

Strain-based Failure Analysis of Bicuspid Aortopathy

Giuseppe Romano¹, Salvatore Pasta^{1,2}, Giuseppe M Raffa¹

¹ Department for the Treatment and Study of Cardiothoracic Diseases and Cardiothoracic Transplantation, IRCCS-ISMETT, via Tricomi n.5, 90127, Palermo, Italy

² Fondazione Ri.MED, via Bandiera n.11, 90133, Palermo, Italy

INTRODUCTION

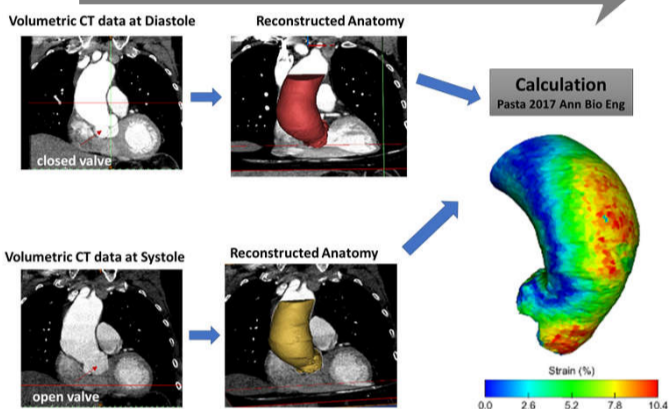
The development of ascending thoracic aortic aneurysm (ATAA) in patients with bicuspid aortic valve (BAV) is highly variable, and this makes surgical decision strategies particularly challenging.

OBJECTIVE

- To investigate the impact of aortic wall strain on ATAAs by applying a novel failure potential criterion on the basis of the aortic aneurysm extensibility.

METHOD

CT Strain

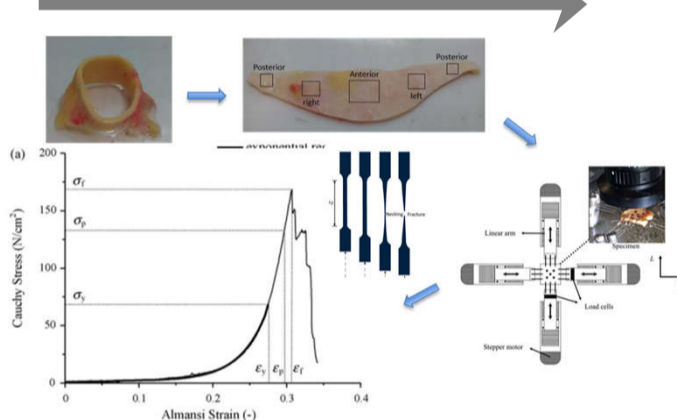


Risk Model

Failure occur when CT strain on the ATAA wall due to physiological loading exceeds its extensibility (i.e., the strain at the rupture)

$$\text{Risk of Failure} = \frac{\text{CT Strain}}{\text{Strain at Rupture}}$$

Strain at Rupture



Echocardiography

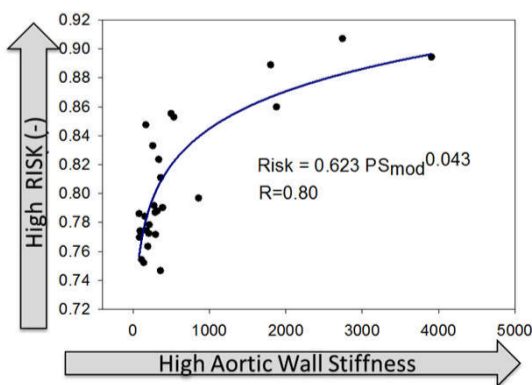
$$\text{Aortic Stiffness} = \frac{2(As - Ad)}{Ad(Ps - Pd)}$$

Where

- As and Ad are M-mode guided systolic and diastolic aortic diameters
- Ps and Pd are the systolic and diastolic arterial cuff pressure

RESULTS

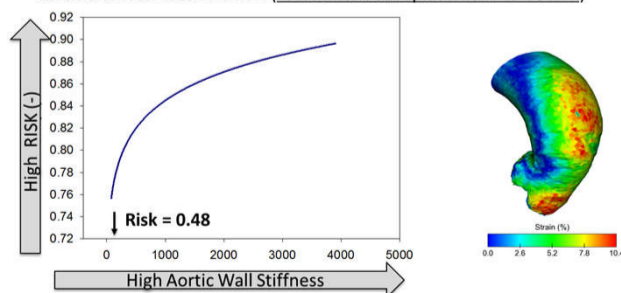
Relation between echo and risk model



Prospective Model application

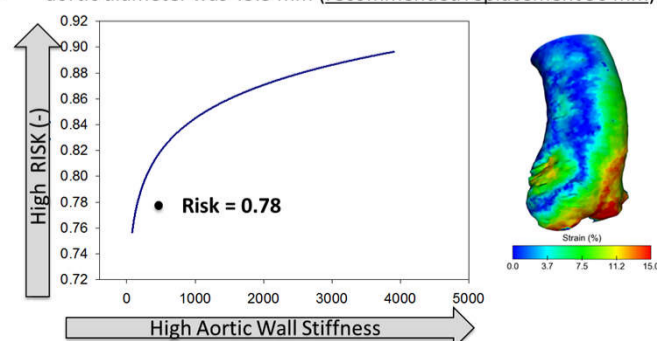
Case Study #1:

- 42-old-male, BAV (no signs of dysfunction)
- aortic diameter was 47.5 mm (recommended replacement 45-50 mm)



Case Study:

- 51-old-female, TAV
- aortic diameter was 43.5 mm (recommended replacement 50 mm)



CONCLUSION

- The strain-based failure criterion for bicuspid aortopathy risk stratification correlated well with echocardiographic measurements
- Prospective application of the strain-based failure criterion on borderline cases showed promising clinical application