Welcome to the 5th European Bifurcation Club 16-17 September 2009 - BERLIN

SB Diameter as an Index of MI

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European Bifurcation Club

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Yves's Questions

- Treatment definition of a bifurcation lesion, when to treat the SB?
- What is the relation between biomarker elevation and size of SB?
- What is the relation between size of SB and potential infarct if SB is occluded?

Allometric Scaling Laws of Biology

A biological variable Y is related to the mass M of the organism by a power law: $Y=Y_0M^b$; b-allometric exponent

(b=3/4 for metabolic rates)

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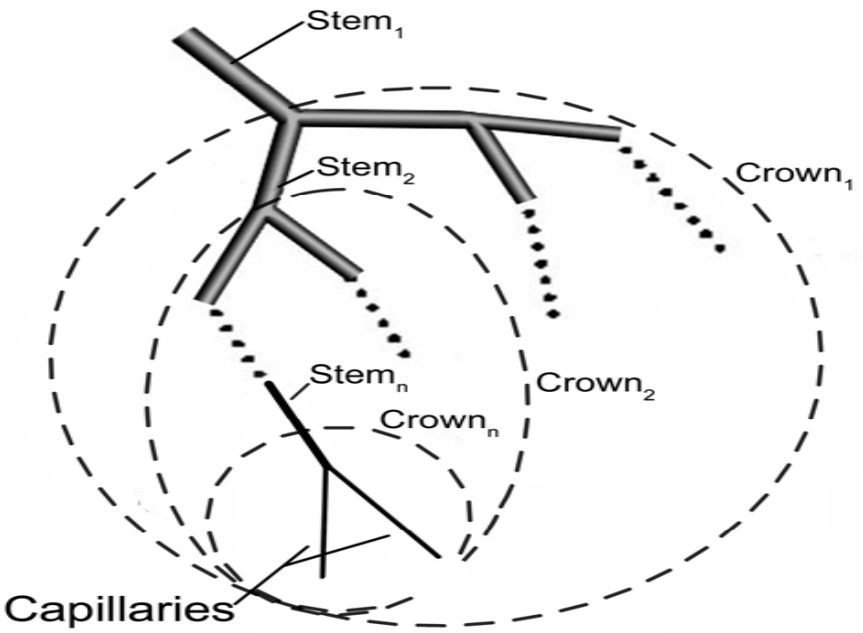
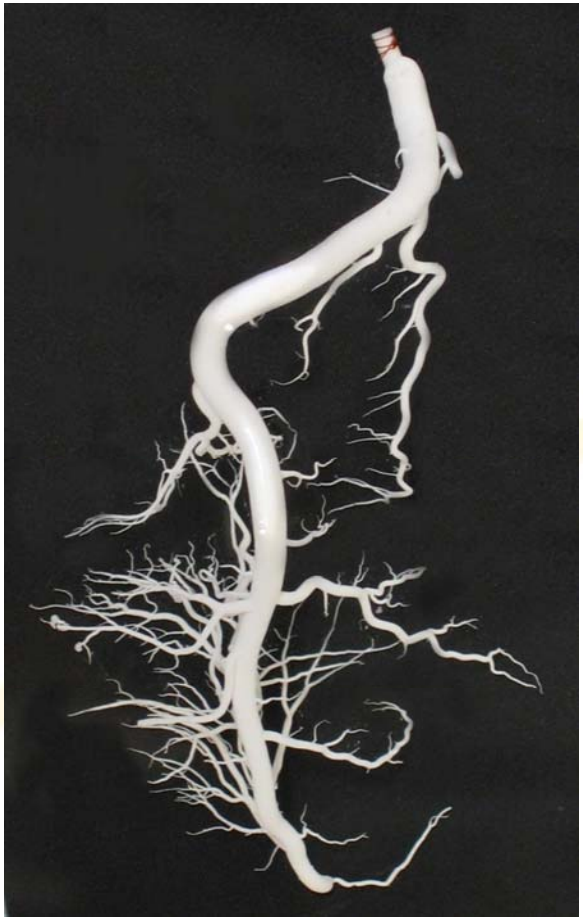
Application to the Heart

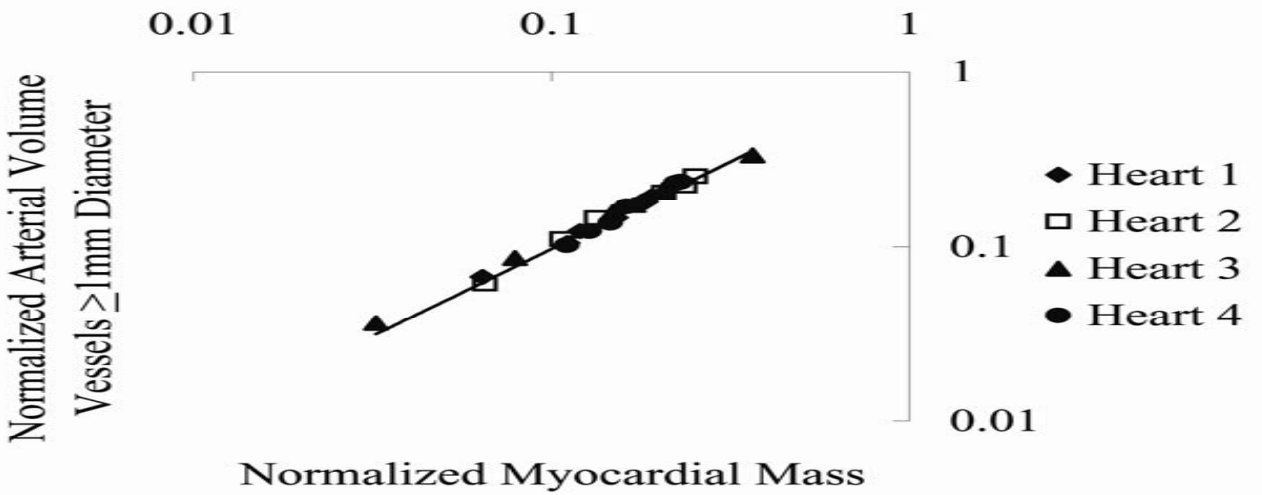
- Hypotheses
  - CSA~$M^{3/4}$; CSA: Cross-sectional area and M:Myocardial mass
  - Q~$M^{3/4}$; Q:Volumetric flow
  - V~M; V:Volume of distal arteries
  - L~$M^{3/4}$; L:Cumulative length of vessels

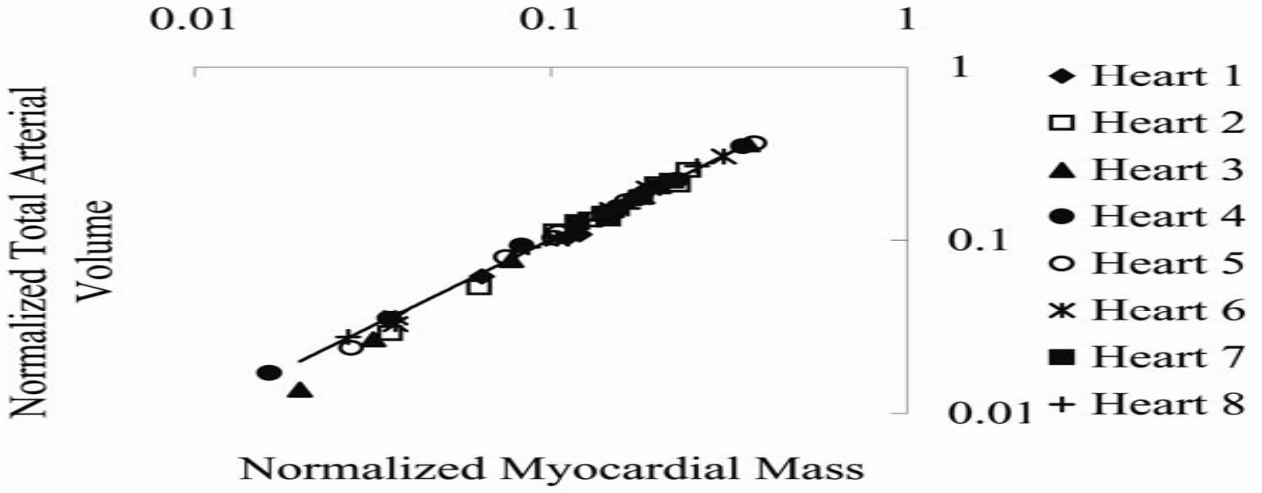


Flow/Cast Measurements

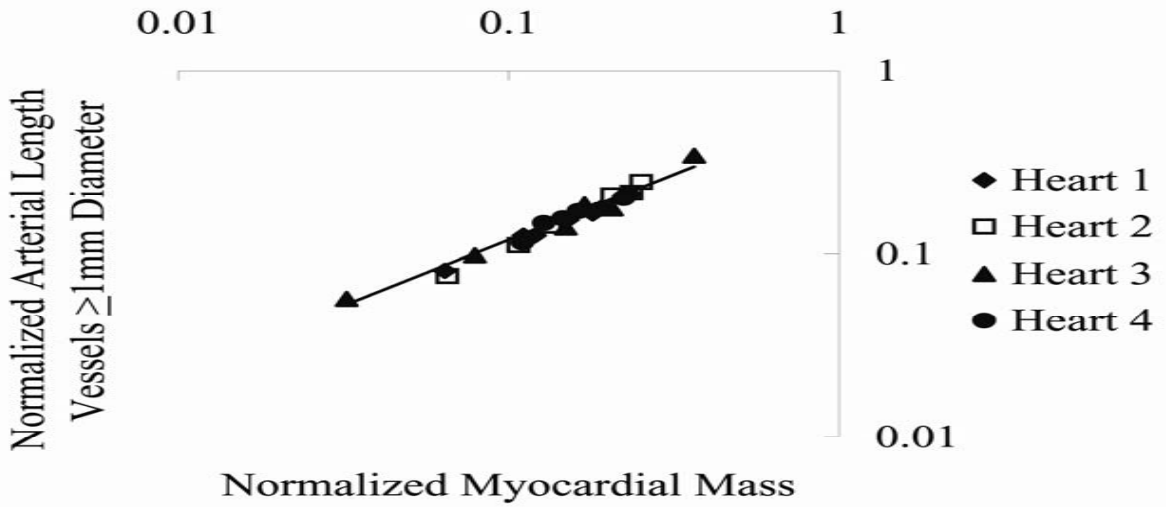


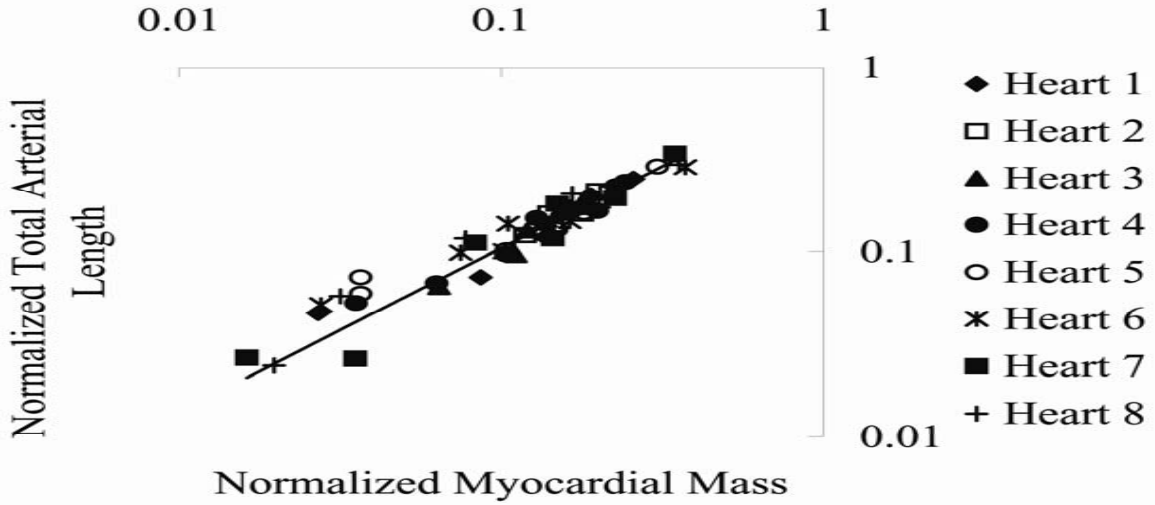
Volume~Mass


0.01
0.1
1
Normalized Arterial Volume
Vessels ≥1mm Diameter
1
0.1
0.01
Heart 1
Heart 2
Heart 3
Heart 4
Normalized Myocardial Mass

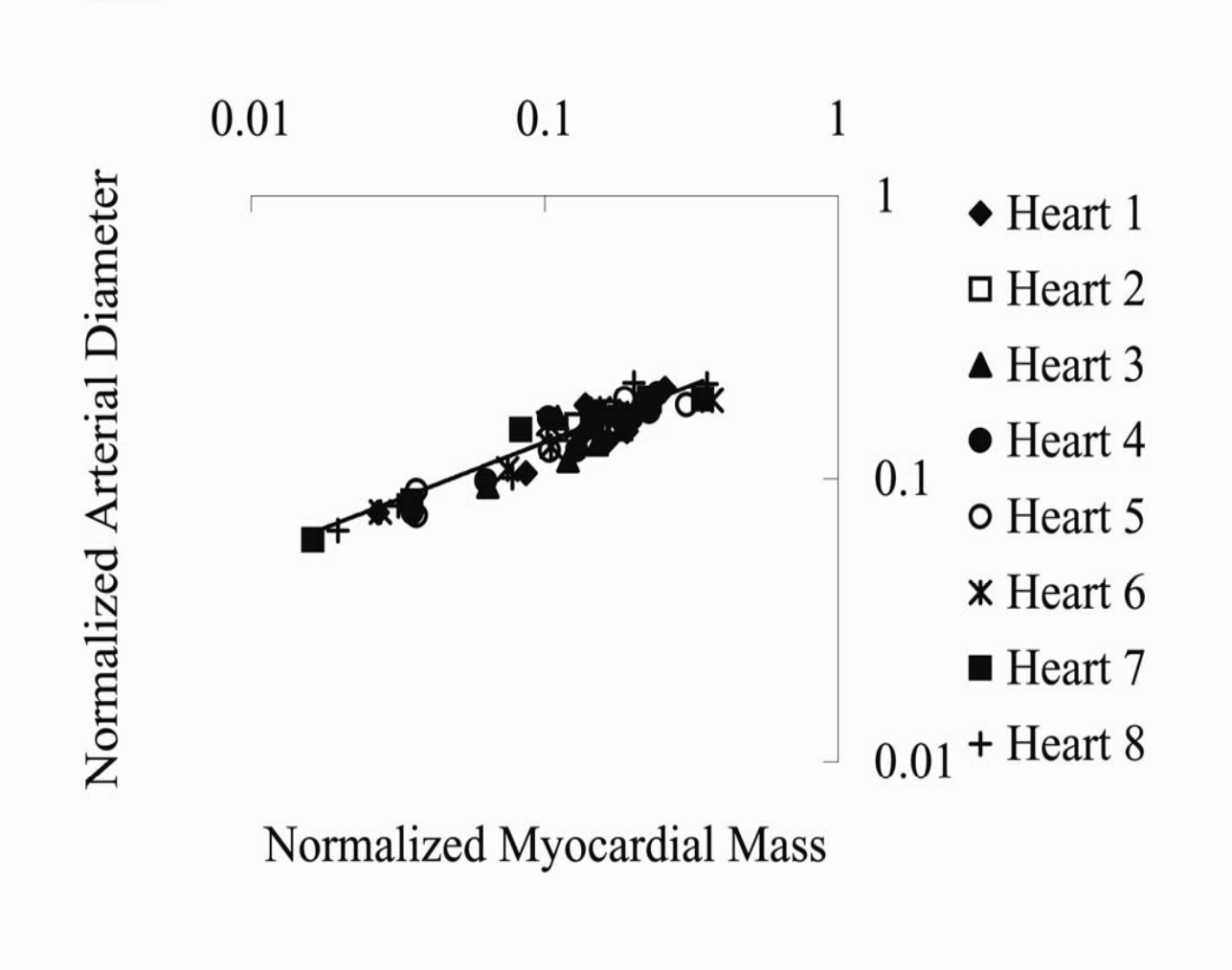

0.01
0.1
1
Normalized Total Arterial
Volume
1
0.1
0.01
Heart 1
Heart 2
Heart 3
Heart 4
Heart 5
Heart 6
Heart 7
Heart 8
Normalized Myocardial Mass

Length~Mass$^{3/4}$

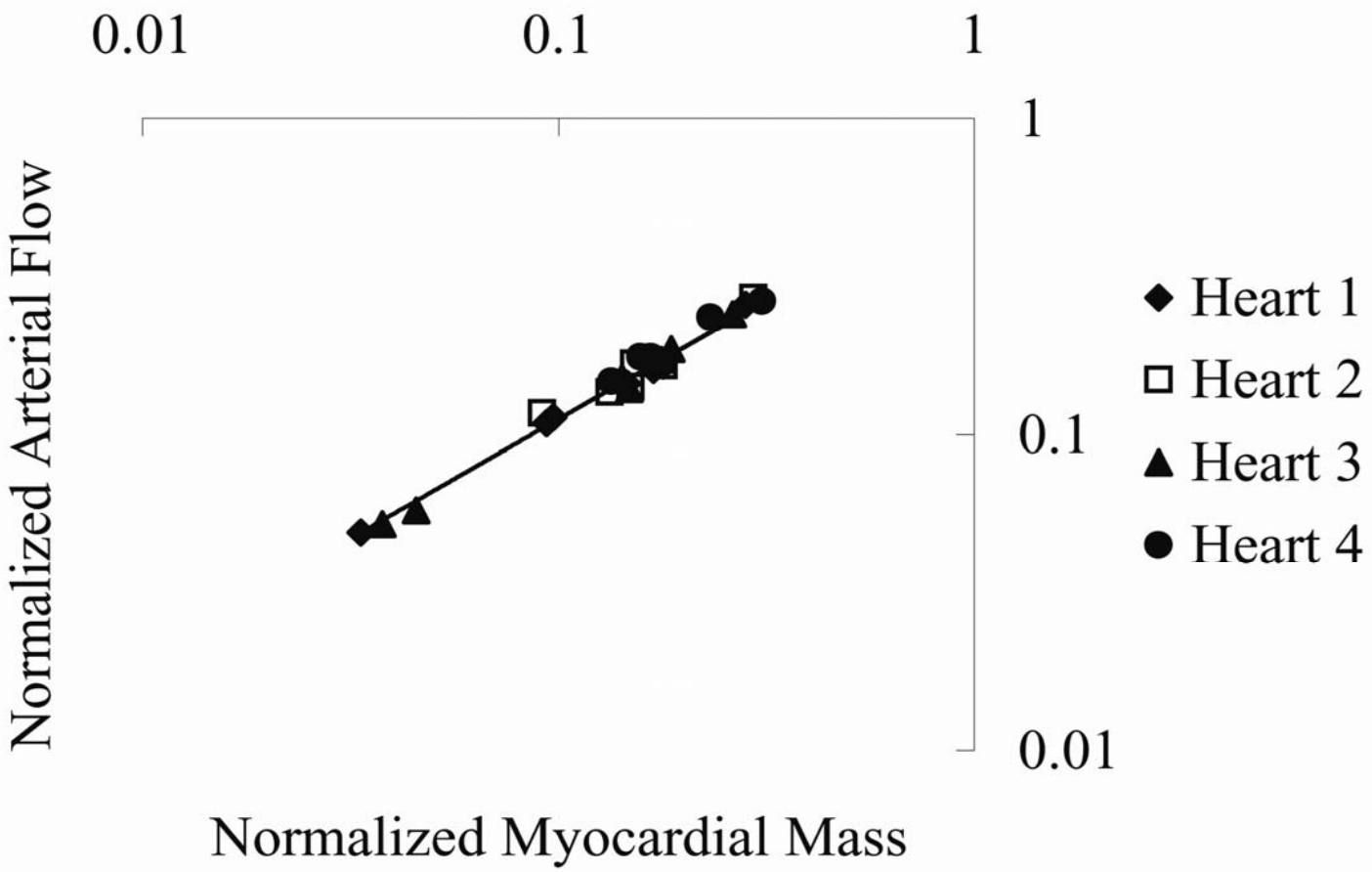




Diameter~Mass$^{3/8}$ or Area~Mass$^{3/4}$



Flow~Mass$^{3/4}$


0.01
0.1
1
1
0.1
0.01
Normalized Arterial Flow
Normalized Myocardial Mass
Heart 1
Heart 2
Heart 3
Heart 4

A least square fit as well as a scaling model fit ($Y=Y_0 m^b$)

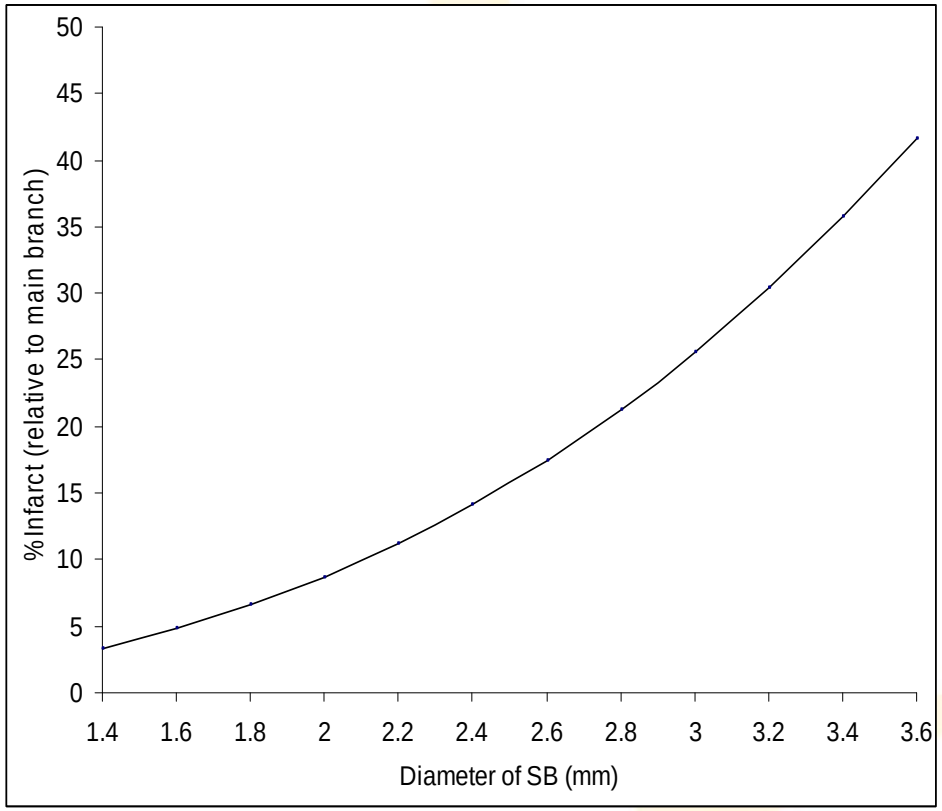
	Least Squares Fit				Scaling Model Fit			
Full Extrapolated Model	Y_0	b	R^2	P	Y_0	b	R^2	P
V (mL)	0.013±0.002	1.05±0.06	0.99	<0.001	0.015±0.001	1	0.99	<0.001
L (cm)	49.4±30.2	0.81±0.12	0.93	<0.001	53.2±13.0	3/4	0.92	<0.001
D (mm)	0.72±0.13	0.41±0.05	0.87	0.005	0.80±0.04	3/8	0.82	0.009
Q (mL/min)	0.64±0.03	0.74±0.04	0.97	<0.001	0.71±0.15	3/4	0.97	<0.001
Truncated Model								
V (mL)	0.013±0.001	0.97±0.04	0.99	<0.001	0.012±0.001	1	0.99	<0.001
L (cm)	0.89±0.18	0.76±0.07	0.98	<0.001	0.89±0.08	3/4	0.97	<0.001

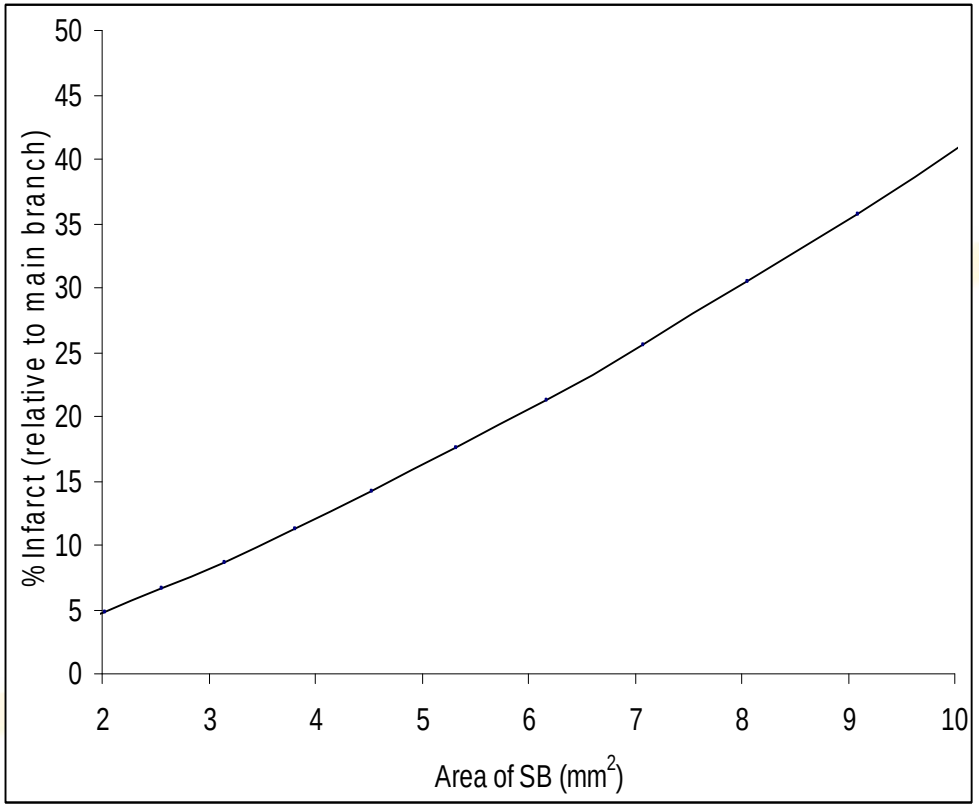
SB Diameter as an Index of MI

$$\%Infarct_{artery} = M_{SB}/M_{MP} \times 100 = (CSA_{SB}/CSA_{MP})^{4/3} \times 100$$

where SB-Side branch; MP-Most proximal artery (e.g., LAD, LCx or RCA)

SB-%Infarct Relation





Summary

- An allometric scaling law relates the various morphological (e.g., diameter, length and volume) and function (e.g., flow) to myocardial mass.

- A quantitative relation between SB diameter/area and %Infarct (relative to main artery or entire heart) exists in swine hearts and needs to be established in patients.

Additional Works

- Further validate the ¾ law under disease conditions
- Correlate with clinical biomarkers (biological, molecular, imaging, etc.)
- Diffuse Disease, use length rather than diameter