Effect of calibre and curvature on hemodynamics after CoA repair

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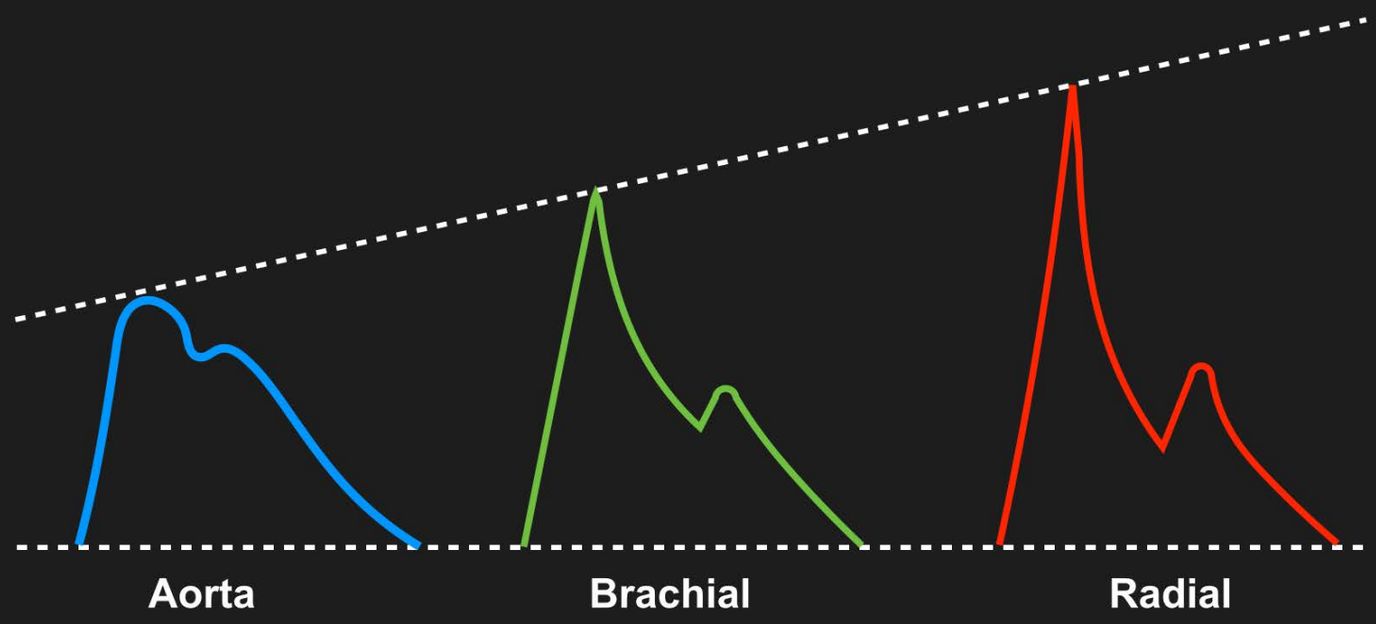
Introduction

Hypertensive (rest or exercise)

Associated CVD, CHD, HEFPEF

No surgical or catheter interventions

Central aortic systolic pressure

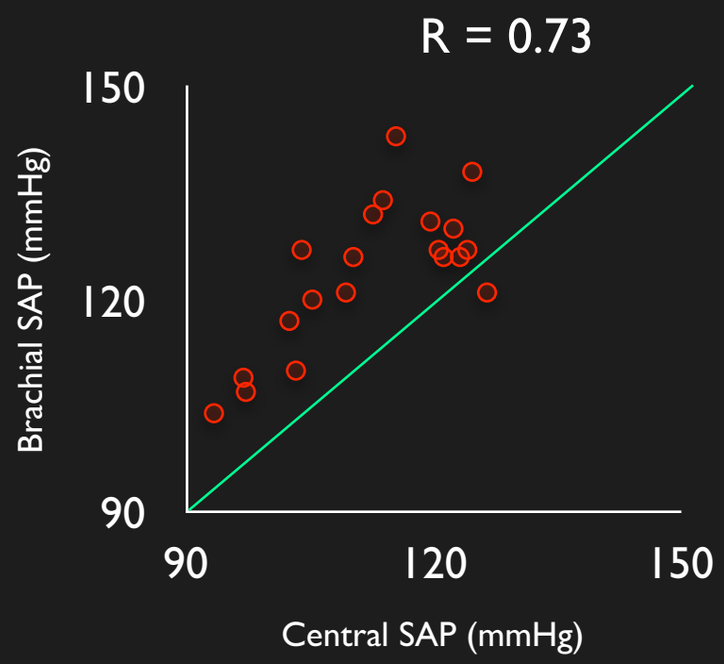


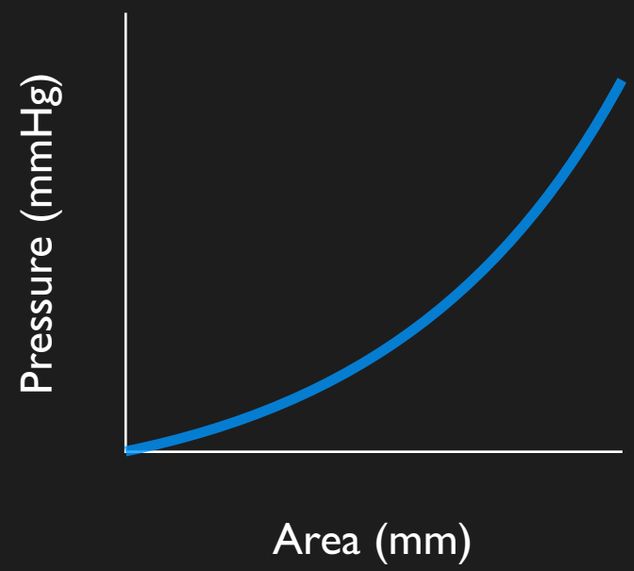
Brachial artery pressure

Pressure augmentation

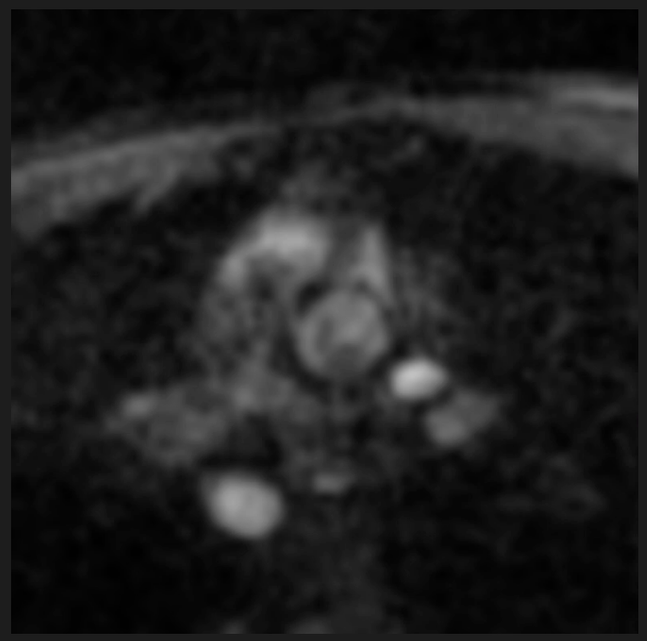
Patient specific

Moderate association

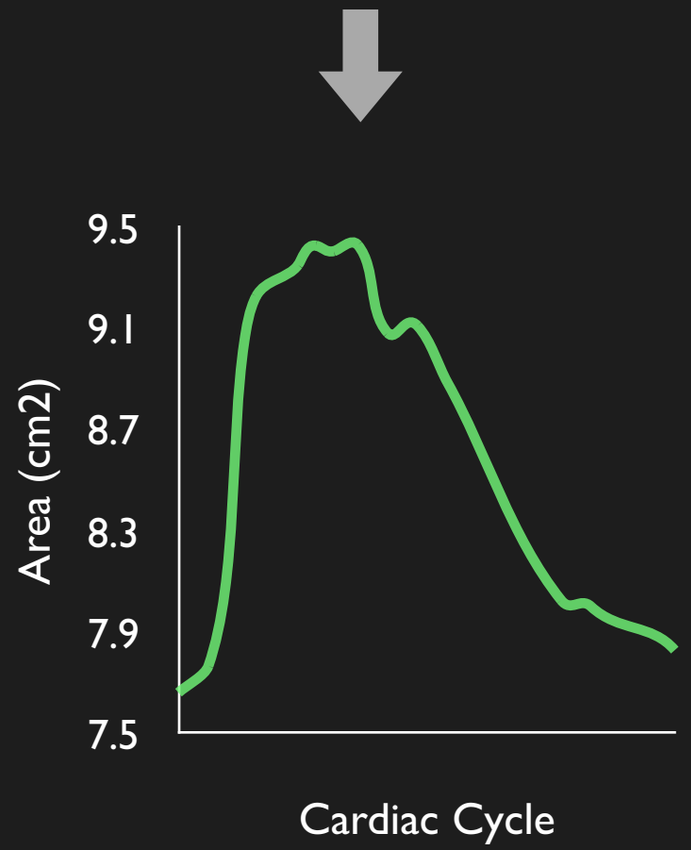




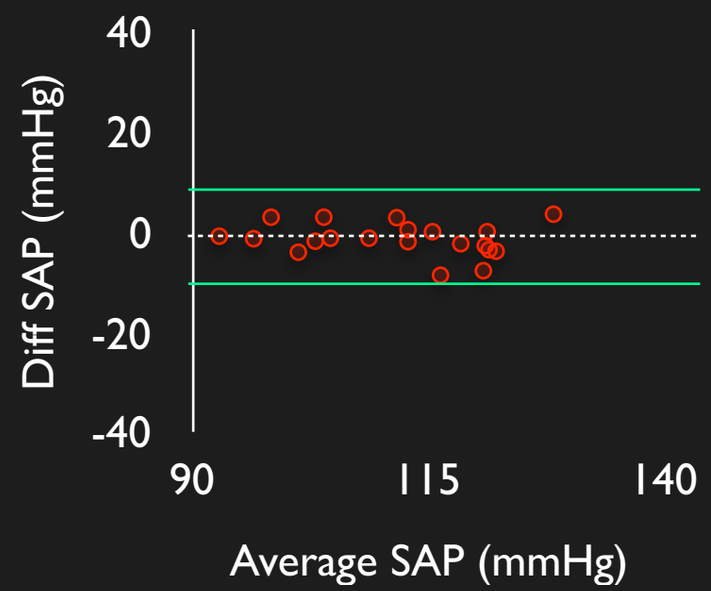
MR-CASP

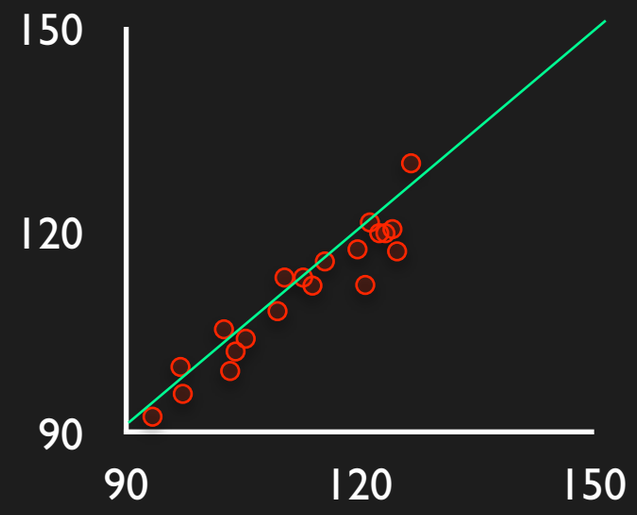


Cine - PCMR - SSFP



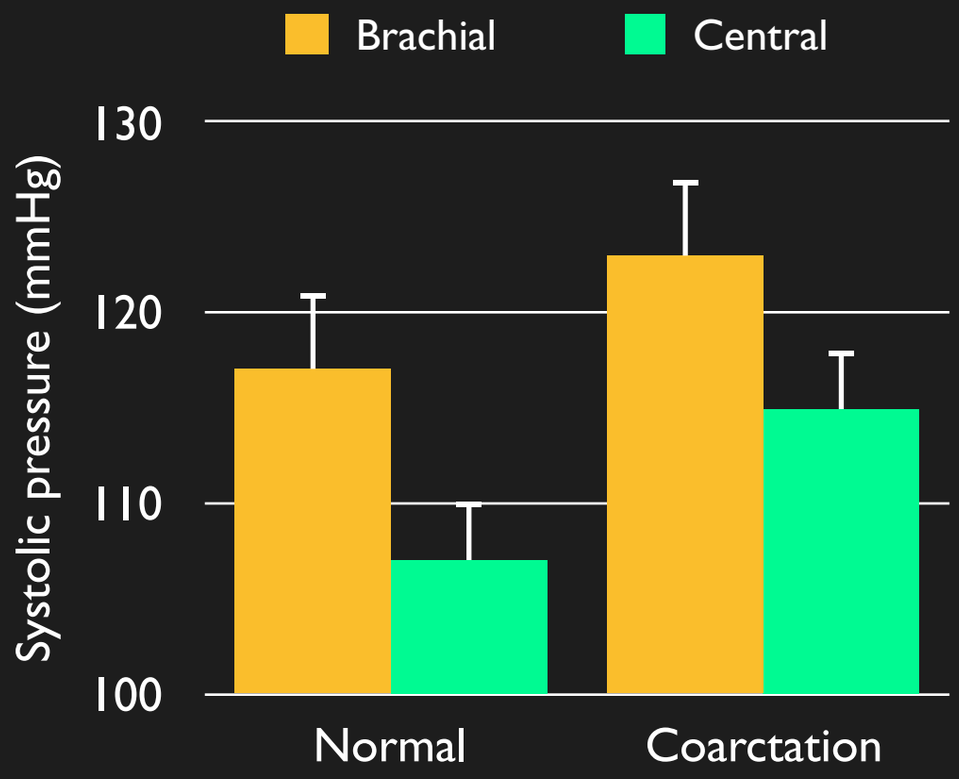
Accurate CASP



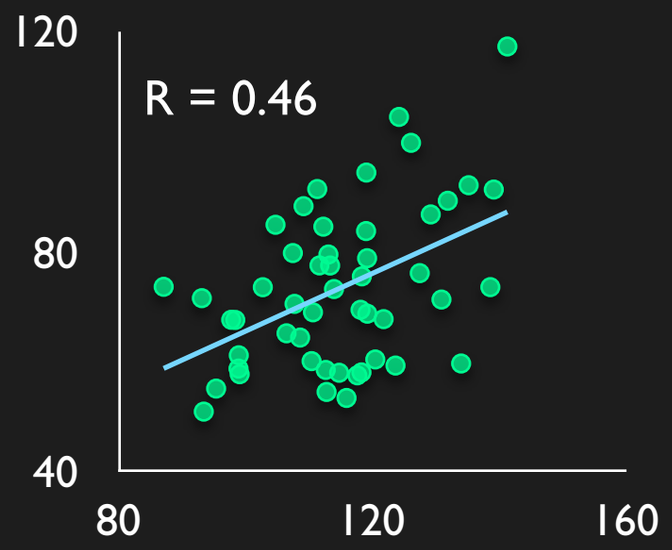


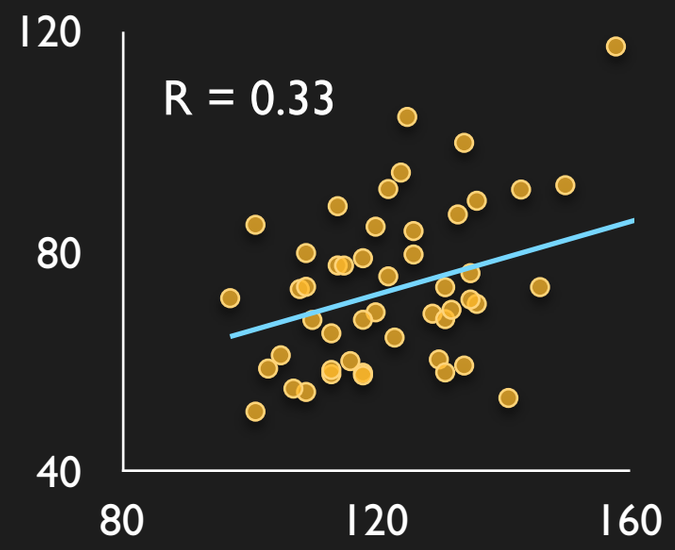
Quail et al. JMRI *2014*

Central aortic pressure coarctation



Is it accurate?



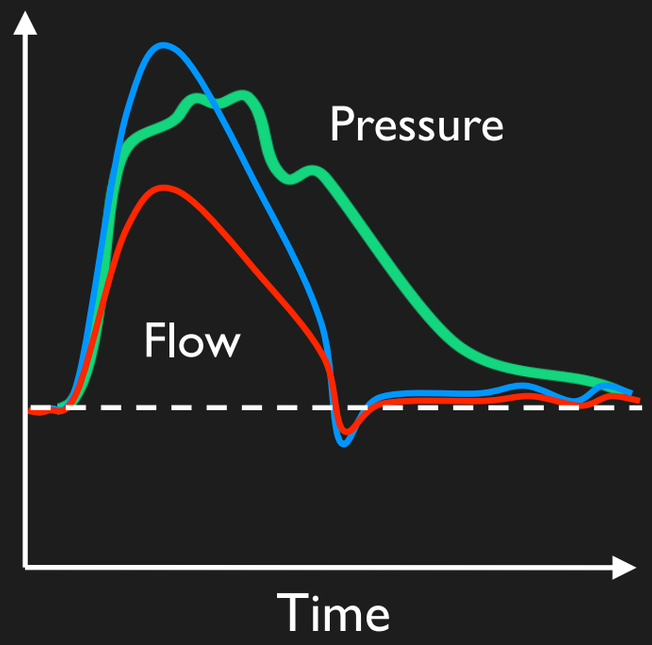


CASP correlates LVM

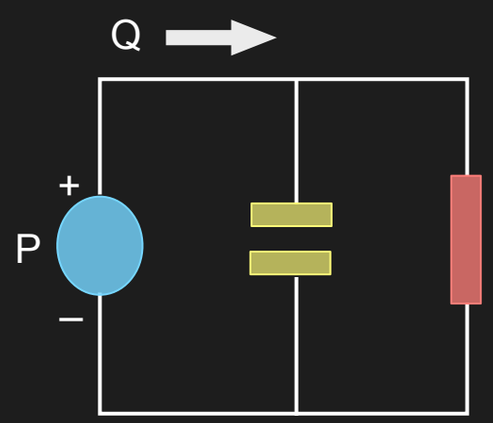
BASP not significant

Quail et al. Hypertension 2017

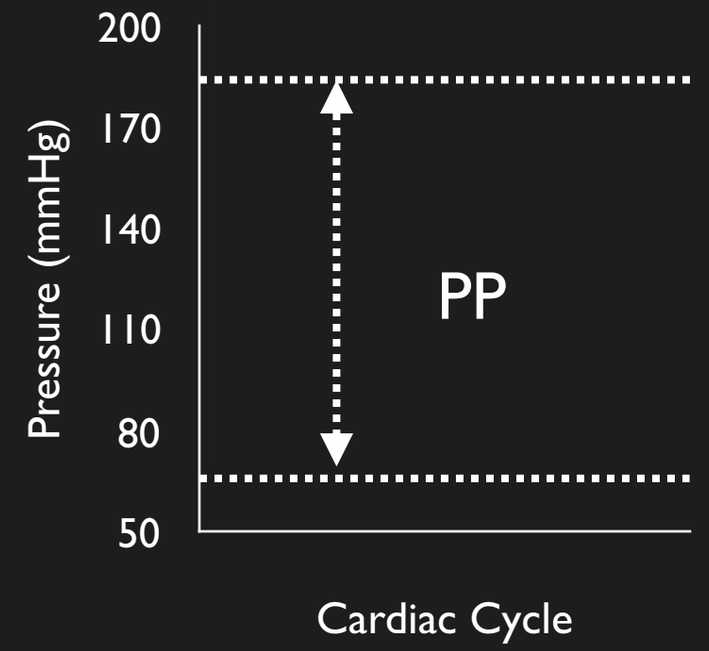
Resistance and compliance

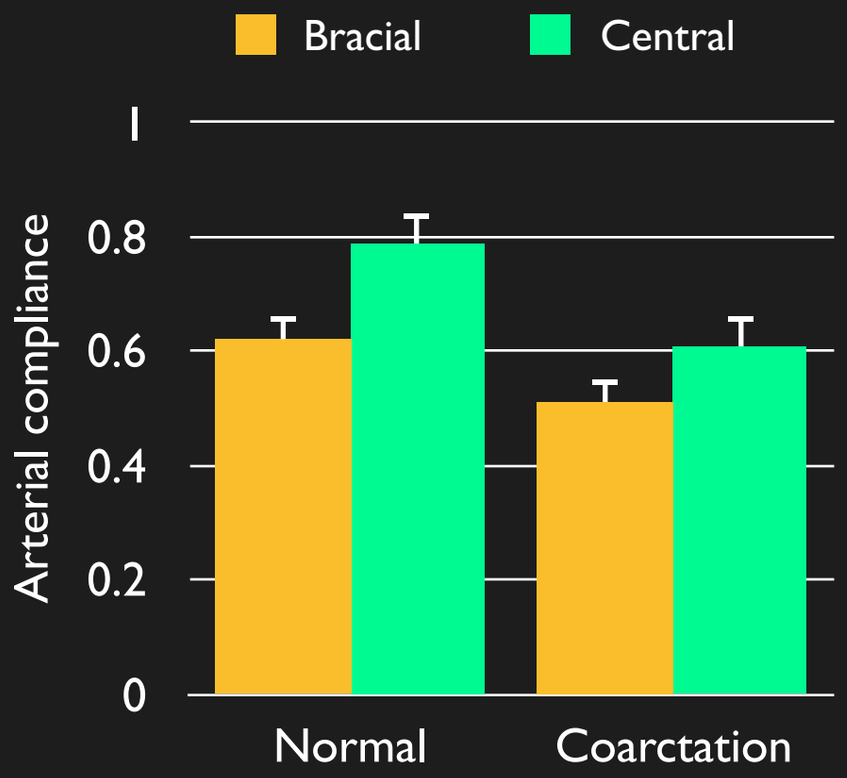


Tune model



R = P/Q





TAC with CASP more significant

Aorta is stiffer

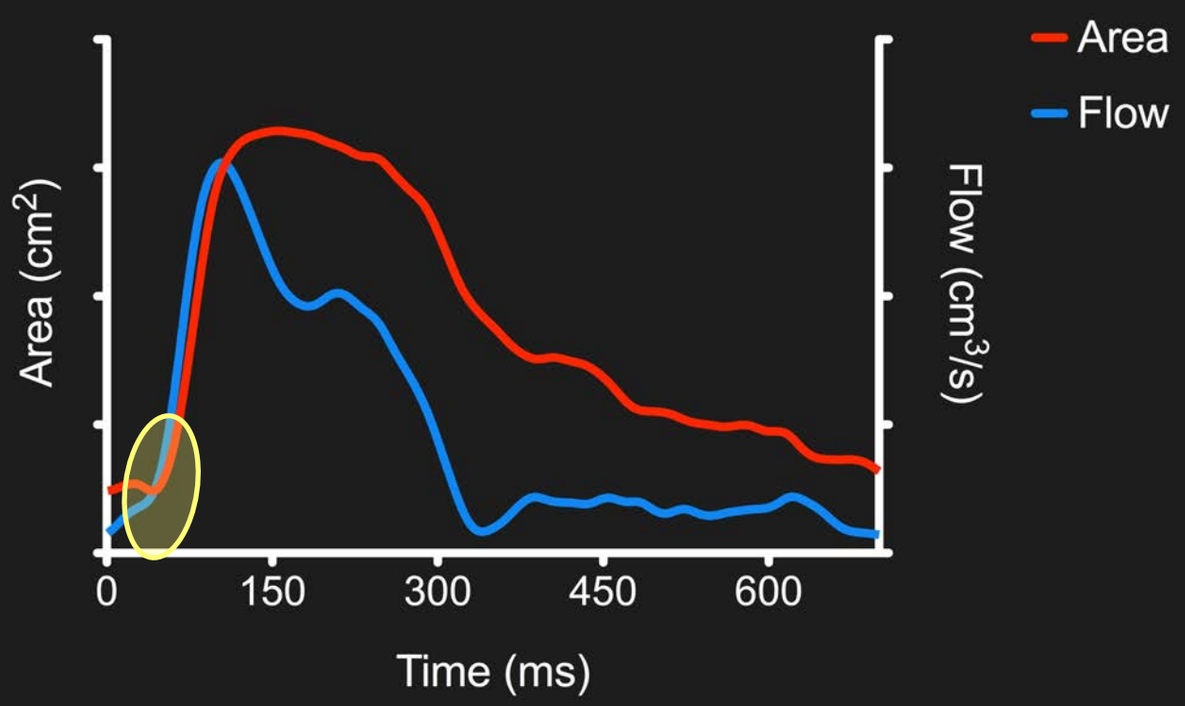
Ongoing vascular disease

Quail et al. Hypertension 2017

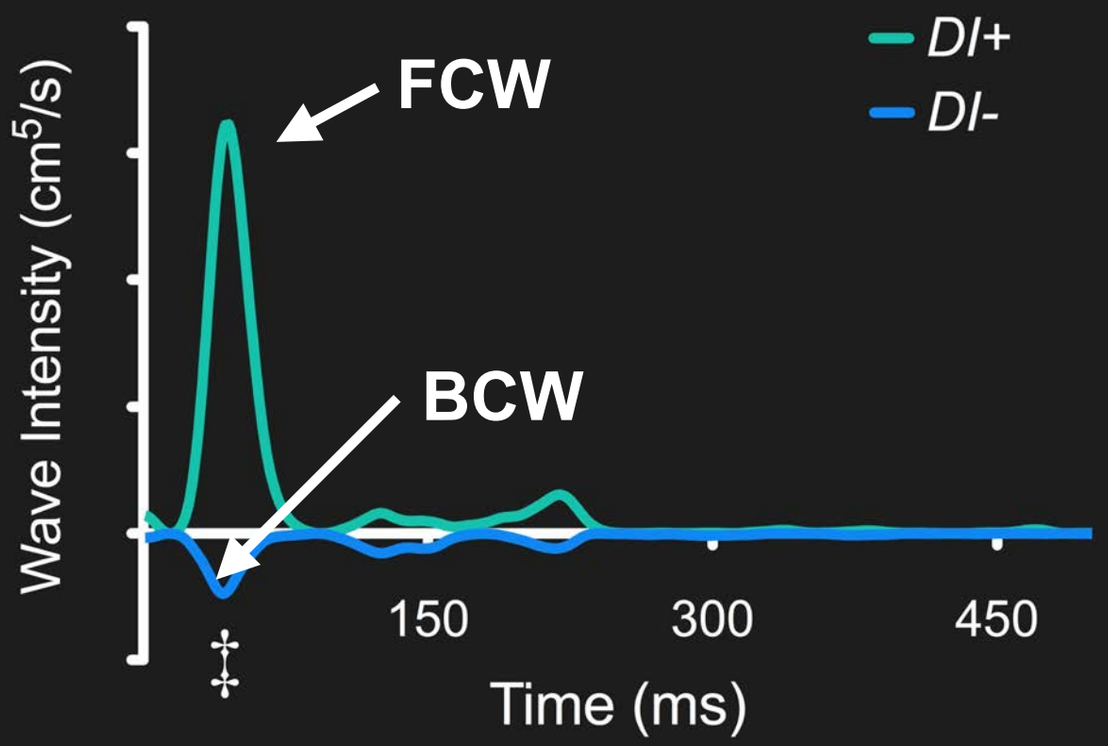
Wave Intensity Analysis

Pressure + Velocity

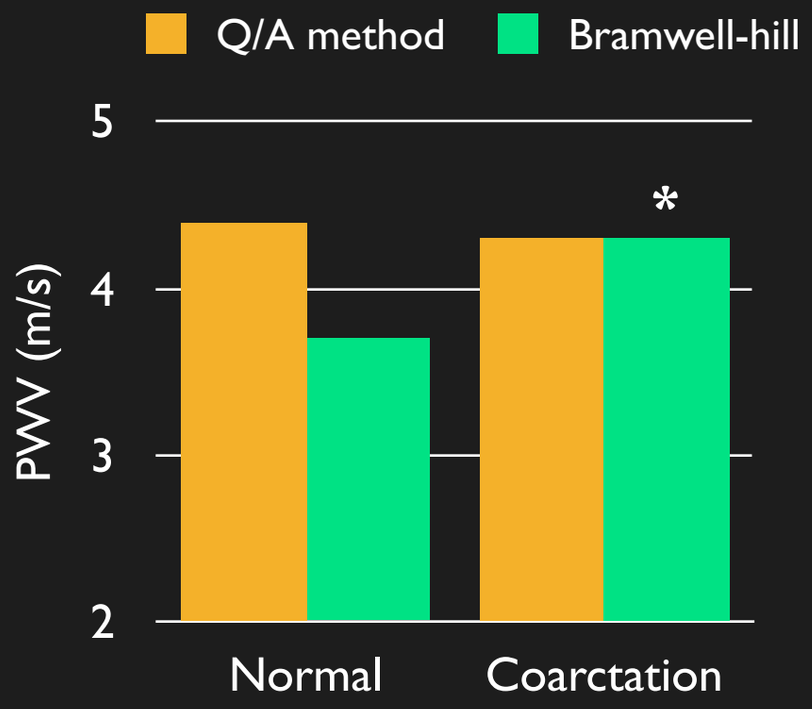
Backwards compression



PWV = ΔQ/ΔA



Wave Intensity Analysis

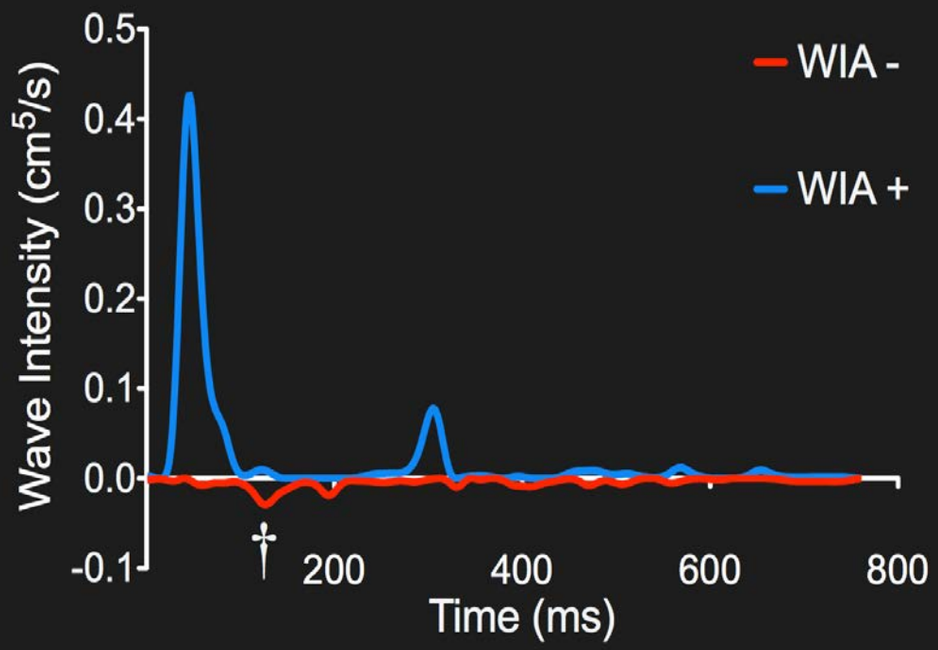


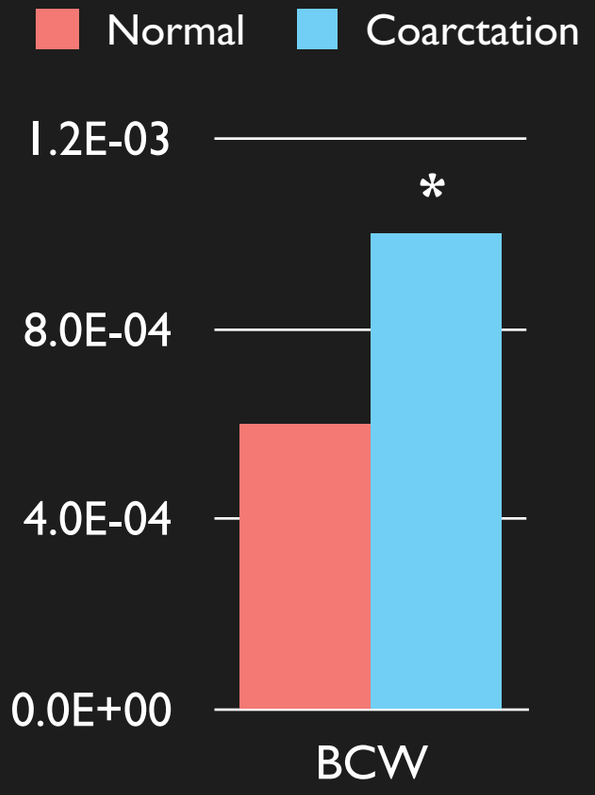
Early reflection

↓Flow and ↑Area

Falsely reduces PWV

$$PWV = \sqrt{A_d \frac{CASP - DBP}{\Delta A}}$$





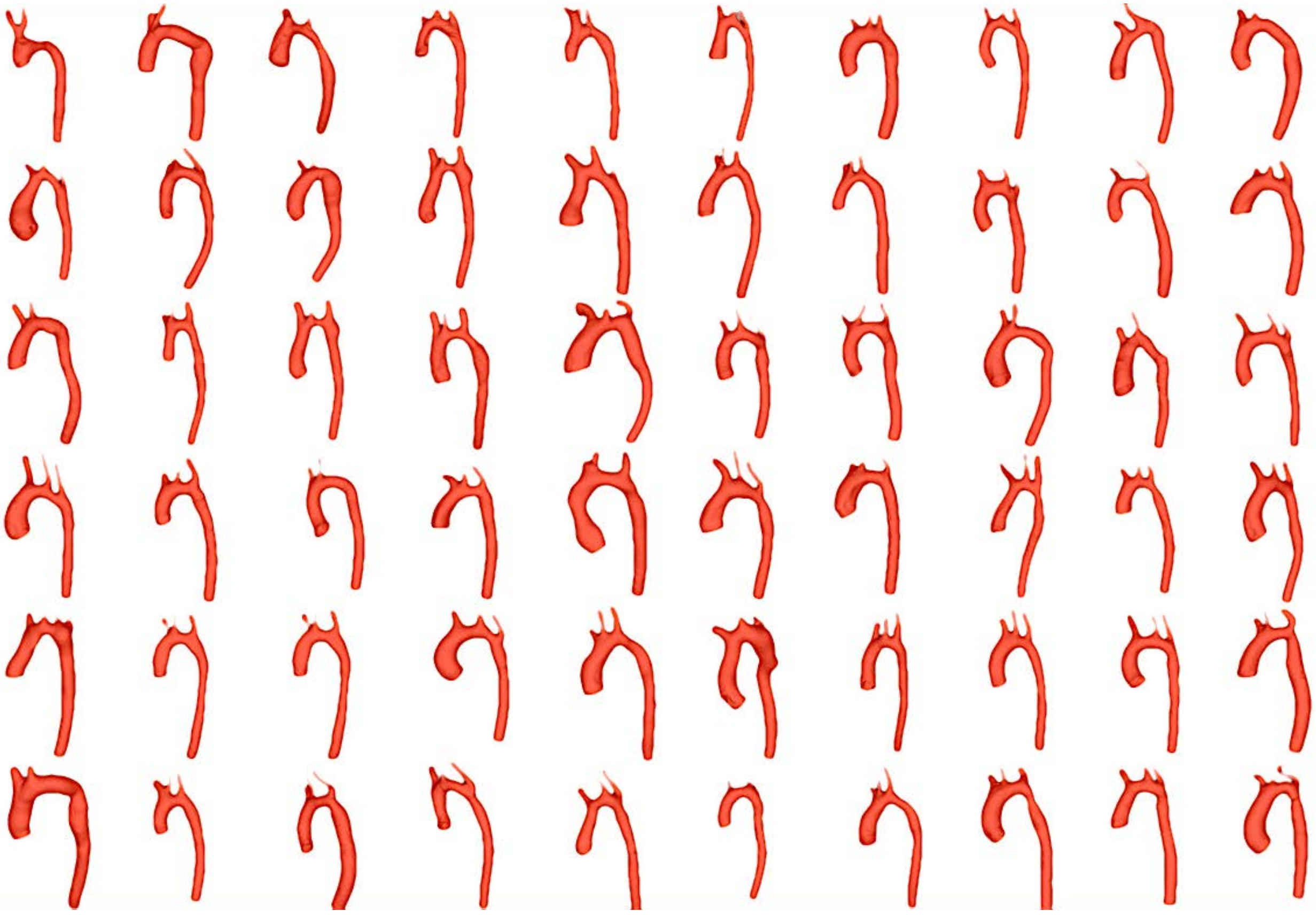
BCW increased

Stiff repair site

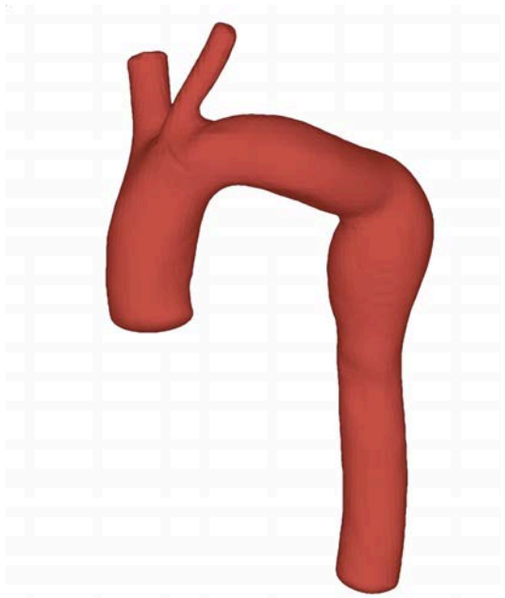
Predicts LV mass

Quail et al. Hypertension 2017

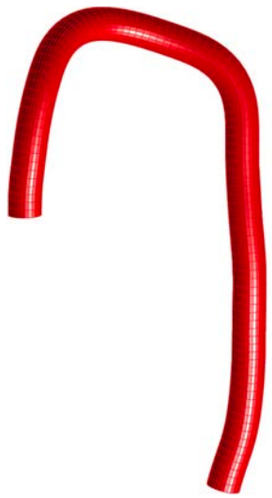
Is shape important?



What is shape?



Quantify



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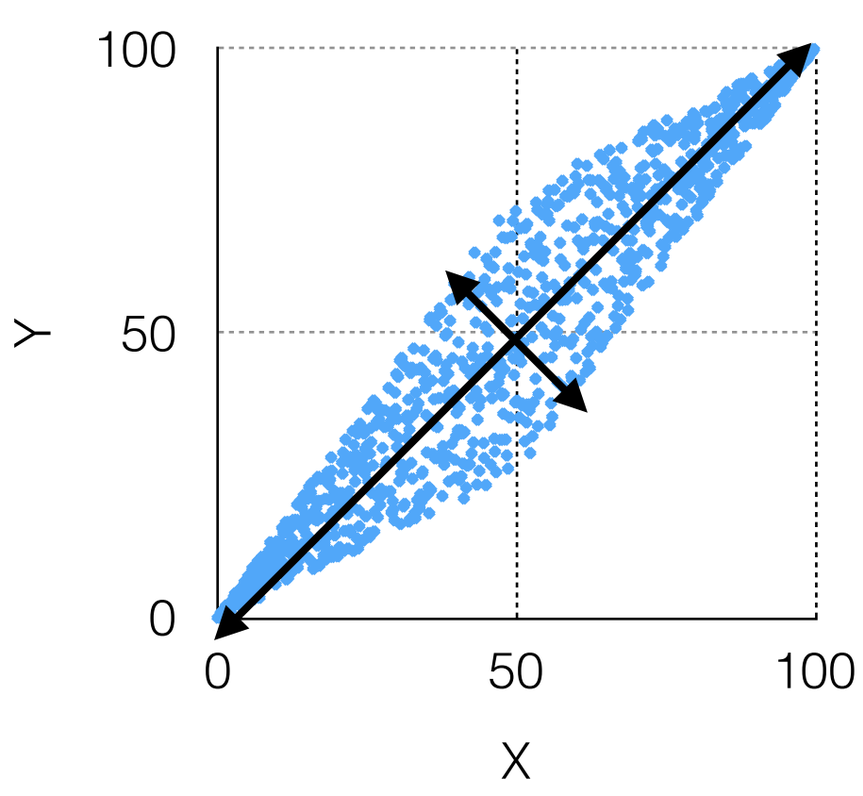
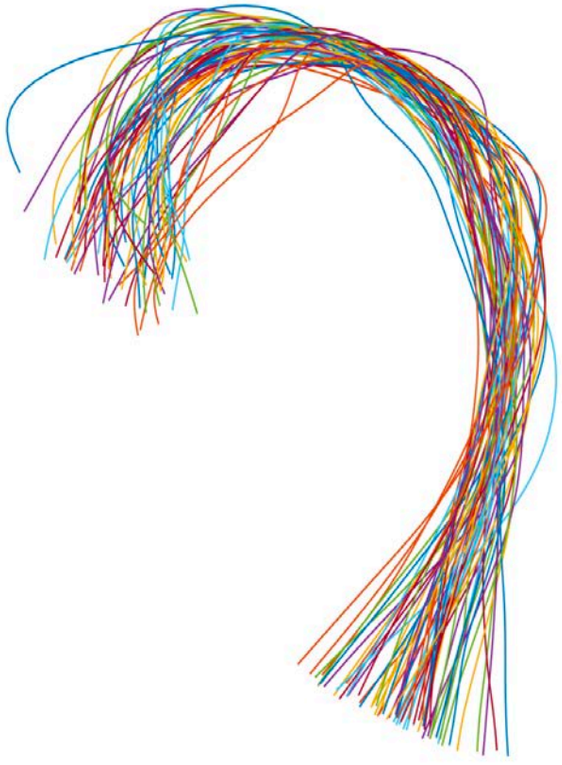


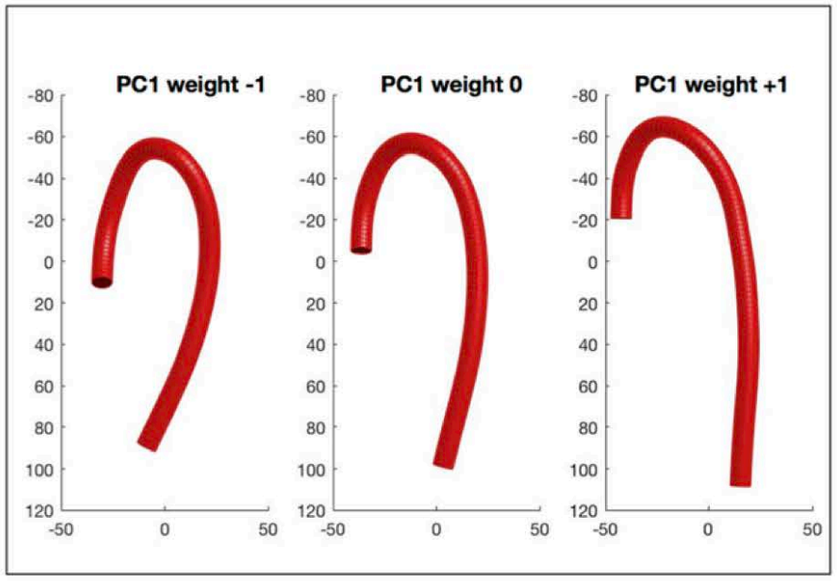


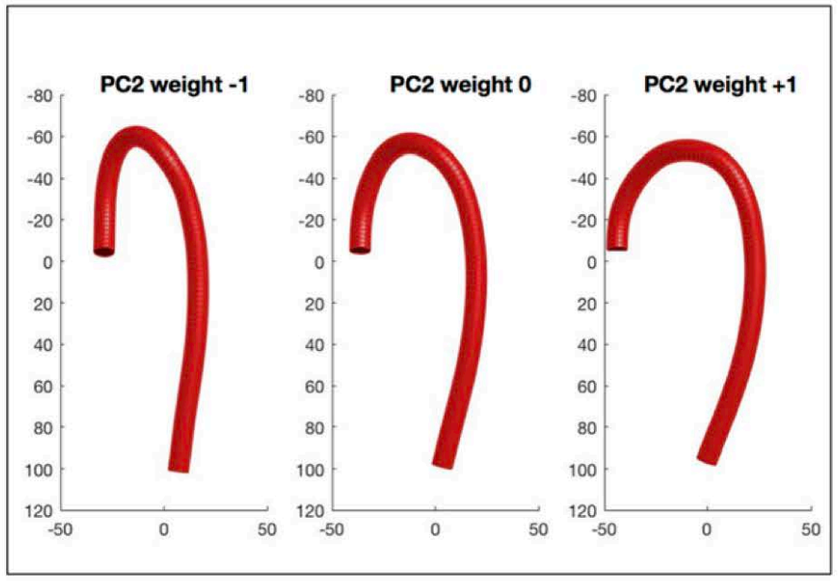
PCA

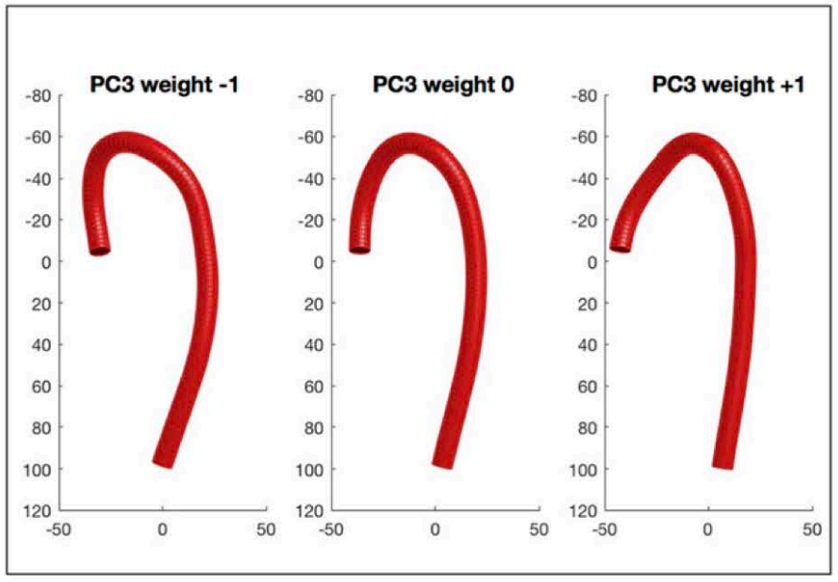
Curvature

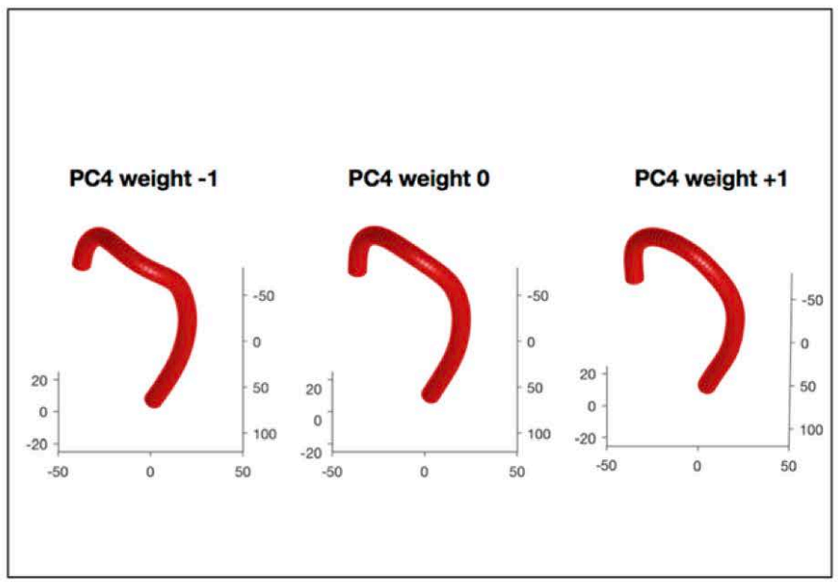
Radius

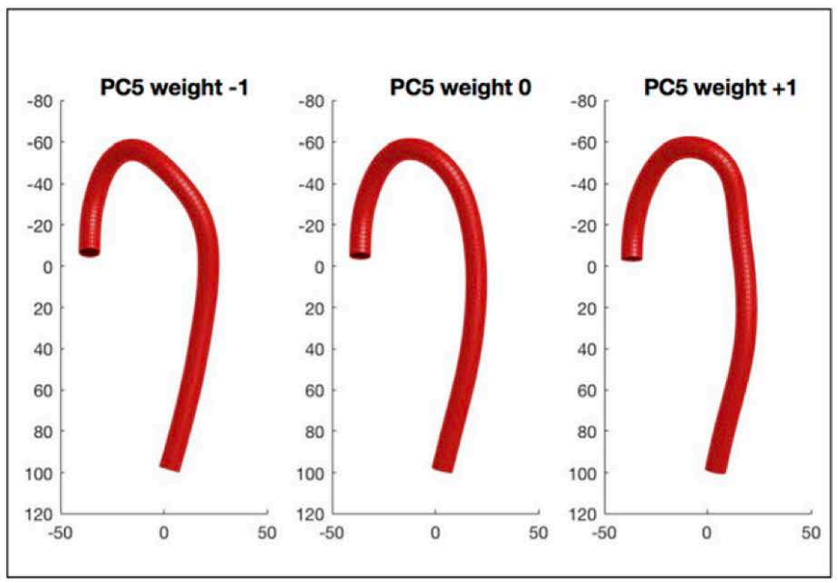
Curvature











PC1: Ascending aorta length	-1 Longer ascending aorta +1 Shorter ascending aorta
PC2: Arch angulation	-1 Greater angulation +1 Less angulation
PC3: Ascending aorta angle	-1 Forward tilt +1 Backward tilt
PC4: Transverse arch lateral curvature	-1 Greater curvature +1 Less curvature
PC5: Length and angle of transverse arch	-1 Longer steeper transverse arch +1 Shorter horizontal transverse arch

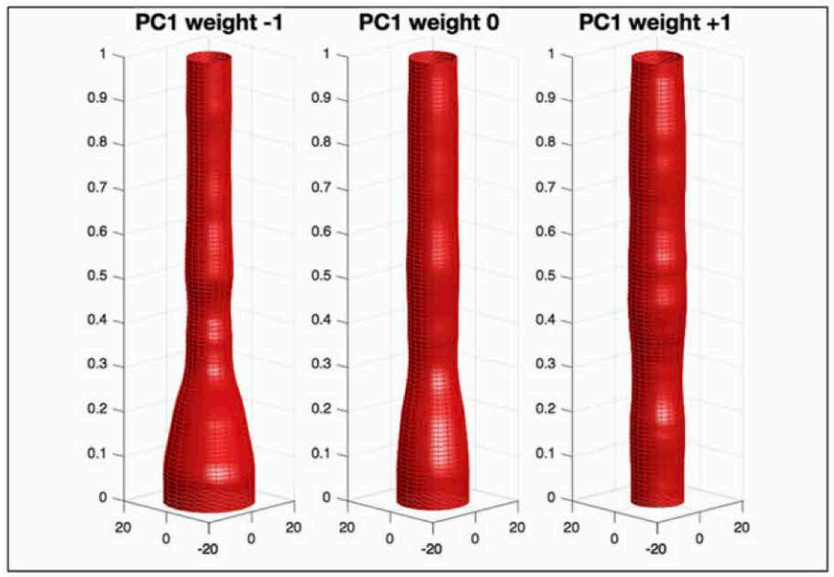
First 5 PC's account for 96% of variation

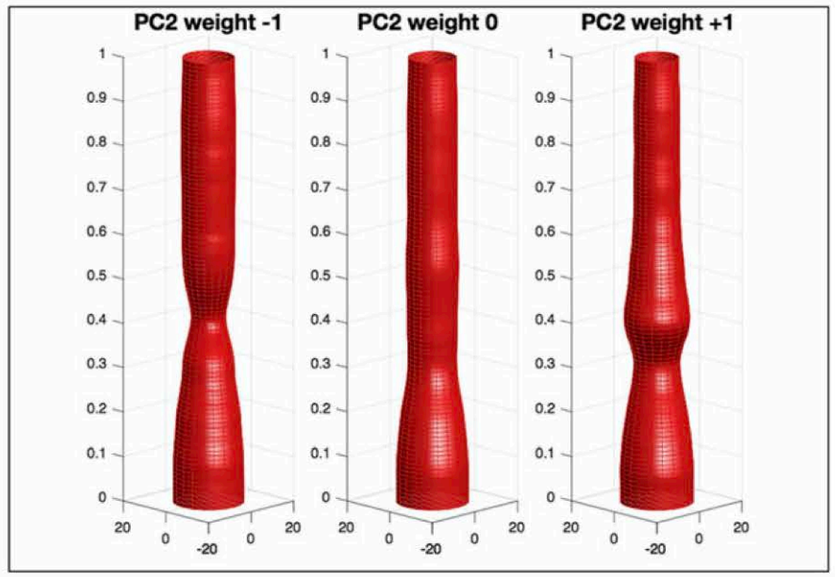
PC 2 associated with gothic arch

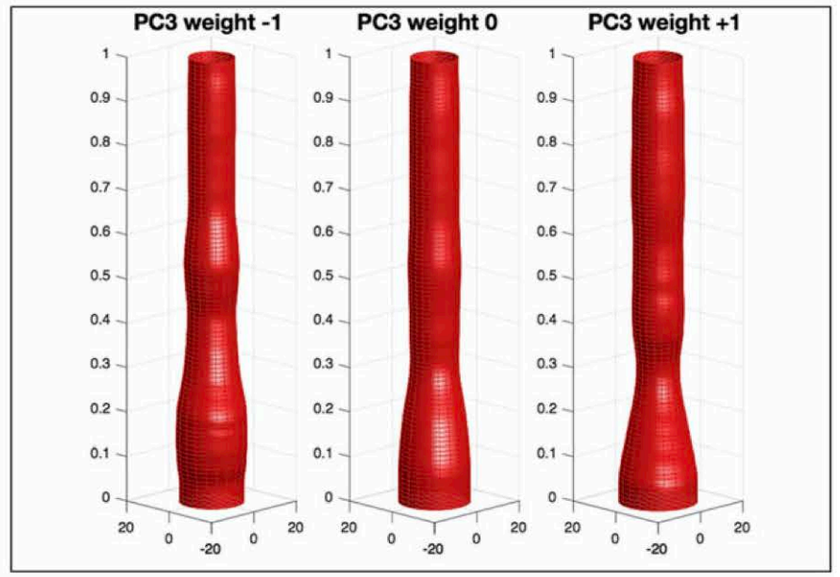
No correlation with any hemodynamics

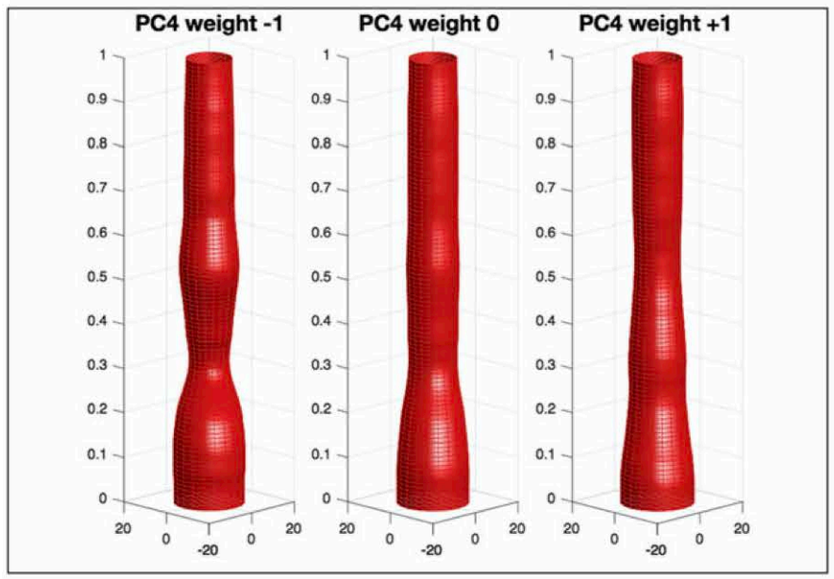
Quail et al. JCMR 2019

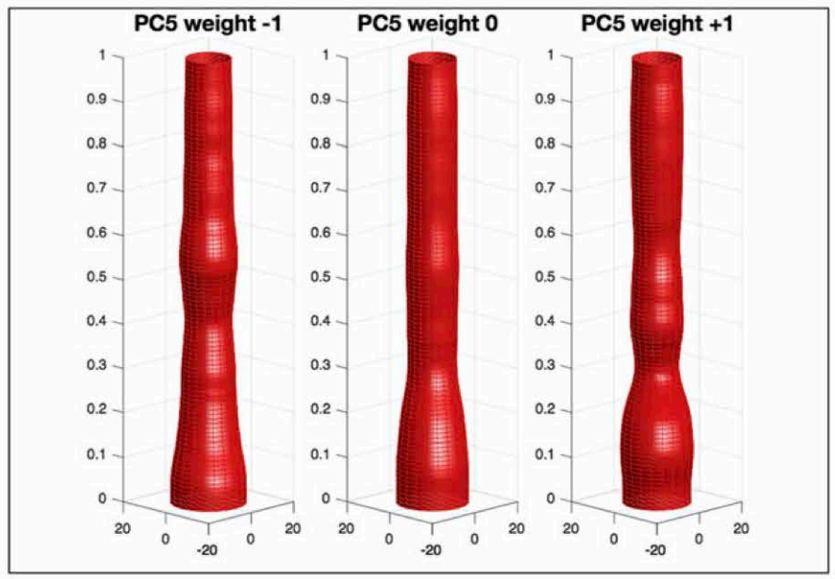
What is shape?











PC1: Aortic Root	-1 Larger root relative to small arch and descending +1 Uniform calibre - loss of taper
PC2: Isthmus	-1 Narrower isthmus +1 Dilated isthmus
PC3: Transverse Arch	-1 Larger transverse arch +1 Narrower transverse arch
PC4: Distal Arch/ Proximal Descending	-1 Dilated proximal descending +1 Dilated transverse arch
PC5: Ascending aorta/ proximal arch	-1 Tapered ascending aorta and proximal arch +1 Tubular ascending with calibre change at proximal arch

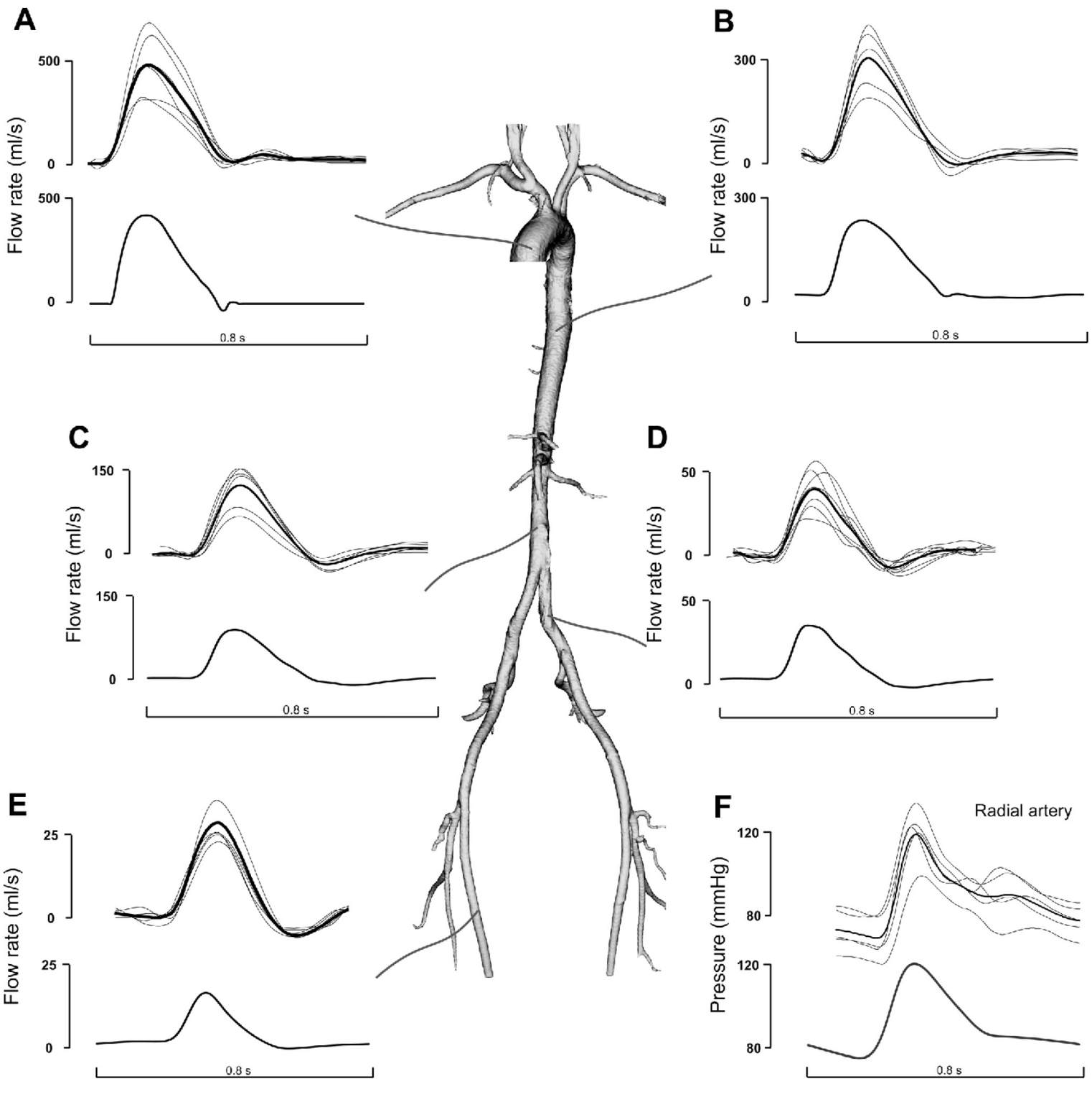
First 5 PC's account for 89% of variation

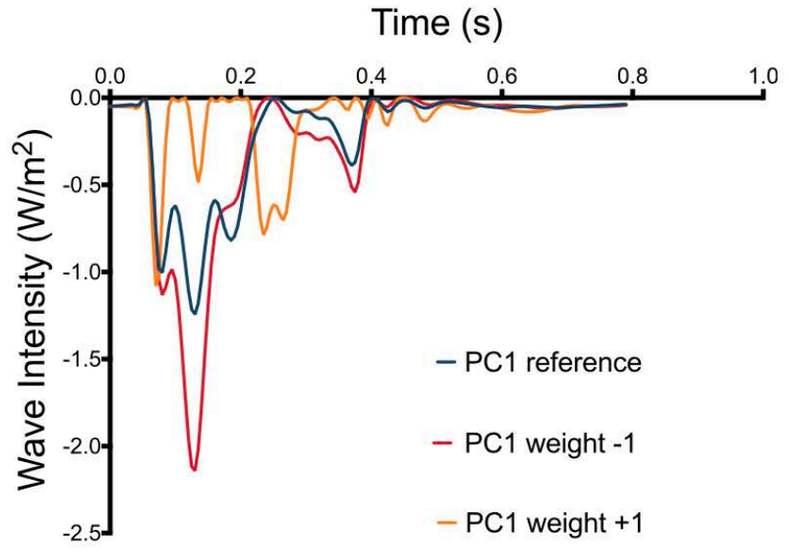
1st, 3rd, & 4th PC associated with BCW

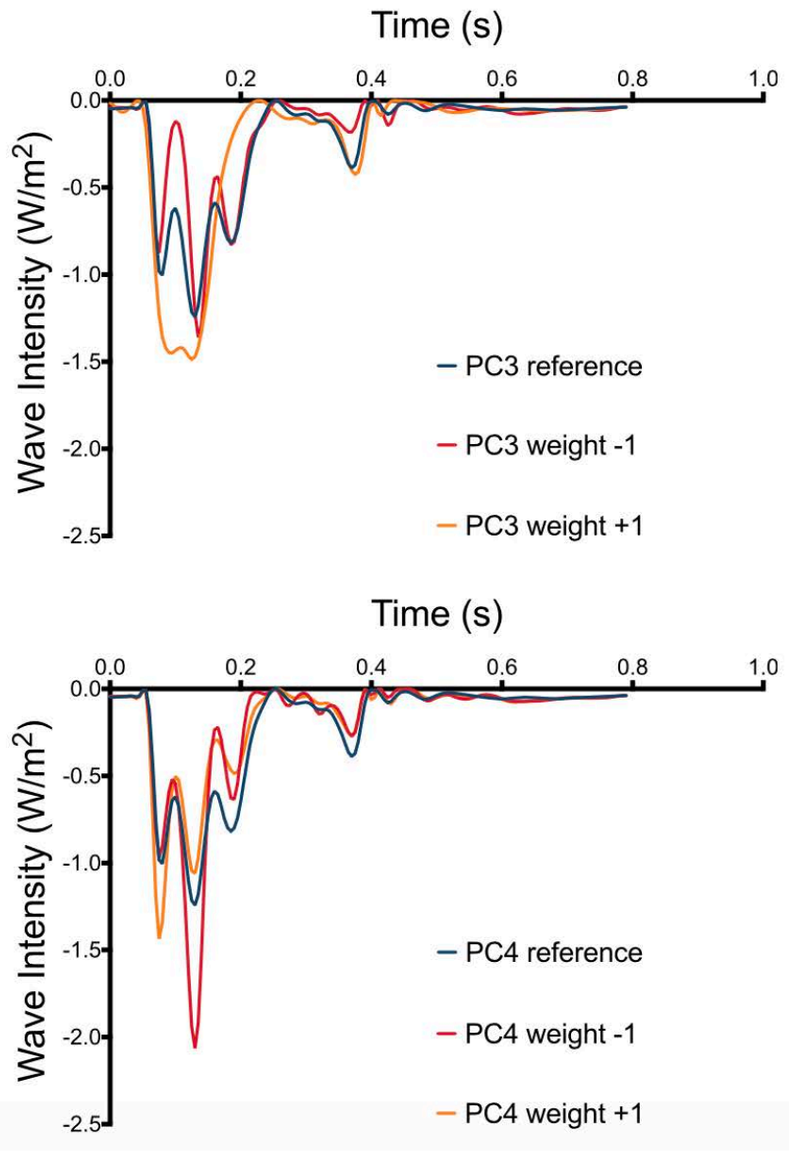
Radius 1 associated with curvature 2

Quail et al. JCMR 2019

Confirmation with Models

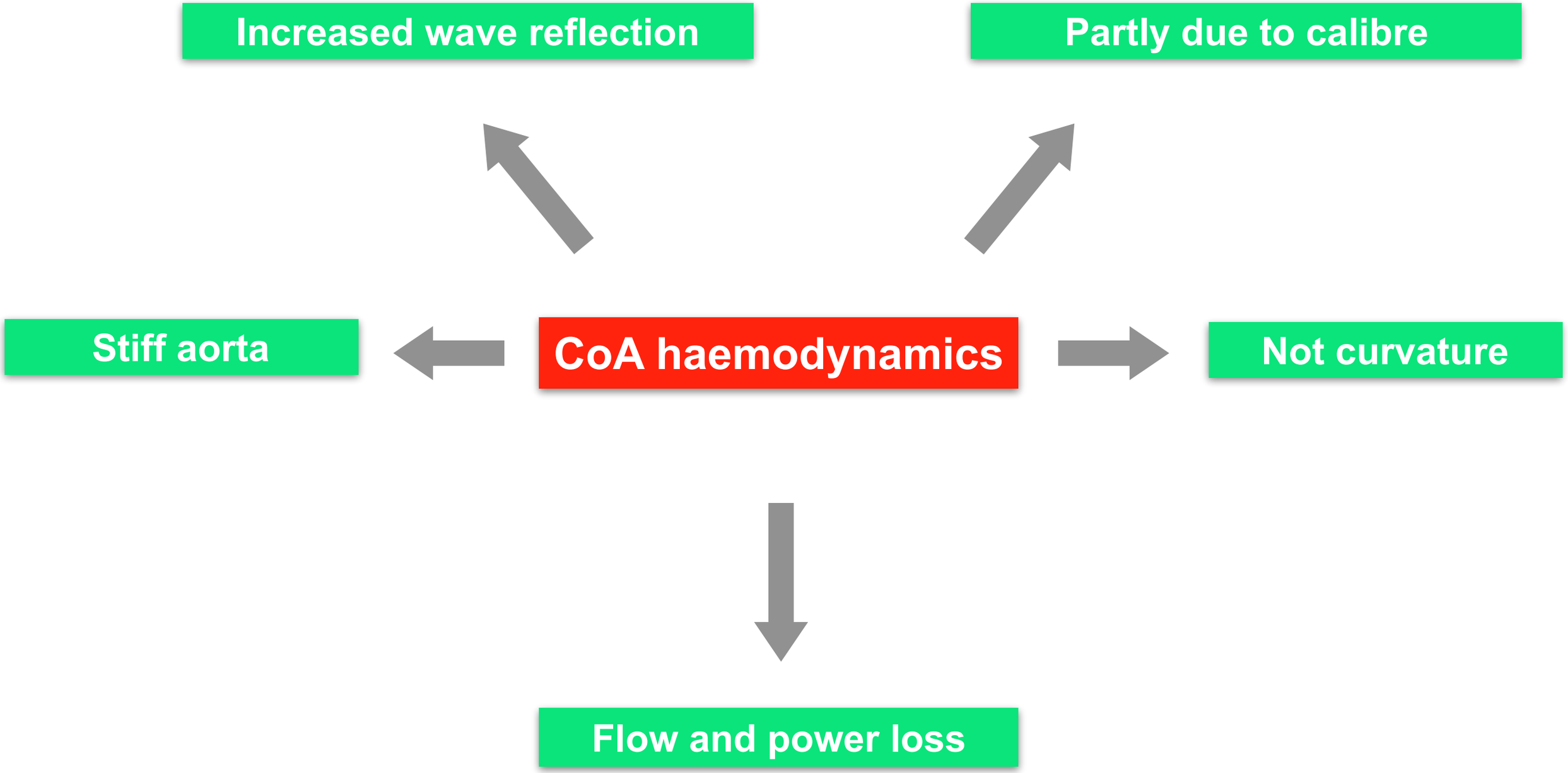






1D systemic arterial model

Conclusion


Increased wave reflection
Partly due to calibre
Stiff aorta
CoA haemodynamics
Not curvature
Flow and power loss