Joint Coronary Revascularization 2018

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IMPORTANCE OF BIFURCATION ANGLES IN DIFFERENT LEFT MAIN BIFURCATION STENTING TECHNIQUES: INSIGTHS FROM A COMPUTATIONAL FLUID DYNAMIC STUDY

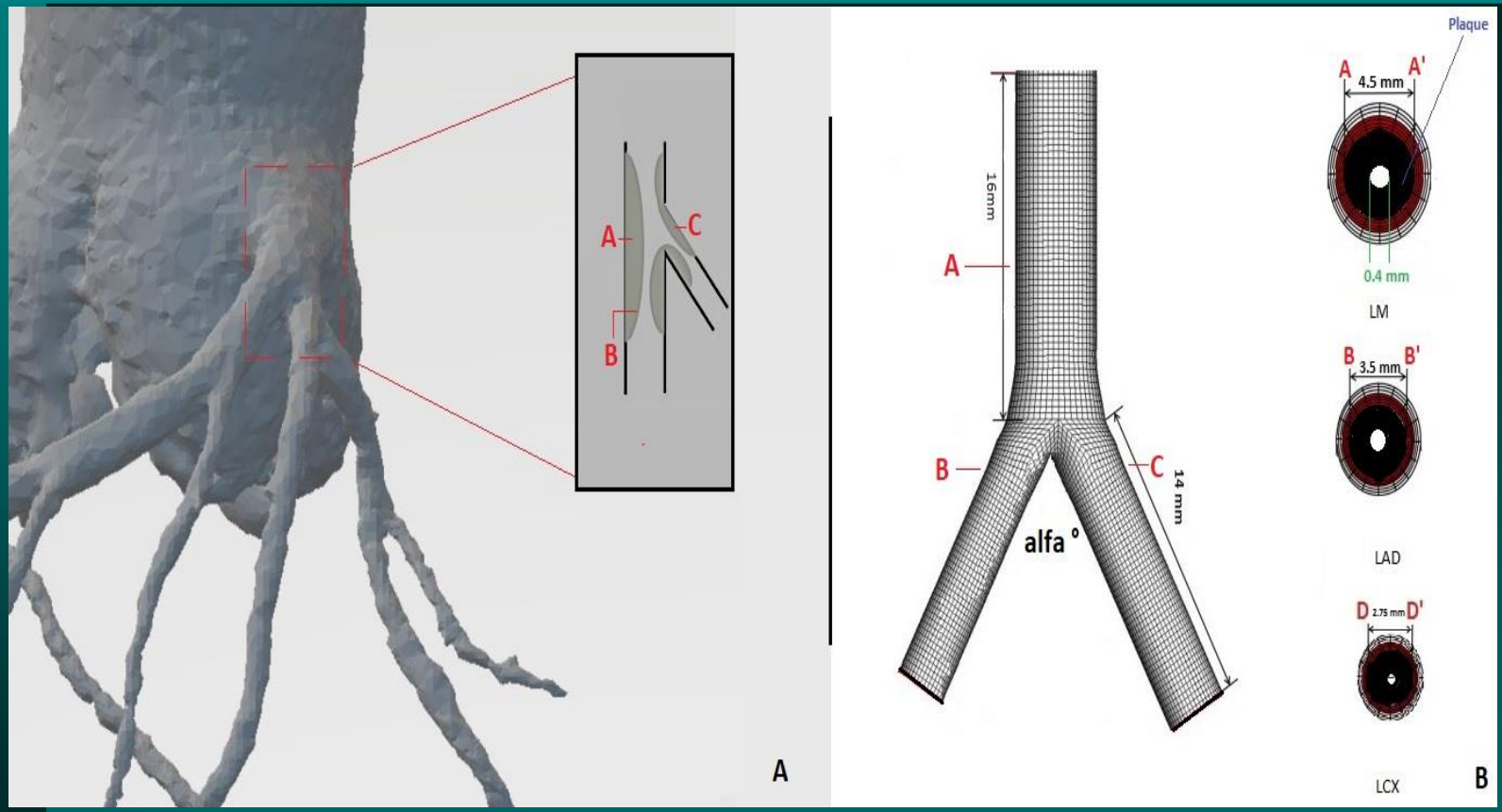
Background

Problem : wide angles have been suggested to induce low wall shear stress (WSS) gradient specific stent techniques used in bifurcation stenting have been recently reported to impact on the level of shear stress at the carina and side branch

Question: Which is the impact of angles in LM stenting technique?

CFD might be a type of answer….

Computed flow dynamic in Left Main



50 consecutive patients (mean age 77.4 ± 4.3, 39 males) diameters of LCA and LCX were modelled as following: LM 4.5 mm, LAD 3.5 mm, LCX 2.75 mm. The mean LAD-LCX bifurcation angle divided in three models: Model 1) α° 45°, Model 2) α° 60°, Model 3) α° 85 °.

Computed flow dynamic in coronary Left main

Stent simulation

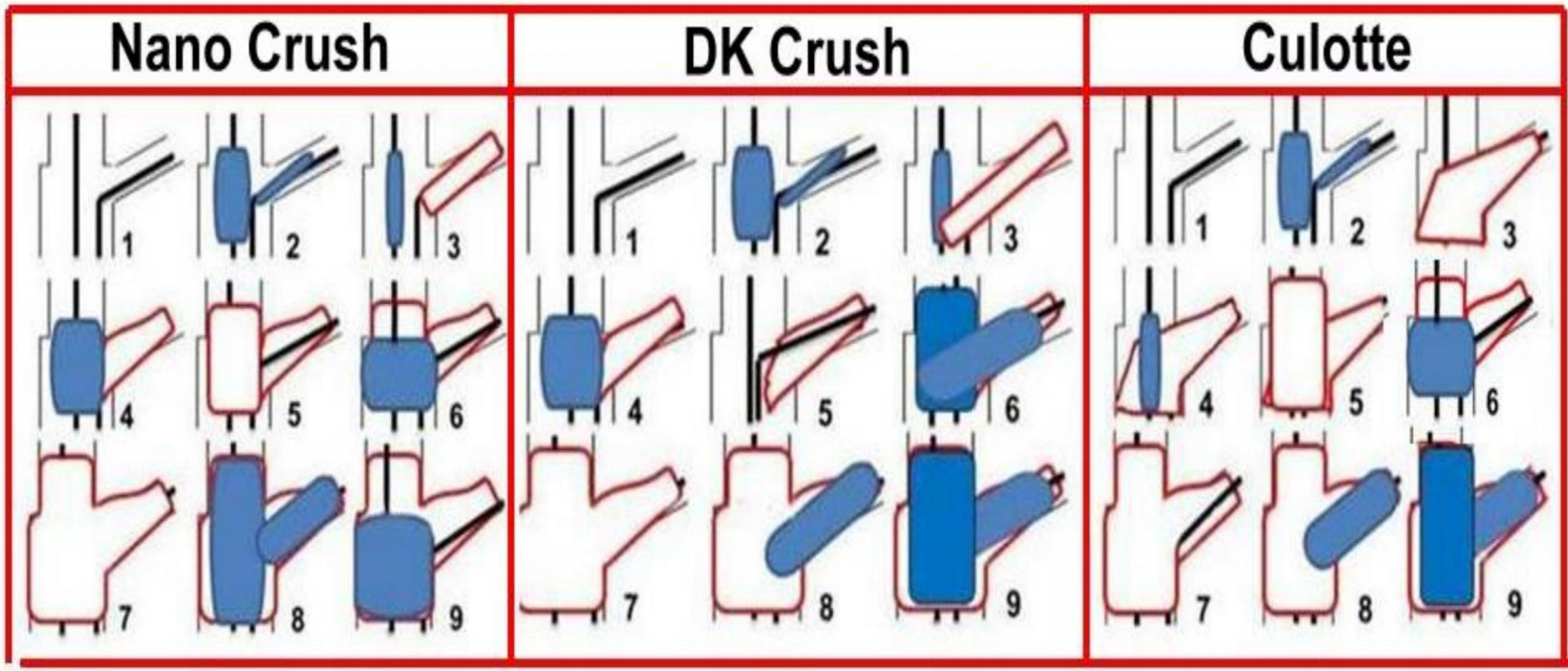
The strut design and linkage pattern of a third-generation, everolimus-elunting stent used in our institution: Xience (Abbott Corp, USA) but with 80 micron struts

Virtual implantation

After placed the stent model in the correct position, according to the different stenting techniques, material removal, depending on the considering techniques was applied. Using Boolean operation, the modified solid model is subtracted from the bifurcation model to obtain the final geometry

Virtual implantation Steps

The virtual simulations included three bifurcation angles and three different double stenting techniques: the Nano-crush, the DK-Crush and the Culotte

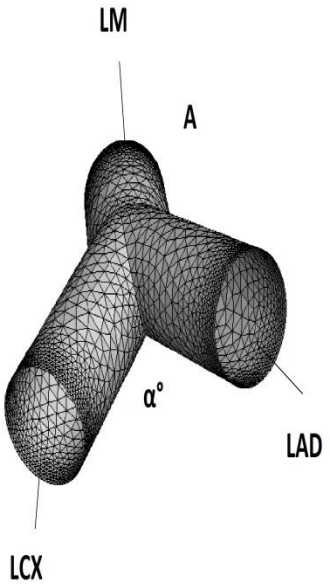


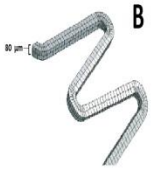
WSS distribution in the LM before stenting

	Model 1 α° = 43.2±2.2	Model 2 α° = 58.8±3.1	Model 3 α° = 82.3.±3.8	p
Physiological model				
Averaged WSS at the carina (Pa)	0.25±0.4	0.46±0.3	0.66±0.8	0.02
Area of lower WSS at the carina (mm^2)	2.1±0.4	3.8±0.4	4.5±0.5	0.01
Averaged WSS MB (Pa)	0.25±0.3	0.45±0.2	0.65±0.6	0.03
Averaged WSS SB (Pa)	0.25±0.4	0.45±0.4	0.66±0.3	0.01
Pathological model MEDINA 1,1,1				
Averaged WSS at the carina (Pa)	2.78±0.5	3.22±0.5	3.89±0.6	0.001
Area of lower WSS at the carina (Pa)	0.15±0.2	0.22±0.5	0.42±0.3	0.01
Averaged WSS MB (Pa)	1.52±0.4	1.92±0.6	2.54±0.5	0.01
Averaged WSS SB (Pa)	2.66±0.4	3.04±0.4	3.22±0.3	0.03

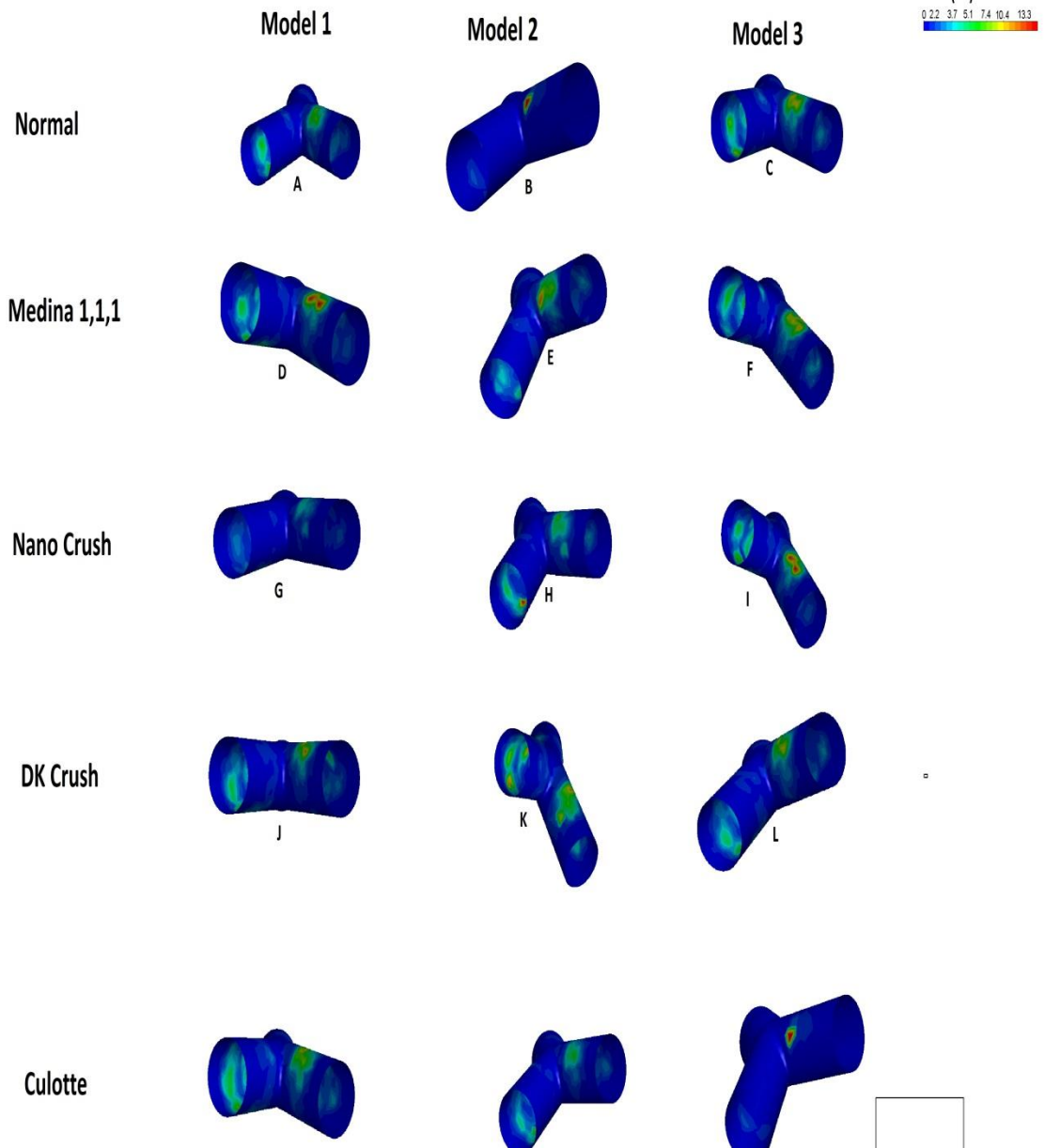
WSS distribution in the LM after stenting

	Model 1 α° = 43.2±2.2	Model 2 α° = 58.8±3.1	Model 3 α° = 82.3.±3.8	p
Averaged WSS carina (Pa)				
Nano Crush	0.23±0.3	0.42±0.4	0.68±0.4	0.02
DK Crush	0.27±.0.3	0.47±0.2	0.67±0.5	0.01
Culotte	0.26±0.4	0.49±0.3	0.70±0.8	0.01
Area of lower WSS at the carina (mm2)				
Nano Crush	2.3±0.4	3.9±0.6	4.9±0.2	0.02
DK Crush	2.2±0.7	3.6±0.3	4.7±0.2	0.03
Culotte	2.4±0.2	3.9±0.8	4.6±0.2	0.01
Averaged WSS MB (Pa)				
Nano Crush	0.26±0.3	0.47±0.3	0.70±0.2	0.01
DK Crush	0.28±.0.4	0.46±0.2	0.68±03	0.02
Culotte	0.29±0.4	0.49±0.6	0.66±0.5	0.02
Averaged WSS SB (Pa)				
Nano Crush	0.24±0.3	0.43±0.4	0.69±0.2	0.01
DK Crush	0.26±0.4	0.42±0.3	0.67±0.1	0.01
Culotte	0.27±0.5	0.48±0.4	0.66±0.2	0.02

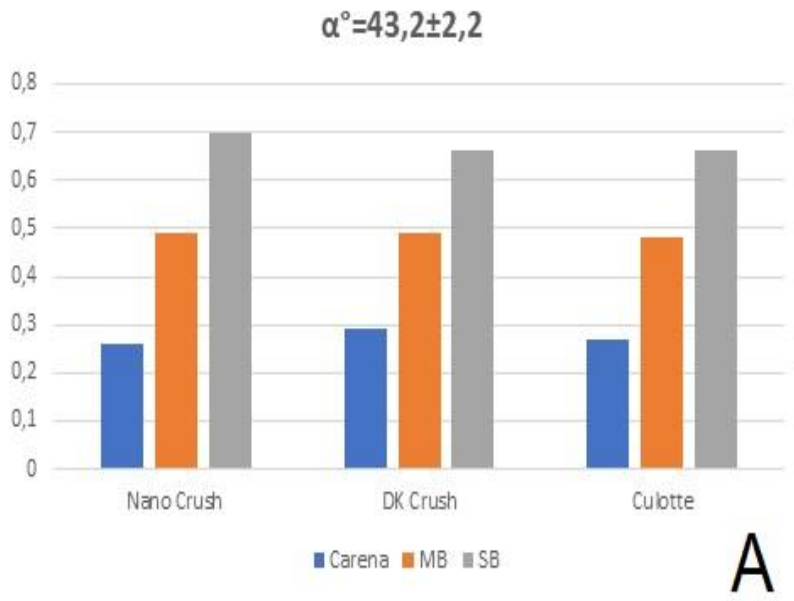

LM
A
α°
LAD
LCX

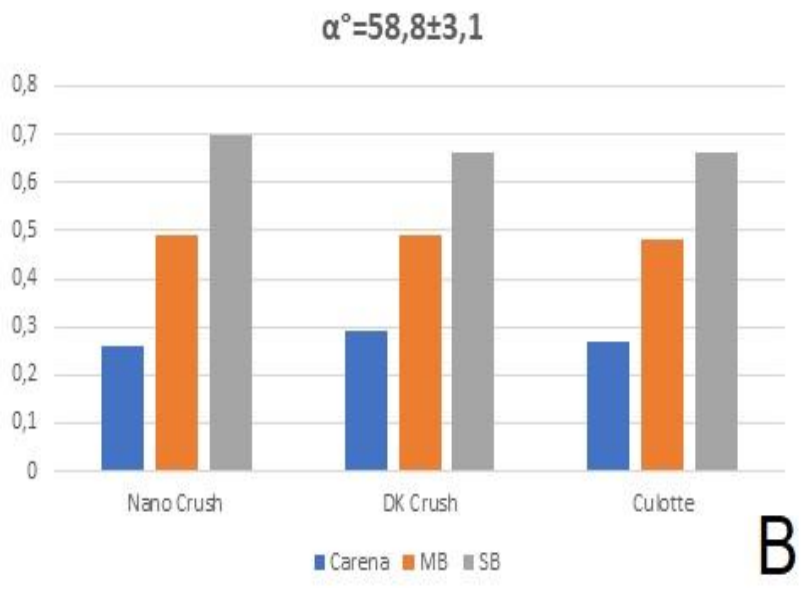

B

A

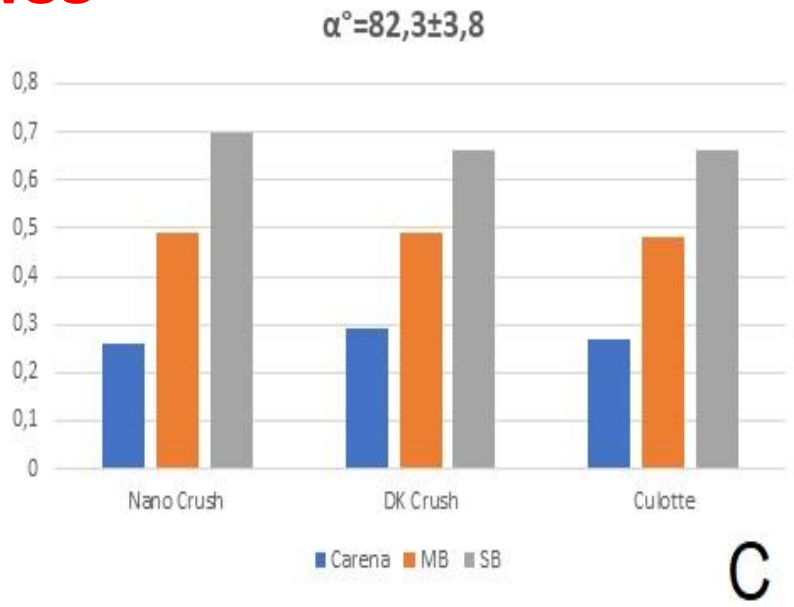

WSS (Pa)
0 2.2 3.7 5.1 7.4 10.4 13.3
Model 1
Model 2
Model 3
Normal
Medina 1,1,1
Nano Crush
DK Crush
Culotte
A
B
C
D
E
F
G
H
I
J
K
L

B





Averaged WSS



CONCLUSIONS….

- ✓In the physiological model the averaged WSS and the lower WSS area at the carina increased as angle widened
- ✓Nano-crush seems to work more physiologically at angles over 45°
- ✓DK crush has a good performance at angles between 45° and 60° degrees.
- ✓the Culotte seems to be ideal at angles approaching 60° but less than 85° degrees