Welcome to the 7th
European Bifurcation Club
14-15 October 2011 - LISBON

Is respect of bifurcation branching laws the best option for LM stenting?

European Bifurcation Club

EBC

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Yes! (based on EBC2010 presentation)

Y Huo, G Finet, T Lefevre, Y Louvard, I Moussa and GS Kassab. Optimal Diameter of Diseased Bifurcation Segment: A Practical Rule for Percutaneous Coronary Intervention. In Review

$$D_m^{7/3} = D_l^{7/3} + D_s^{7/3}$$

Where Dm, Dl and Ds represent the diameter of mother, larger and smaller daughter vessels

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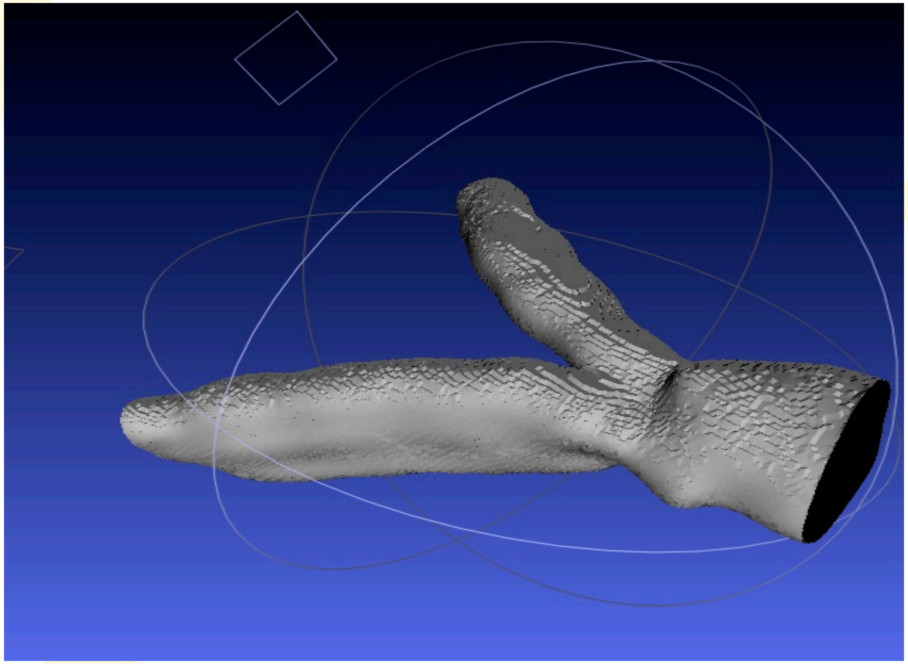
Y Huo, G Finet, T Lefevre, Y Louvard, I Moussa and GS Kassab. Which Diameter and Angle Rule Provides Optimal Flow Patterns in a Coronary Bifurcation? In Review

$$\cos(\alpha) = \frac{\left(1+\left(\frac{D_s}{D_l}\right)^{\frac{7}{3}}\right)^{\frac{12}{7}} - \left(1+\left(\frac{D_s}{D_l}\right)^{4}\right)}{2\left(\frac{D_s}{D_l}\right)^{2}}$$

α = angle between daughter vessels

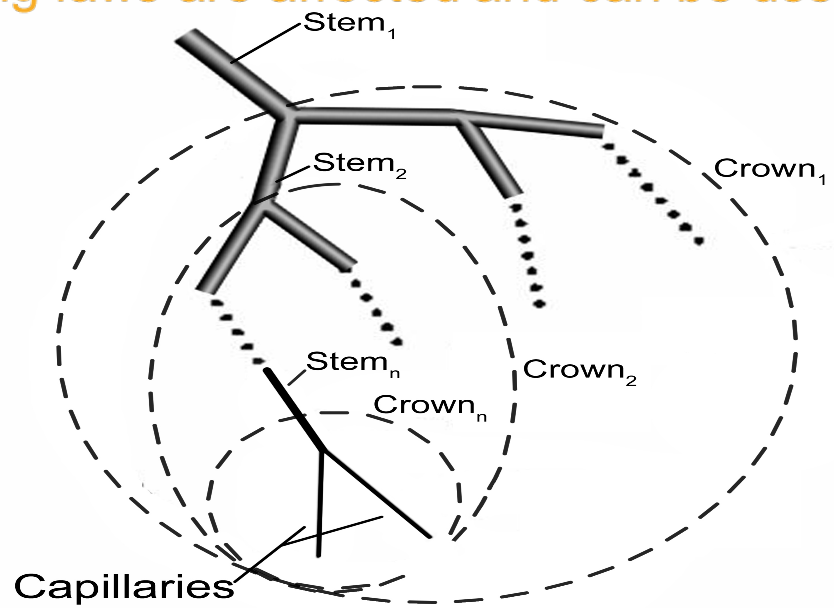
Role of Diffuse Disease

- All bifurcation vessels may have some DCAD
- Confirmed in John Doe's LM Bifurcation



Question: Does bifurcation law still hold in presence of DCAD?

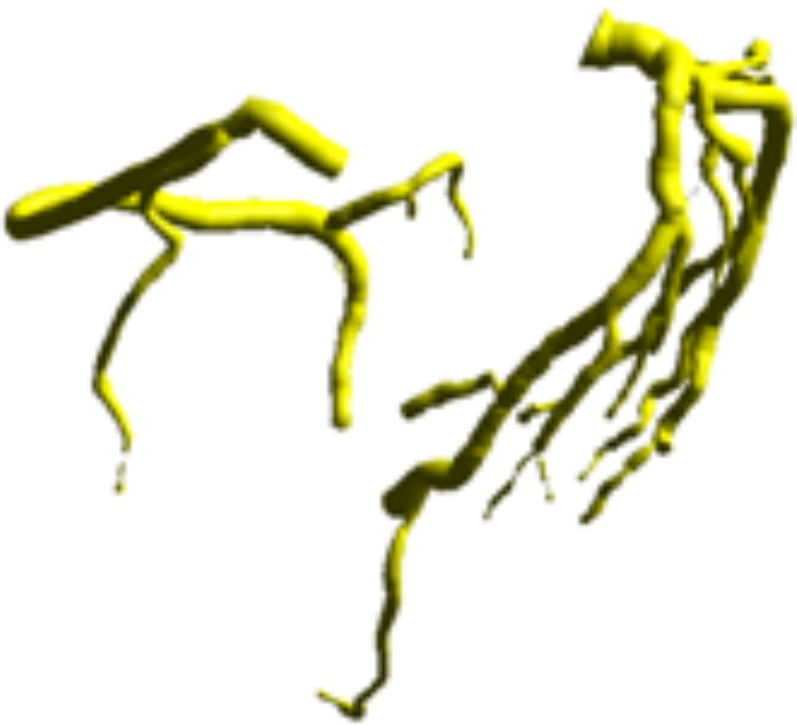
- Hypotheses:
  - Flow structure (flow-CSA: $Q_S = K_{QA} A_S^{\frac{7}{6}}$ and flow –volume: $Q_S = K_{QV} V_C^{\frac{9}{7}}$ where s and c refer to stem and crown of arterial tree) scaling laws are not affected because maximal myocardial flow decreases only in the presence of diameter stenosis > 50%.
  - Structure-structure (e.g. length-CSA: $L_C = K_{LA} A_S^{\frac{7}{6}}$ and length-volume: $L_C = K_{LA} V_C^{\frac{9}{7}}$) scaling laws are affected and can be used to diagnose DCAD



Baseline demographics of the study population

	Metabolic Syndrome (n=93)	Control Group (n=31)	p value
Age, years	56 ± 9.2	55 ± 9	0.691
Male gender	63 (68%)	21 (68%)	1
BMI, kg/m2	34.8 ± 7.3	26.9 ± 3.3	< 0.001
SBP, mmHg	133 ± 18	127 ± 16	0.038
DBP, mmHg	80 ± 10	78 ± 10	0.118
Hypertension	73 (78%)	7 (24%)	< 0.001
Diabetes mellitus	25 (27%)	None	< 0.001
Active smoker	11 (12%)	5 (16%)	0.525
Family history of CAD	26 (28%)	13 (42%)	0.084
Total cholesterol, mg/dL	188 ± 48	199 ± 37	0.051
Triglycerides, mg/dL	190 ± 133	108 ± 51	< 0.001
LDL, mg/dL	105 ± 38	117 ± 33	0.036
HDL, mg/dL	45 ± 14	60 ± 15	< 0.001
Fasting glucose, mg/dL	119 ± 45	92 ± 14	< 0.001

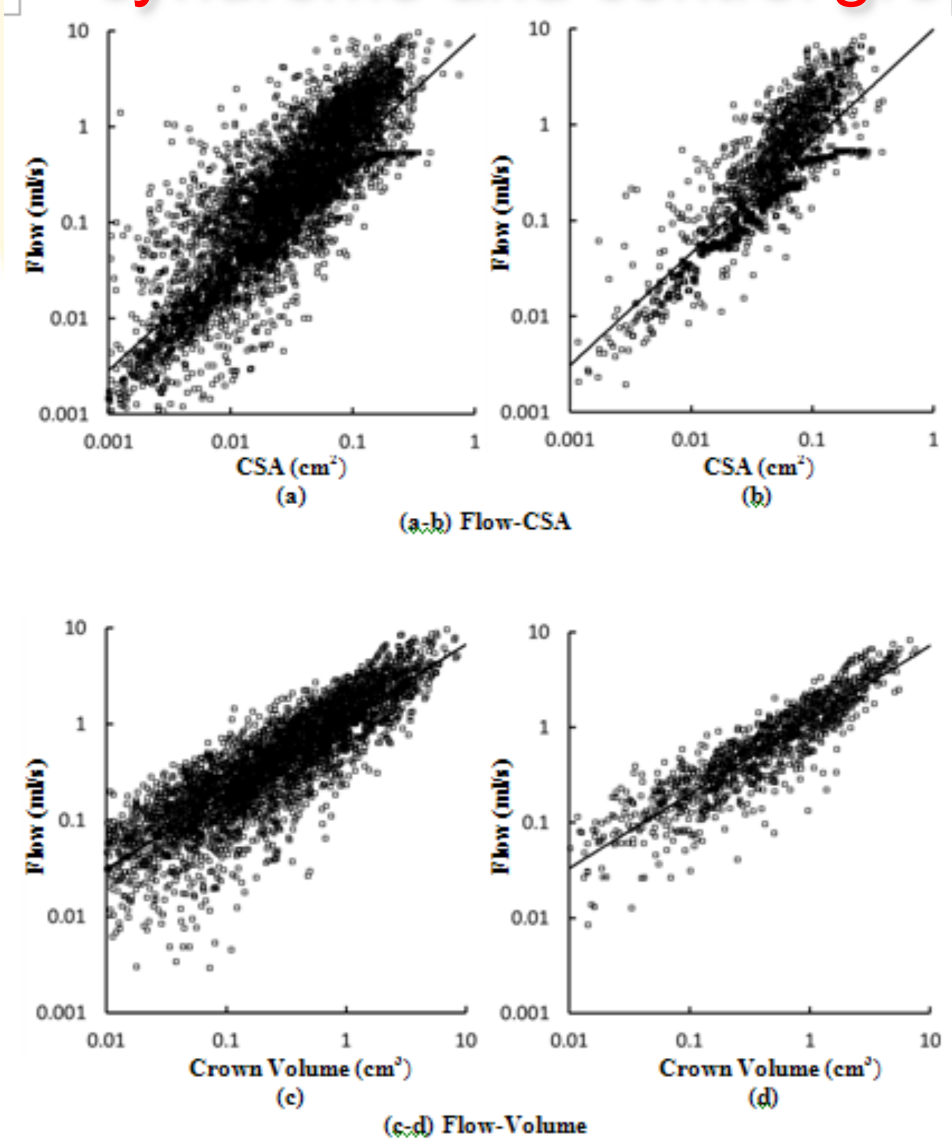
Schematic representation of epicardial coronary arterial trees reconstructed from CTA



DCAD

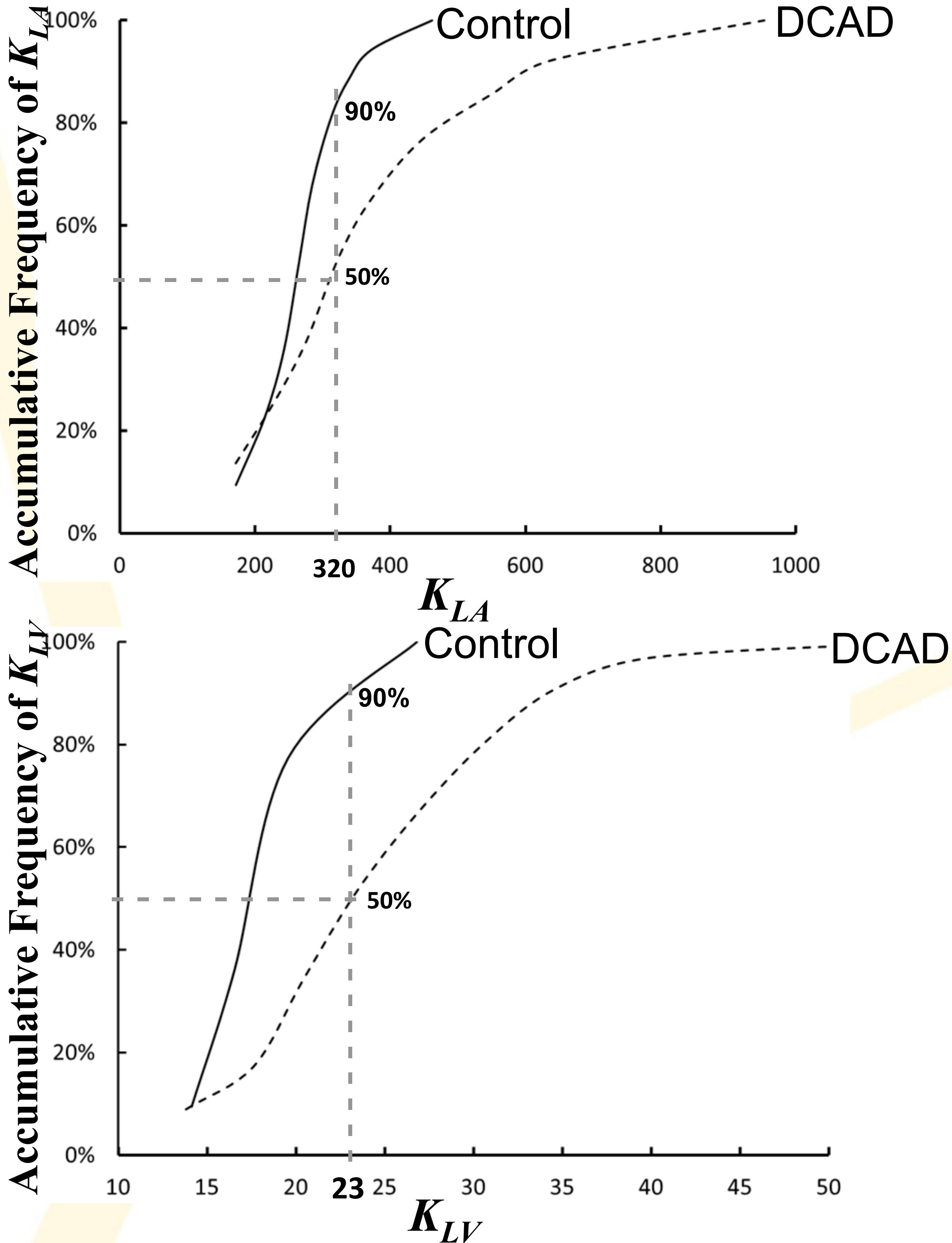
Control

Log-log plots of flow-CSA scaling law and flow-volume scaling law for all patients of metabolic syndrome and control groups



Structure-function Scaling Laws		Metabolic Syndrome (n=93)	Control Group (n=31)	Percent Difference	p value
Least-squares fit of both K^0 and X values (two-parameter model)					
Flow-CSA Scaling Law	K^0_{QA} $(\mathrm{cm}^{-\frac{2}{3}} \cdot \mathrm{s}^{-1})$	11.9 ± 7.5	17.1 ± 9.3	-30.4%	< 0.001
	X	1.20 ± 0.17	1.30 ± 0.19	-7.7%	< 0.001
$(Q_s = K^0_{QA} A_s^X)$	R^2	0.73 ± 0.15	0.71 ± 0.12		
Flow-Volume Scaling Law	K^0_{QV} $(\mathrm{cm}^{-\frac{2}{3}} \cdot \mathrm{s}^{-1})$	1.15 ± 0.55	1.19 ± 0.33	-3.4%	0.592
	X	0.80 ± 0.23	0.80 ± 0.15	0%	0.997
$(Q_s = K^0_{QV} V_c^X)$	R^2	0.83 ± 0.12	0.85 ± 0.11		
Least-squares fit of K values with X equal to theoretical values (one-parameter model)					
Flow-CSA Scaling Law	K_{QA} $(\mathrm{cm}^{-\frac{2}{3}} \cdot \mathrm{s}^{-1})$	8.90 ± 1.69	9.56 ± 1.10	-6.9%	0.001
	CV $(\frac{\mathrm{SD}}{\mathrm{mean}} \times 100\%)$	27 ± 11 %	22 ± 4 %		
$(Q_s = K_{QA} A_s^{\frac{7}{6}})$	R^2	0.73 ± 0.15	0.71 ± 0.12		
Flow-Volume Scaling Law	K_{QV} $(\mathrm{cm}^{-\frac{2}{3}} \cdot \mathrm{s}^{-1})$	1.10 ± 0.41	1.19 ± 0.28	-7.6%	0.057
	CV $(\frac{\mathrm{SD}}{\mathrm{mean}} \times 100\%)$	178 ± 44 %	141 ± 53 %		
$(Q_s = K_{QV} V_c^{\frac{7}{9}})$	R^2	0.83 ± 0.12	0.85 ± 0.11		

Structure-Structure Scaling Laws		Metabolic Syndrome (n=93)	Control (n=31)	Percent Difference	p value
Least-squares fit of both K^0 and X values (two-parameter model)					
Length-CSA Scaling Law ($L_c = K_{LA}^0 A_s^X$)	K_{LA}^0 (cm$^{\frac{4}{3}}$)	109 ± 107	255 ± 199	-57.3%	< 0.001
	X	0.71 ± 0.31	1.05 ± 0.30	-32.4%	< 0.001
	R^2	0.56 ± 0.25	0.58 ± 0.21		
Length-Volume Scaling Law ($L_c = K_{LV}^0 V_c^X$)	K_{LV}^0 (cm$^{\frac{4}{3}}$)	20.9 ± 6.4	18.2 ± 3.4	14.8%	< 0.001
	X	0.63 ± 0.13	0.71 ± 0.11	-11.3%	< 0.001
	R^2	0.91 ± 0.09	0.92 ± 0.07		
Least-squares fit of K values with X equal to theoretical values (one-parameter model)					
Length-CSA Scaling Law ($L_c = K_{LA} A_s^{\frac{7}{6}}$)	K_{LA} (cm$^{\frac{4}{3}}$)	395 ± 215	279 ± 70	41.6%	< 0.001
	CV ($\frac{SD}{mean} \times 100\%$)	0.69 ± 0.29 %	0.73 ± 0.22 %		
	R^2	0.56 ± 0.25	0.58 ± 0.21		
Length-Volume Scaling Law ($L_c = K_{LV} V_c^{\frac{7}{9}}$)	K_{LV} (cm$^{\frac{4}{3}}$)	26.5 ± 9.1	19.9 ± 4.3	33.2%	< 0.001
	CV ($\frac{SD}{mean} \times 100\%$)	6.3 ± 2.6 %	7.2 ± 1.8 %		
	R^2	0.91 ± 0.09	0.92 ± 0.07		



Accumulative Frequency of K_{LA}
100%
80%
60%
40%
20%
0%
0
200
320
400
600
800
1000
K_{LA}
Control
DCAD
90%
50%
Accumulative Frequency of K_{LV}
100%
80%
60%
40%
20%
0%
10
15
20
23
25
30
35
40
45
50
K_{LV}
Control
DCAD
90%
50%

Conclusion

- Since $D_m^{7/3} = D_l^{7/3} + D_s^{7/3}$ is derived from flow-structure scaling law and conservation of mass, DCAD will not affect the bifurcation law. Hence, despite DCAD, if the diameter of the two ‘normal’ vessel segments is known, the third diseased segment can be determined from the bifurcation law.

- The coefficient of structure-structure scaling laws can be used to diagnose DCAD.