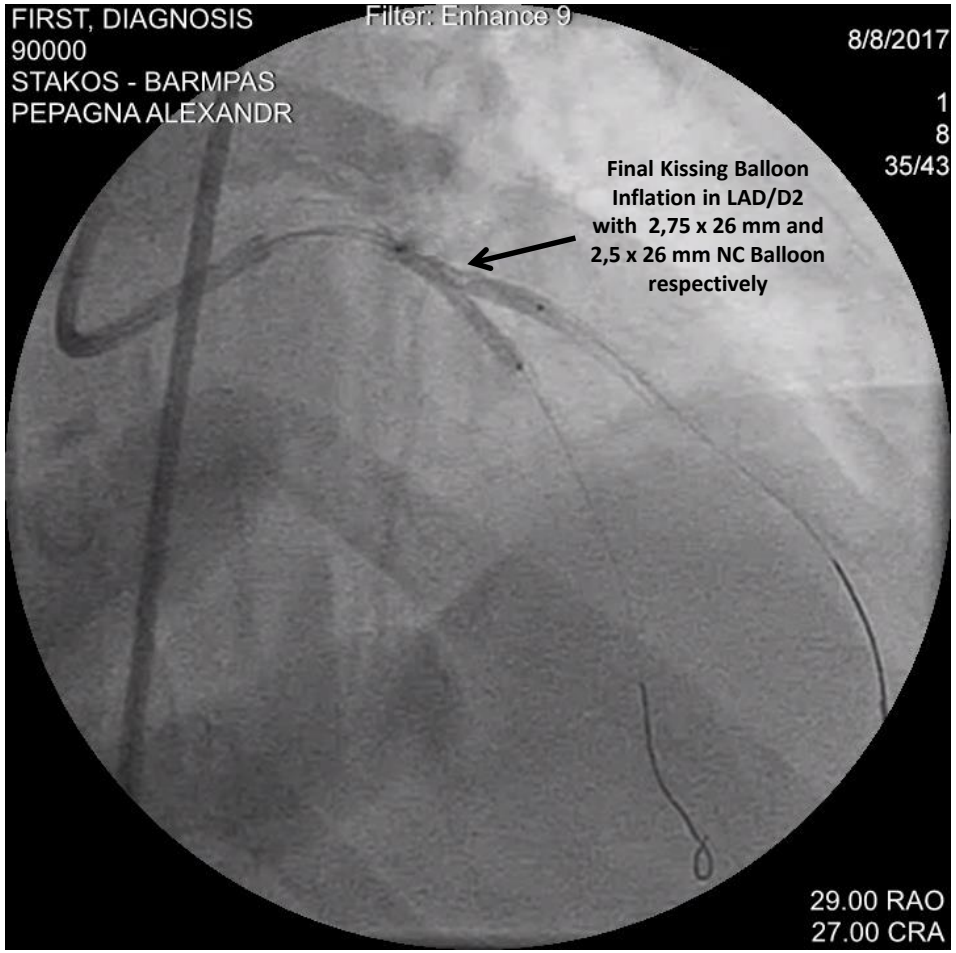


Case Presentation
Proximal Struts Rewiring of the SB with the Twin-Pass Catheter

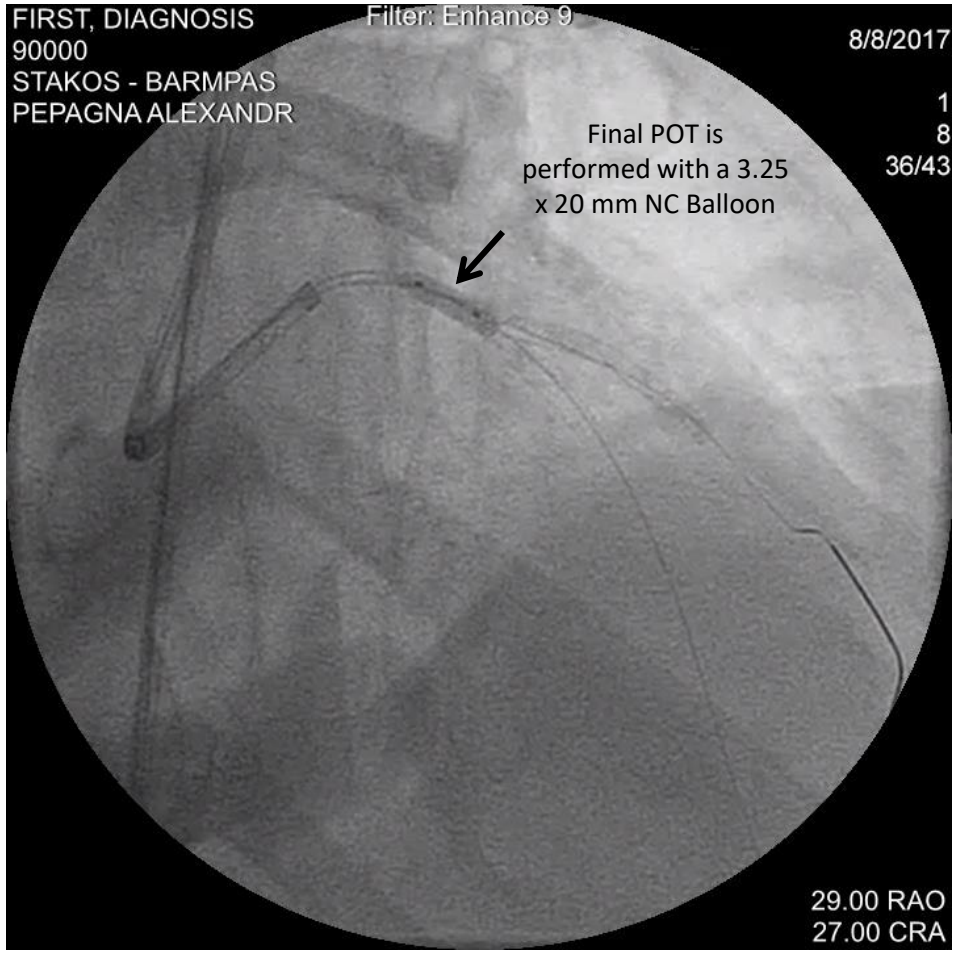


Case Presentation
2-Step Final Kissing Balloon Inflation

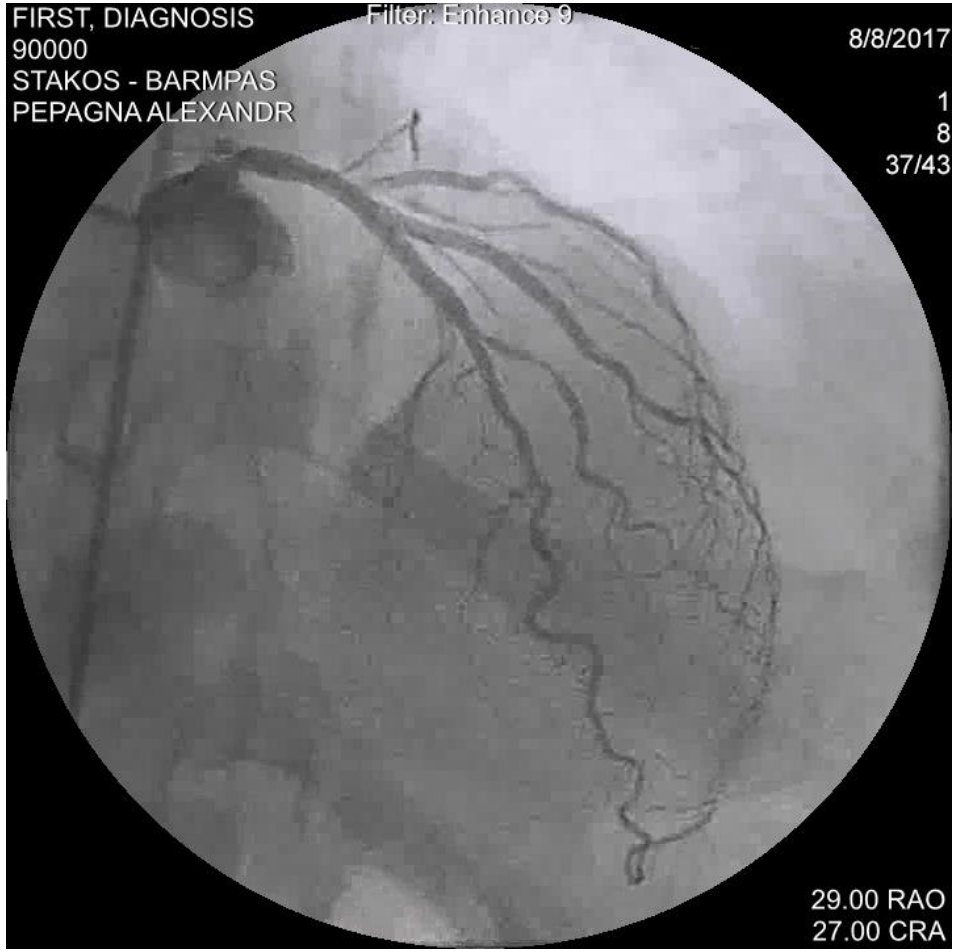




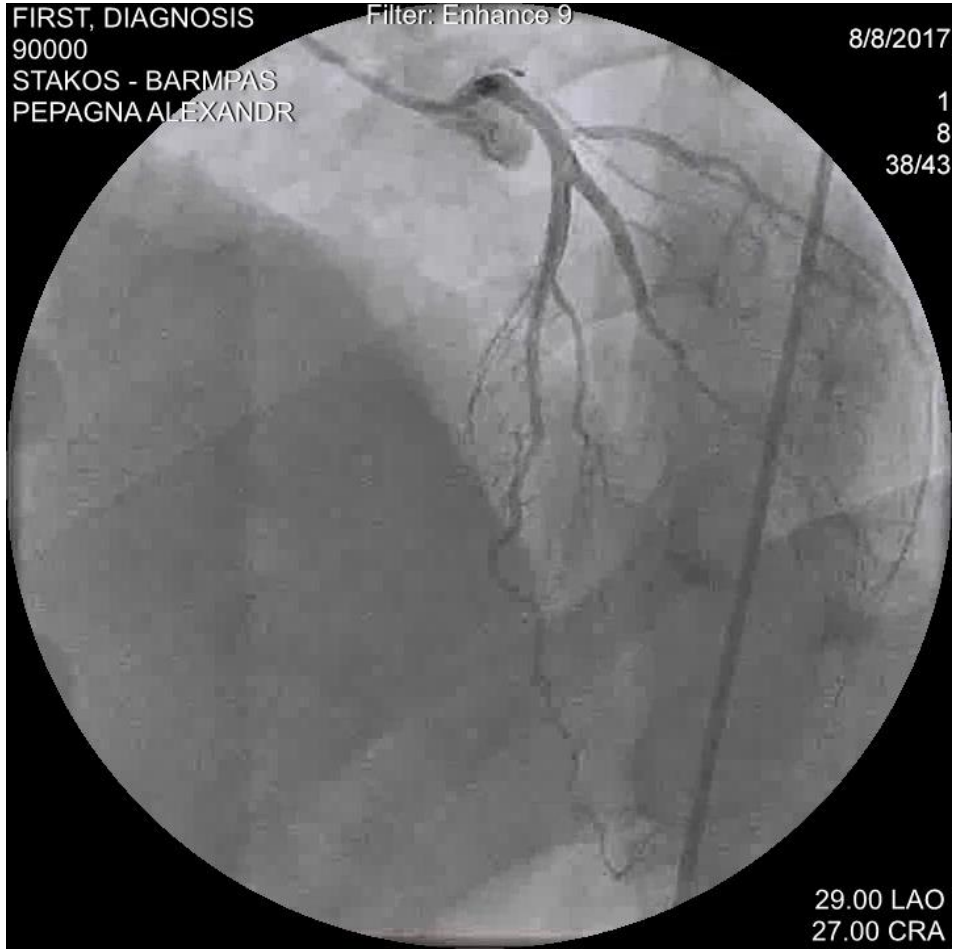
Case Presentation
Final POT with a 3,25x 20 mm NC Balloon



Case Presentation
Final Angiographic Result



Case Presentation
Final Angiographic Result



DK Crush Summary

- If a 2-stent strategy is needed, the DK Crush provides a viable and data-driven option
- Key Advantages:
  - 6 French compatible
  - More reliable final kissing inflation
  - Better SB coverage (therefore lower SB restenosis), largely independent of angle
- Remember the extra kiss!
  - For re-crossing: 1st kiss: proximal struts of crushed stent,

    2nd kiss: prox/mid struts

Study comparing the double kissing (DK) crush with classical crush for the treatment of coronary bifurcation lesions: the DKCRUSH-1 Bifurcation Study with drug-eluting stents

S. L. Chen[*], J. J. Zhang[*], F. Ye[*], Y. D. Chen[†], T. Patel[‡], K. Kawajiri[§], M. Lee[¶], T. W. Kwan[**], G. Mintz[††] and H. C. Tan[‡‡]

[*]Nanjing First Hospital of Nanjing Medical University, Nanjing, China, [†]Beijing Anzhen Hospital of Capital Medical University, Beijing, China, [‡]Krishina Heart Institute, Ahmedabad, India, [§]Tokushio Hospital, Osaka, Japan, [¶]Queen Mary Hospital, Hong Kong, China, [**]Beth Israel Hospital, New York, USA, [††]Cardiac Research Foundation, Columbia University, New York, USA, [‡‡]National University Hospital, Singapore

Eur J Clin Invest. 2008 Jun; 38(6): 361–371.

Table 6 Major adverse cardiac events

	Classical crush				
	Overall	**Without final kissing balloon**	**With final kissing balloon**	**DK crush**	***P* Overall classical vs. DK crush**
No. of lesions	156	39	117	155	
Angiographic success (%)	97·4	94·9	98·3	100	0·9
Procedural success (%)	91·1	87·2	92·3	96·1	0·3
In hospital MACE (%)	6·4	7·7	5·9	4·1	0·9
Cardiac death	0	0	0	0	
Q wave MI	0	0	0	0	
Non-Q MI	5·8	7·7	5·9	4·1	0·5
TLR	0·6	2·6	0	0	0·5
TVR	0·6	2·6	0	0	0·5
Stent thrombosis	0·6	2·6	0	0·7	0·7
8-month MACE (%)					
Cumulative	24·4	35·9*	19·7	11·4**	0·02
Cardiac death	1·7	2·5	2·5	0·6	0·5
Q wave MI	3·5	5·1	0·9	1·2	0·7
Non-Q MI	11·1	10·2	8·1	9·1	0·9
TLR	18·9	22·6*	17·8	9·0	0·03
TVR	21·9	26·5*	20·0	10·3	0·03
Stent thrombosis	3·2	5·1	1·7	1·3	1·0

Abbreviations: MACE, major adverse cardiac events; MI, myocardial infarction; TLR, target lesion revascularization; TVR, target vessel revascularization; DK, double kissing.

*$P < 0{\cdot}01$ comparing classical crush without final kissing inflations to both classical crush with final kissing inflations as well as DK crush.

**$P < 0{\cdot}05$ comparing classical crush with final kissing inflations to DK crush.

A Randomized Clinical Study Comparing Double Kissing Crush With Provisional Stenting for Treatment of Coronary Bifurcation Lesions

Results From the DKCRUSH-II (Double Kissing Crush versus Provisional Stenting Technique for Treatment of Coronary Bifurcation Lesions) Trial

Shao-Liang Chen, MD,* Teguh Santoso, MD,¶ Jun-Jie Zhang, MD,* Fei Ye, MD,* Ya-Wei Xu, MD,† Qiang Fu, MD,‡ Jing Kan, MBBS,* Chitprapai Paiboon, MD,# Yong Zhou, MD,§ Shi-Qing Ding, MD,‖ Tak W. Kwan, MD**

Nanjing, Shanghai, Xuzhou, Zhangjiagang, and Huainan, China; Jakarta, Indonesia; Bangkok, Thailand; and New York, New York

J Am Coll Cardiol 2011; 57: 914–20

Table 6 Clinical Outcome

	DK Group (n = 185)	PS Group (n =185)	p Value
Intra-procedural			
Acute closure	0 (0)	3 (1.6)	0.248
Cardiac death	0 (0)	0 (0)	1.000
Emergent CABG	0 (0)	0 (0)	1.000
Needing IABP	0 (0)	0 (0)	1.000
MI	0 (0)	3 (1.6)	0.248
In-hospital			
Cardiac death	1 (0.5)	0 (0)	0.500
MI	6 (3.2)	4 (2.2)	0.751
CABG	0 (0)	0 (0)	1.000
TLR	1 (0.5)	1 (0.5)	1.000
TVR	1 (0.5)	1 (0.5)	1.000
MACE	6 (3.2)	4 (2.2)	0.751
Stent thrombosis definite	4 (2.2)	1 (0.5)	0.372
Procedural success	179 (96.8)	173 (93.5)	0.217
At 6-month			
Cardiac death	1 (0.5)	2 (1.1)	1.000
MI	6 (3.2)	4 (2.2)	0.751
CABG	0 (0)	1 (0.5)	0.500
TLR	2 (1.1)	6 (3.2)	0.284
TVR	3 (1.6)	8 (4.3)	0.220
MACE	6 (3.2)	11 (5.9)	0.321
Stent thrombosis definite	4 (2.2)	1 (0.5)	0.372
At 12-month			
Cardiac death	2 (1.1)	2 (1.1)	1.000
MI	6 (3.2)	4 (2.2)	0.751
CABG	0 (0)	1 (0.5)	0.500
TLR	8 (4.3)	24 (13.0)	0.005
TVR	12 (6.5)	27 (14.6)	0.017
MACE	19 (10.3)	32 (17.3)	0.070
Stent thrombosis	5 (2.7)	2 (1.1)	0.449
Definite	4 (2.2)	1 (0.5)	0.372
Possible	1 (0.5)	1 (0.5)	1.000

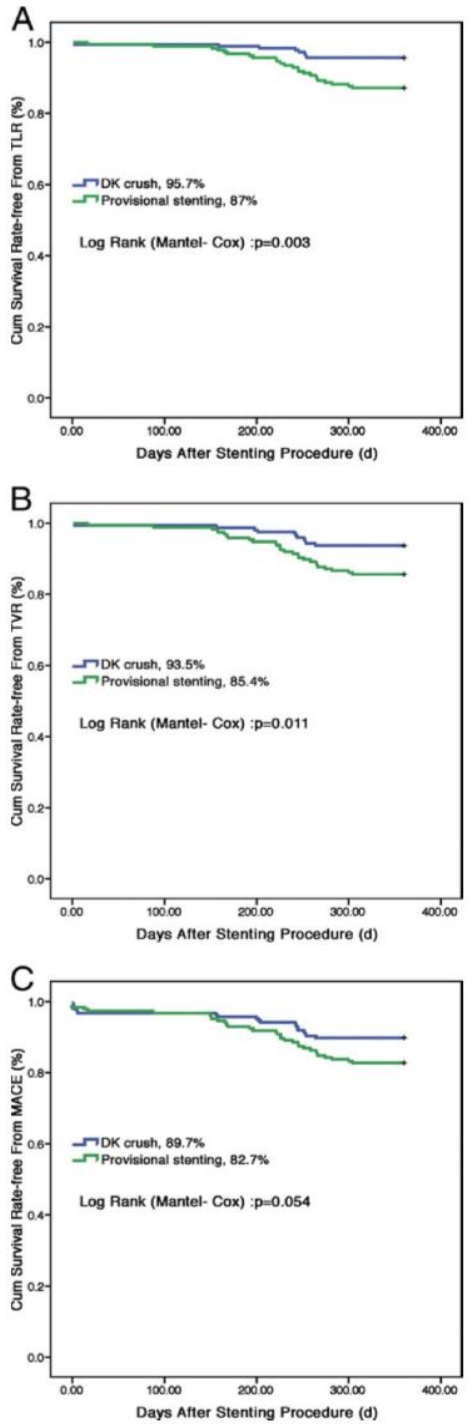


Table 2 Lesion Characteristics

	DK Group (n = 185)	PS Group (n = 185)	p Value
Number of diseased vessels			0.066
1-vessel disease	56 (30.3)	64 (34.6)	
2-vessel disease	75 (40.5)	51 (27.6)	
3-vessel disease	54 (29.1)	70 (37.8)	
Lesion site			0.746
LAD-LCX	33 (17.8)	29 (15.7)	
LAD-diagonal	112 (60.5)	110 (59.5)	
LCX-obtuse marginal	23 (12.4)	30 (16.2)	
Distal right coronary artery	17 (9.2)	16 (8.6)	
Medina stratification			0.187
1,1,1	155 (83.8)	144 (77.8)	
0,1,1	30 (16.2)	41 (22.2)	
Main vessel TIMI flow grade			0.414
0~2	26 (14.1)	31 (16.8)	
3	159 (85.9)	154 (83.2)	
Lesions in main vessel			
In-stent restenosis	2 (1.1)	5 (2.7)	0.449
Chronic total occlusion	8 (4.3)	16 (8.6)	0.138
Thrombus-containing	10 (5.4)	5 (2.7)	0.292
Severe tortuous	17 (9.2)	20 (10.8)	0.729
Severe calcification	2 (1.1)	5 (2.7)	0.449
Concentric	13 (7.0)	11 (5.9)	0.680
Lesions in side branch			
In-stent restenosis	3 (1.6)	5 (2.7)	0.504
Chronic total occlusion	3 (1.6)	3 (1.6)	1.000
Thrombus-containing	6 (3.2)	3 (1.6)	0.332
Severe tortuous	25 (13.5)	31 (16.8)	0.469
Severe calcification	2 (1.1)	5 (2.7)	0.449
Concentric	17 (9.2)	15 (8.1)	0.854
Side branch TIMI flow grade			0.610
0~2	11 (6.0)	13 (7.1)	
3	174 (94.1)	172 (93.0)	
Type C lesions			
Main vessel	119 (64.3)	126 (68.1)	0.584
Side branch	46 (24.9)	45 (24.3)	0.141

Clinical Outcome After DK Crush Versus Culotte Stenting of Distal Left Main Bifurcation Lesions

The 3-Year Follow-Up Results of the DKCRUSH-III Study

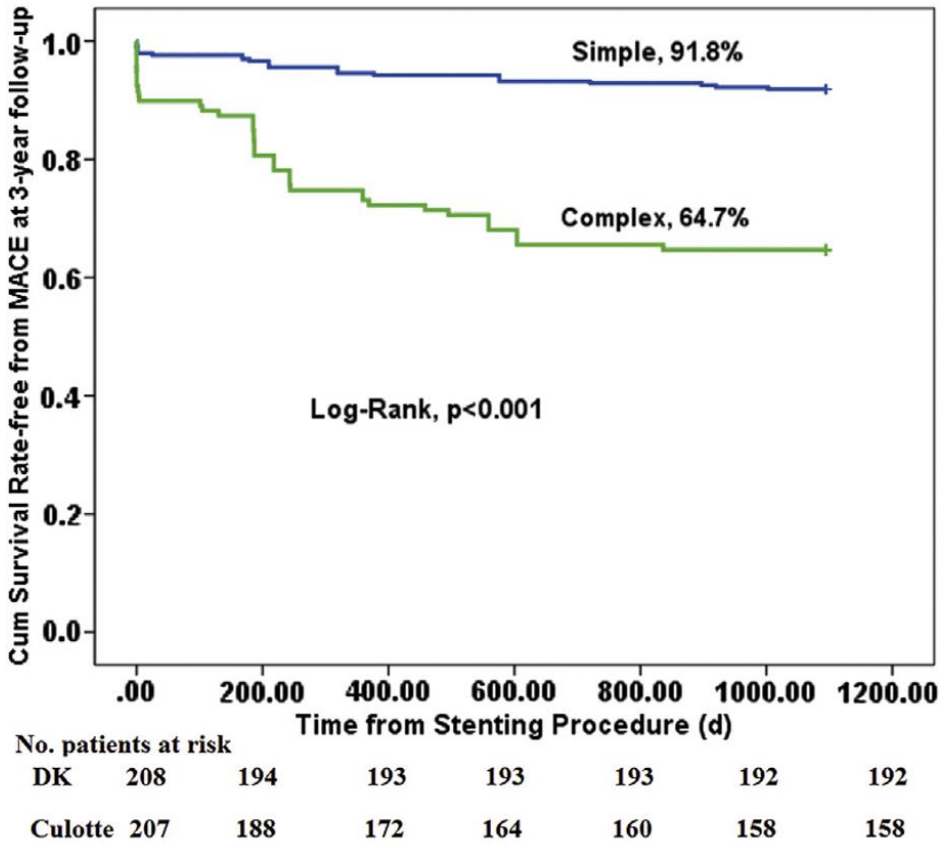
Shao-Liang Chen, MD,* Bo Xu, MBBS,† Ya-Ling Han, MD,‡ Imad Sheiban, MD,§ Jun-Jie Zhang, MD,* Fei Ye, MD,* Tak W. Kwan, MD,‖ Chitprapai Paiboon, MD,¶ Yu-Jie Zhou, MD,# Shu-Zheng Lv, MD,# George D. Dangas, MD,** Ya-Wei Xu, MD,†† Shang-Yu Wen, MD,‡‡ Lang Hong, MD,§§ Rui-Yan Zhang, MD,‖‖ Hai-Chang Wang, MD,¶¶ Tie-Ming Jiang, MD,## Yan Wang, MD,*** Teguh Sansoto, MD,††† Fang Chen, MD,# Zu-Yi Yuan, MD,‡‡‡ Wei-Min Li, MD,§§§ Martin B. Leon, MD‖‖‖‖

JACC, VOL. 8, NO. 10, 2015: 1335–42

TABLE 4 The 3-Year Clinical Outcomes in Simple and Complex Left Main Distal Bifurcation Lesions After Either DK Crush or Culotte Stenting

	DK Crush (n = 208)		Culotte (n = 207)		
	Simple (n = 155)	Complex (n = 43)	Simple (n = 141)	Complex (n = 66)	p Value*
MACE	9 (5.8)	8 (15.1)	15 (10.6)	34 (51.5)	<0.001
Cardiac death	1 (0.6)	2 (3.8)	2 (1.4)	4 (6.1)	0.691
MI	3 (1.9)	4 (7.5)	5 (3.5)	12 (18.2)	0.110
TLR	4 (2.6)	4 (7.5)	5 (3.5)	24 (36.4)	<0.001
CABG	0	2 (3.8)	0	1 (1.5)	0.585
TVR	6 (3.9)	6 (11.3)	12 (8.5)	27 (40.9)	<0.001
ST	0	1 (1.9)	3 (2.1)	5 (7.6)	0.224
Definite	0	0	3 (2.1)	4 (6.1)	0.128
Probable	0	0	0	1 (1.5)	0.368
Definite/probable	0	0	3 (2.1)	5 (7.6)	0.041
Possible	0	1 (1.9)	0	0	0.445

FIGURE 4 Kaplan-Meier 3-Year Survival Analysis in Complex and Simple Subgroups



The DK CRUSH studies: An Overview

	DKCRUSH-1	DKCRUSH-II	DKCRUSH-III
Lession types	111/011/101	111/011	111/011
Techniques	DK/crush	DK/provisional	DK/culotte
DES	PES	SES	SES
Locations	all	all	LM
SB diameter	2.0 mm	> 2.5mm	LCX
lesion length	10.2 mm	11.3 mm	16.9 mm
MI (not acute)	√	√	√
CTO	√	√	√
No. patients	312	370	420
Endpoint	MACE 8-m	MACE 12-m	MACE 12-m

c/o S. Chen, from EJCI, JACC, JACC

DK CRUSH studies: Outcomes

	DKCRUSH-1 CRUSH vs DK	DKCRUSH-II PT vs DK	DKCRUSH-III Culotte vs DK
MACE,%	24.4 vs 11.4	17.3 vs 10.3	16.3 vs 6.2
TLR,%	18.9 vs 9.0	13.0 vs 4.3	6.7 vs 2.4
TVR,%	26.5 vs 10.3	14.6 vs 6.5	11.0 vs 4.3
CD,%	1.7 vs 0.6	1.1 vs 1.1	1.0 vs 1.0
QMI,%	3.5 vs 1.2	2.2 vs 3.2	5.3 vs 3.3
ST,%	3.0 vs 1.1	0.6 vs 2.2	1.0 vs 0.5

c/o S. Chen, from EJCI, JACC, JACC