EUROPEAN SOCIETY OF CARDIOLOGY®

EUROPEAN ASSOCIATION OF Echocardiography

JOINT E.A.E./S.I.E.C. TEACHING COURSE
UPDATE IN VALVULAR HEART DISEASES:
FROM CLINICAL IMAGING
TO THERAPEUTIC INNOVATIONS

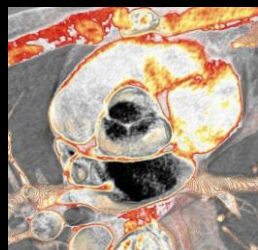
May 8th/9th,

AORTIC VALVE INSUFFICIENCY

MRI in patients with ascending aortic dilation

G. Casolo

Milano / Segrate · presso NH HOTEL
Sala Tintoretto, via F.lli Cervi, 1



MRI in the evaluation of the ascending aorta

- Tomographic and multiplanar imaging
- Non-invasive, no need for contrast media
- Absence of ionizing radiations
- Evaluation of the aortic valve (anatomy, function, flow)
- Quantitative measures of the RV / LV (volume, mass)
- Miscellanea

European Heart Journal (2007) 28, 230–268
doi:10.1093/eurheartj/ehl428

ESC Guidelines

Guidelines on the management of valvular heart disease

The Task Force on the Management of Valvular Heart Disease of the European Society of Cardiology

Authors/Task Force Members, Alec Vahanian (Chairperson) Paris (France)*, Helmut Baumgartner, Vienna (Austria), Jeroen Bax, Leiden (The Netherlands), Eric Butchart, Cardiff (UK), Robert Dion, Leiden (The Netherlands), Gerasimos Filippatos, Athens (Greece), Frank Flachskampf, Erlangen (Germany), Roger Hall, Norwich (UK), Bernard Iung, Paris (France), Jaroslaw Kasprzak, Lodz (Poland), Patrick Nataf, Paris (France), Pilar Tornos, Barcelona (Spain), Lucia Torracca, Milan (Italy), Arnold Wenink, Leiden (The Netherlands)

Magnetic resonance imaging

At present, magnetic resonance imaging (MRI) is not indicated in VHD in routine clinical practice; however, most measurements usually acquired by Doppler echocardiography can also be acquired with MRI and thus MRI can be used as an alternative technique when echocardiography is not feasible. In particular, quantification of cardiac function, dimensions, and regurgitant volume is very accurate with MRI.[29]

Other Techniques

- Exercise testing
  - Objective assessment if equivocal or no symptoms
  - Prognosis in asymptomatic AS
- Stress echocardiography
  - Low dose dobutamine echocardiography in AS with low gradient and LV dysfunction
- Multislice CT / Magnetic resonance imaging
  - In particular for imaging of thoracic aorta
- Cardiac catheterization (to evaluate valve function)
  - Only if non-invasive findings inconsistent or discordant with clinical assessment

Indications for Surgery in Aortic Regurgitation

Whatever the Severity of AR

	Class
Patients who have aortic root disease with maximal aortic diameter*:	
≥ 45 mm for patients with Marfan's syndrome	IC
≥ 50 mm for patients with bicuspid valves	IIaC
≥ 55 mm for other patients	IIaC

* Decision should also take into account the shape and thickness of ascending aorta as well as the shape of the other parts of aorta.
For patients who have an indication for surgery on the aortic valve, lower thresholds can be used for combining surgery on the ascending aorta.

2010 ACCF/AHA/AATS/ACR/ASA/SCA/SCAI/SIR/STS/SVM Guidelines for the Diagnosis and Management of Patients with Thoracic Aortic Disease

Developed in partnership with the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines, American Association for Thoracic Surgery, American College of Radiology, American Stroke Association, Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, Society of Interventional Radiology, Society of Thoracic Surgeons, and Society for Vascular Medicine.

Endorsed by the North American Society for Cardiovascular Imaging.

American Heart Association

Learn and Live

Critical Issues for Thoracic Aortic Diseases

Imaging of the thoracic aorta is the only method to detect thoracic aortic diseases and determine risk for future complications.

Radiologic imaging technologies have improved in terms of accuracy of detection of TAD. However, increased use of these technologies increases the potential risk associated with repeated radiation exposure, as well as contrast medium–related toxicity.

Imaging for asymptomatic patients at high risk based on history or associated diseases is expensive and not always covered by payers.

Recommendations for Aortic Imaging Techniques to Determine the Presence and Progression of TAD

Measurements of aortic diameter should be taken at **reproducible anatomic landmarks**, perpendicular to the axis of blood flow, and reported in a clear and consistent format (see table entitled “Essential Elements of Aortic Imaging Reports”).

For measurements taken by computed tomographic imaging or **magnetic resonance imaging**, the **external diameter** should be measured perpendicular to the axis of blood flow. **For aortic root measurements, the widest diameter, typically at the mid-sinus level, should be used.**

Essential Elements of Aortic Imaging Reports

The following table outlines specific qualitative and quantitative elements that are important to include in CT and MR reports

1.	The location at which the aorta is abnormal.
2.	The maximum diameter of any dilatation, measured from the external wall of the aorta, perpendicular to the axis of flow, and the length of the aorta that is abnormal.
3.	For patients with presumed or documented genetic syndromes at risk for aortic root disease measurements of aortic valve, sinuses of Valsalva, sinotubular junction, and ascending aorta.
4.	The presence of internal filling defects consistent with thrombus or atheroma.
5.	The presence of intramural hematoma (IMH), penetrating atherosclerotic ulcer (PAU), and calcification.
6.	Extension of aortic abnormality into branch vessels, including dissection and aneurysm, and secondary evidence of end-organ injury (eg, renal or bowel hypoperfusion).
7.	Evidence of aortic rupture, including periaortic and mediastinal hematoma, pericardial and pleural fluid, and contrast extravasation from the aortic lumen.
8.	When a prior examination is available, direct image to image comparison to determine if there has been any increase in diameter.

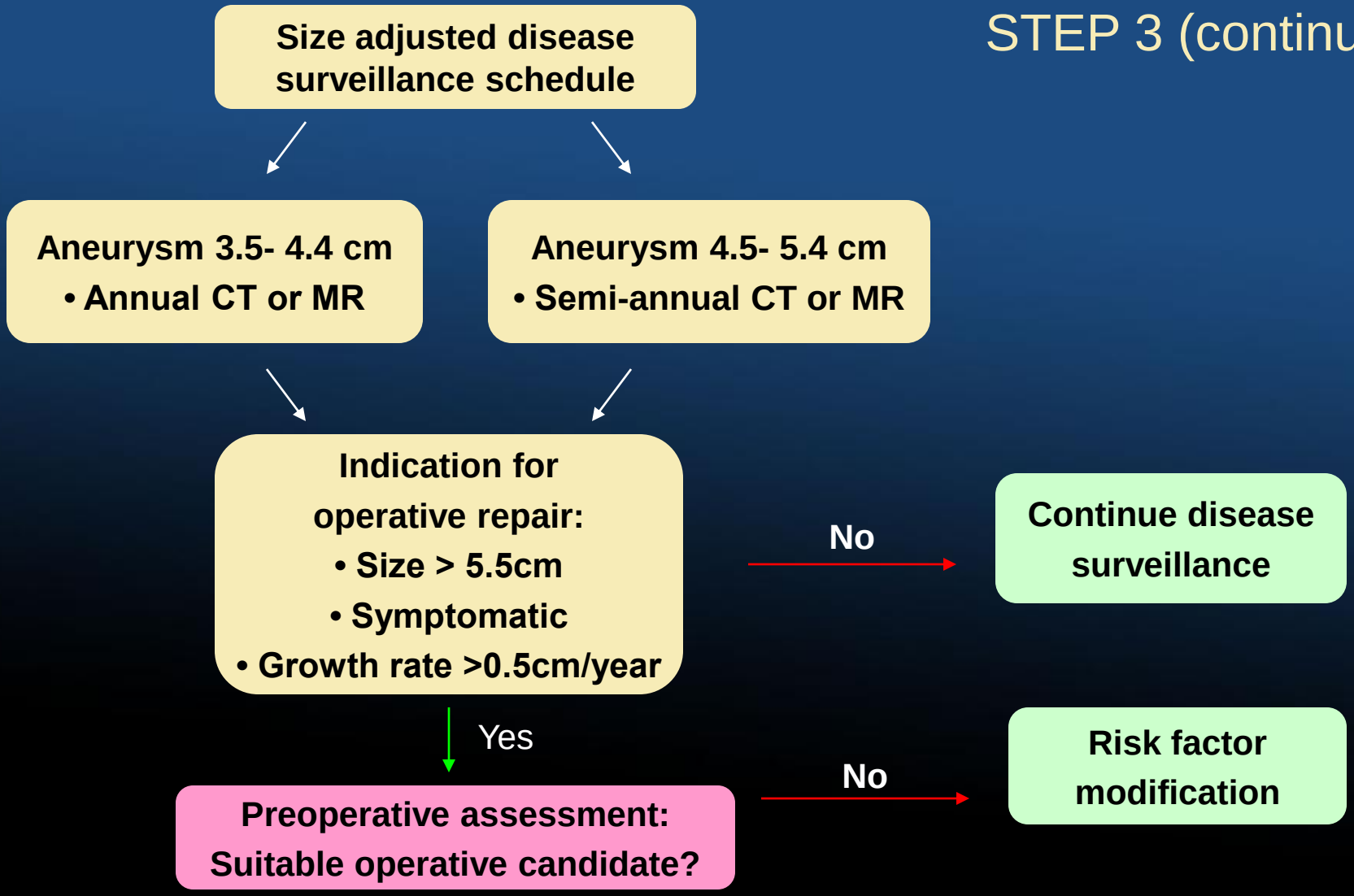
Recommendations for Asymptomatic Patients with Ascending Aortic Aneurysm

Patients with a growth rate of more than 0.5 cm/y in an aorta that is less than 5.5 cm in diameter should be considered for operation.

Patients undergoing aortic valve repair or replacement and who have an ascending aorta or aortic root of greater than 4.5 cm should be considered for concomitant repair of the aortic root or replacement of the ascending aorta.

Ascending Aortic Aneurysm of Degenerative Etiology

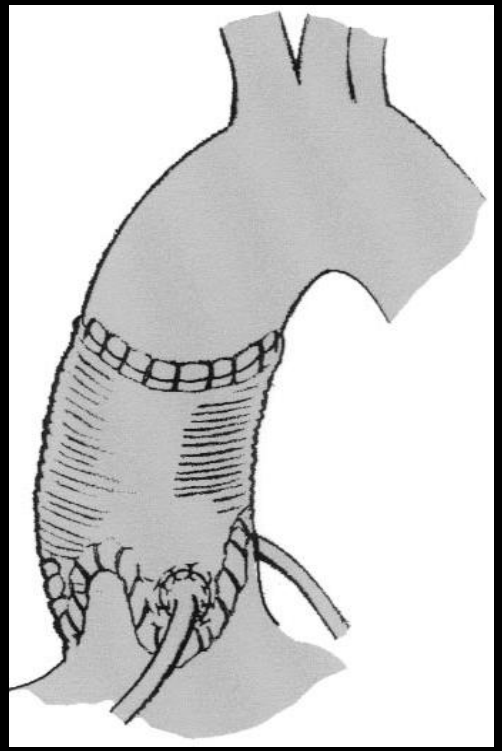
STEP 3 (continued)

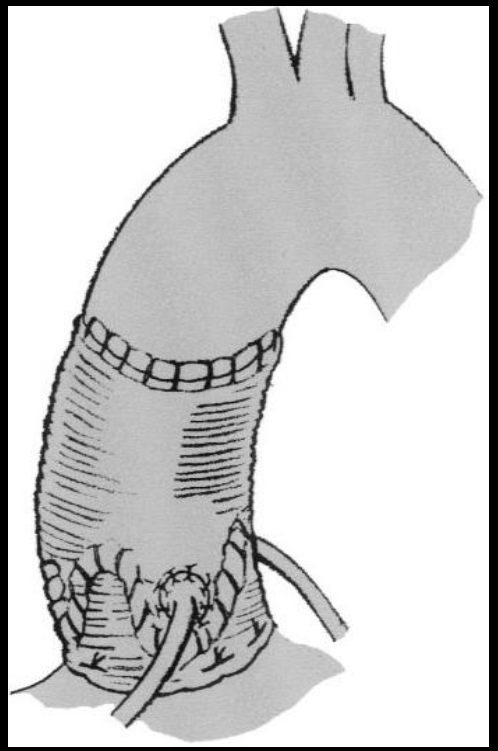


VALVE-PRESERVING REPLACEMENT OF THE ASCENDING AORTA: REMODELING VERSUS REIMPLANTATION

H.-J. Schäfers, MD, PhD[a]
R. Fries, MD[b]
F. Langer, MD[a]
N. Nikoloudakis, MD[a]
T. Graeter, MD[a]
U. Grundmann, MD[c]

Objective: Aortic valve regurgitation in combination with dilatation of the ascending aorta and root requires a combined procedure to restore valve function and eliminate pathologic dilatation of the proximal aorta. Two techniques have been proposed for this purpose; the aortic root may be either remodeled with an especially configured vascular graft or replaced with reimplantation of the aortic valve within the graft. We have used both techniques depending on the individual pathologic condition of the aortic root. *Methods:* Of 107 patients undergoing operation

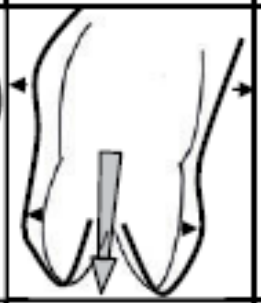
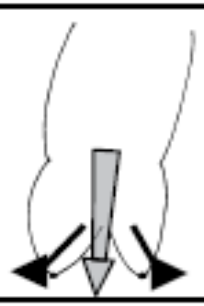
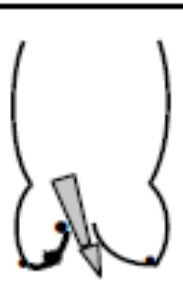




We have therefore chosen remodeling for root dilatation in the presence of normal aortoventricular junction and aggressive root replacement with valve reimplantation in root dilatation with a dilated aortoventricular junction including Marfan's syndrome.

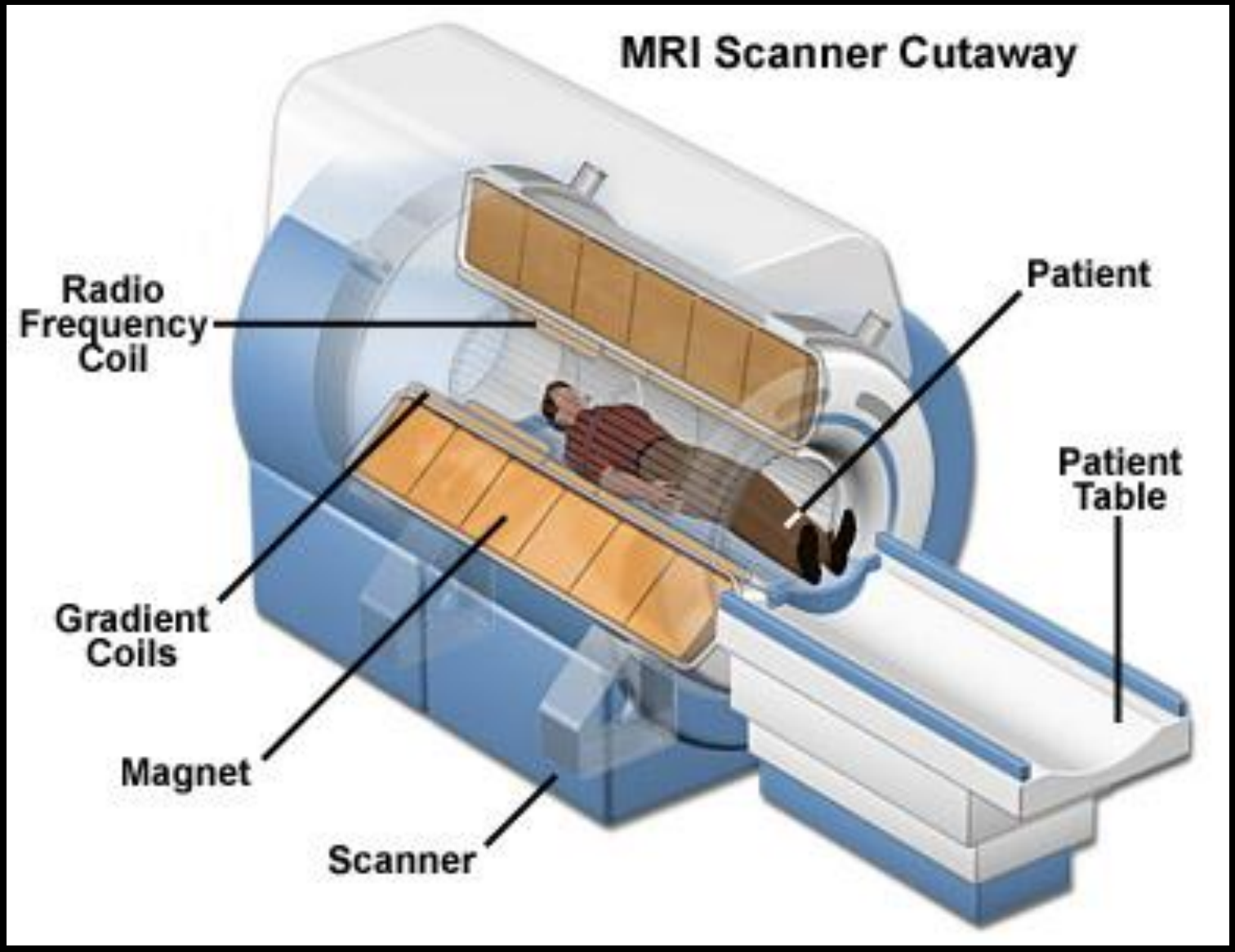
J Thorac Cardiovasc Surg 1998;116:990-996

Repair-oriented functional classification of aortic insufficiency

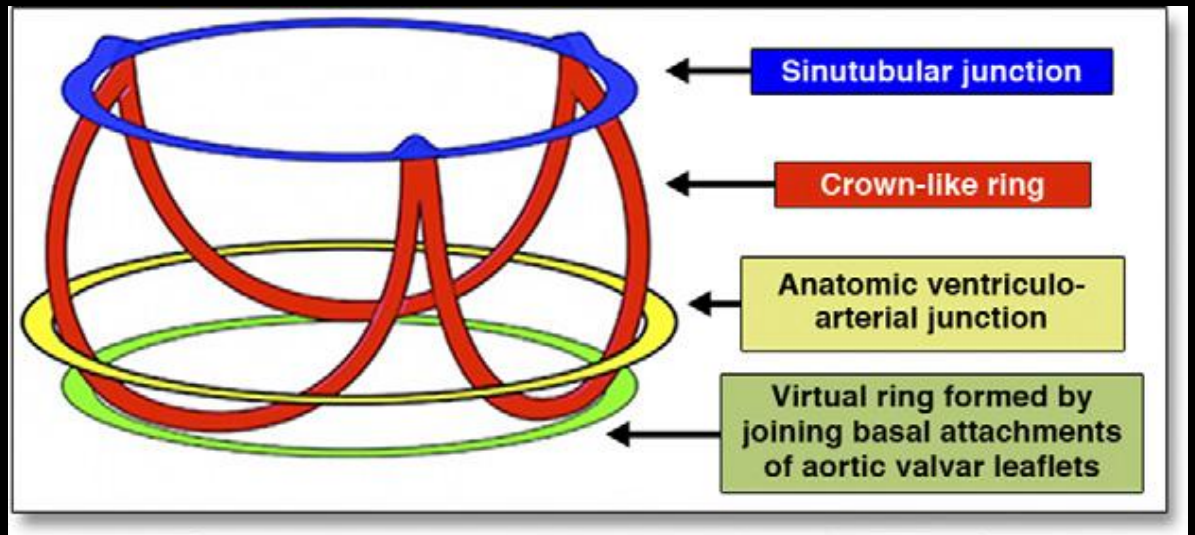
AI Class	Type I Normal cusp motion with FAA dilatation or cusp perforation				Type II Cusp Prolapse	Type III Cusp Restriction
	Ia	Ib	Ic	Id		
Mechanism						
Repair Techniques (Primary)	STJ remodeling *Ascending aortic graft*	Aortic Valve sparing: *Reimplantation or Remodeling with SCA*	SCA	Patch Repair *Autologous or bovine pericardium*	Prolapse Repair *Plication* *Triangular resection* *Free margin Resuspension* *Patch*	Leaflet Repair *Shaving* *Decalcificatio* *Patch*
(Secondary)	SCA		STJ Annuloplasty	SCA	SCA	SCA

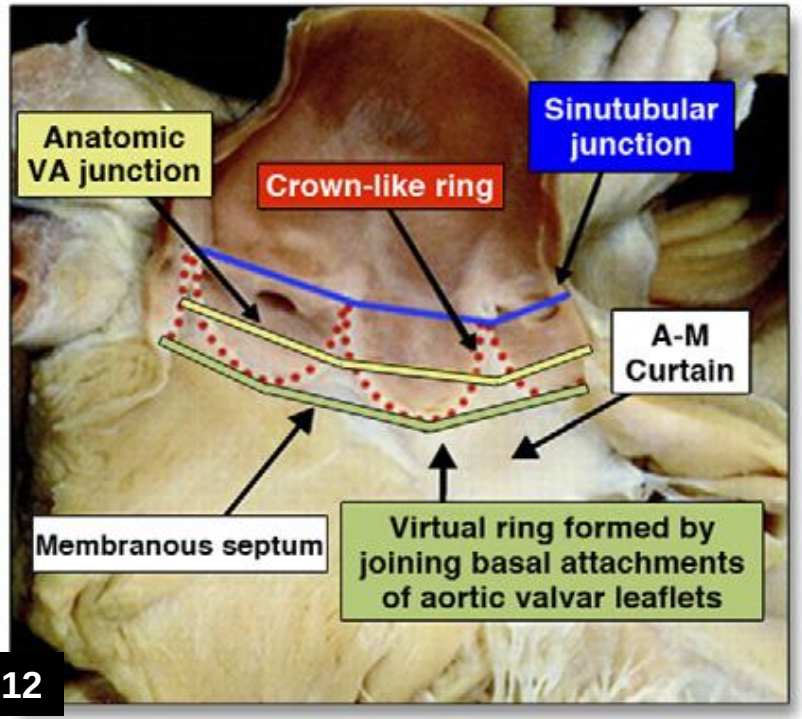
Boodhwani M et Al. J Thor Cardiovasc Surg 2009

Why CMR?

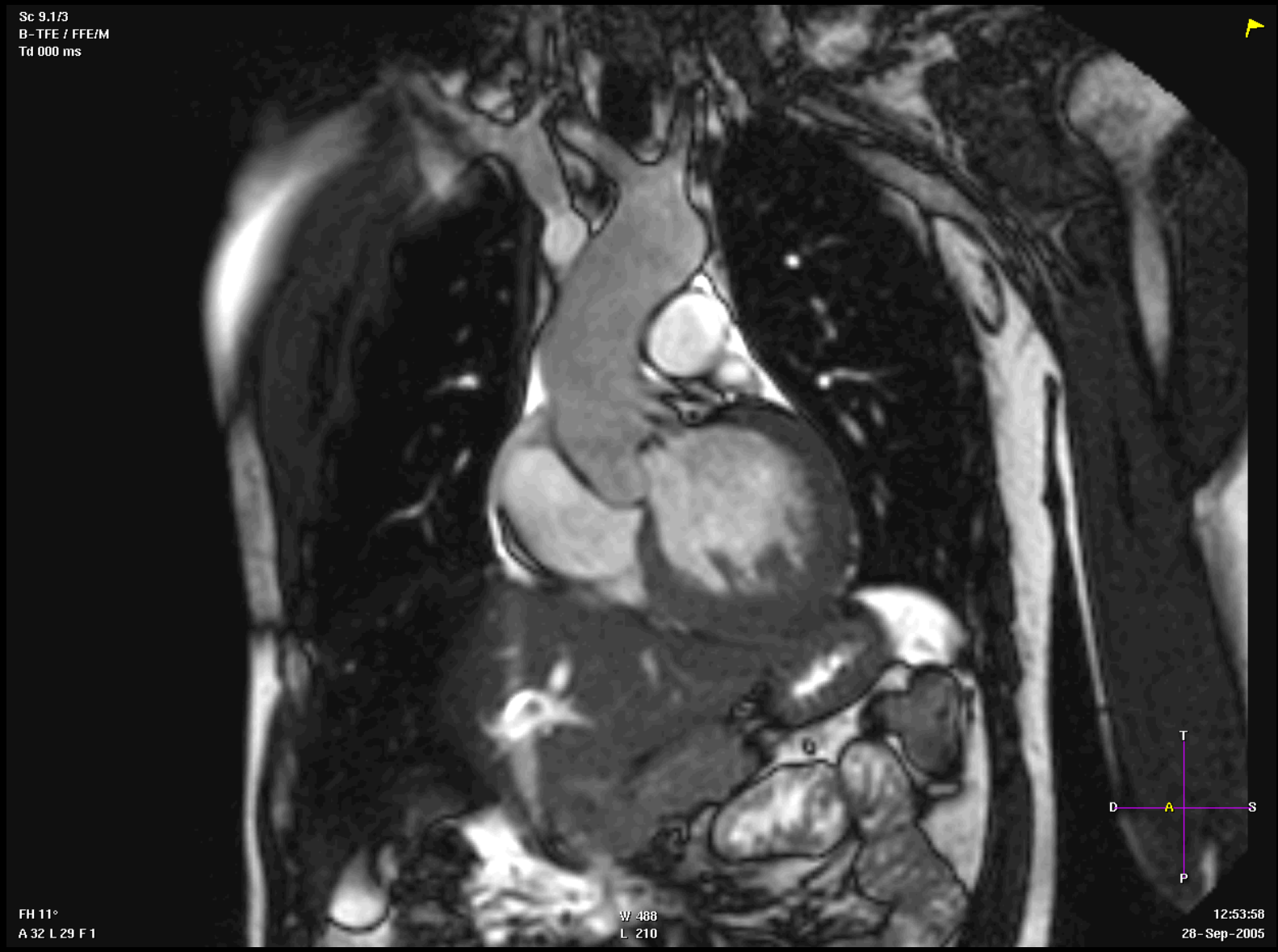

MRI Scanner Cutaway
Radio Frequency Coil
Patient
Patient Table
Gradient Coils
Magnet
Scanner

Aortic Root Anatomy





Bloomfield et Al. Jacc Imag 2012


Sc 9.1/3
B-TFE / FFE/M
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D
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A 32 L 29 F 1
W 488
L 210
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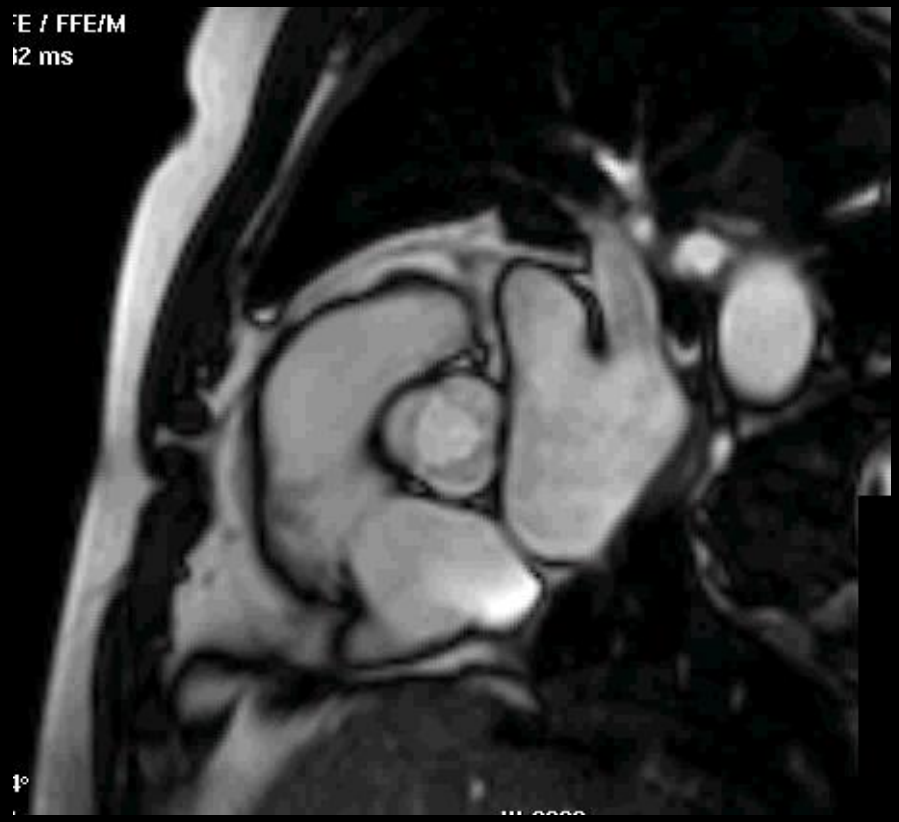
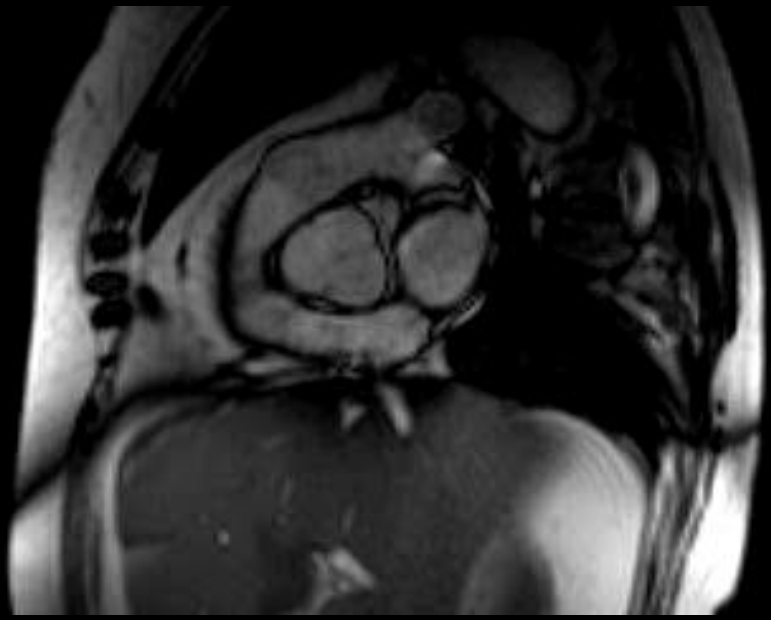
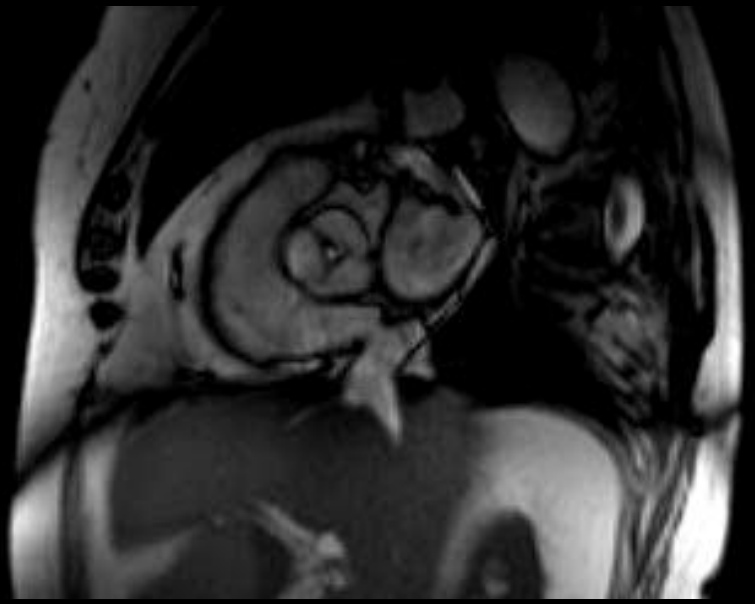
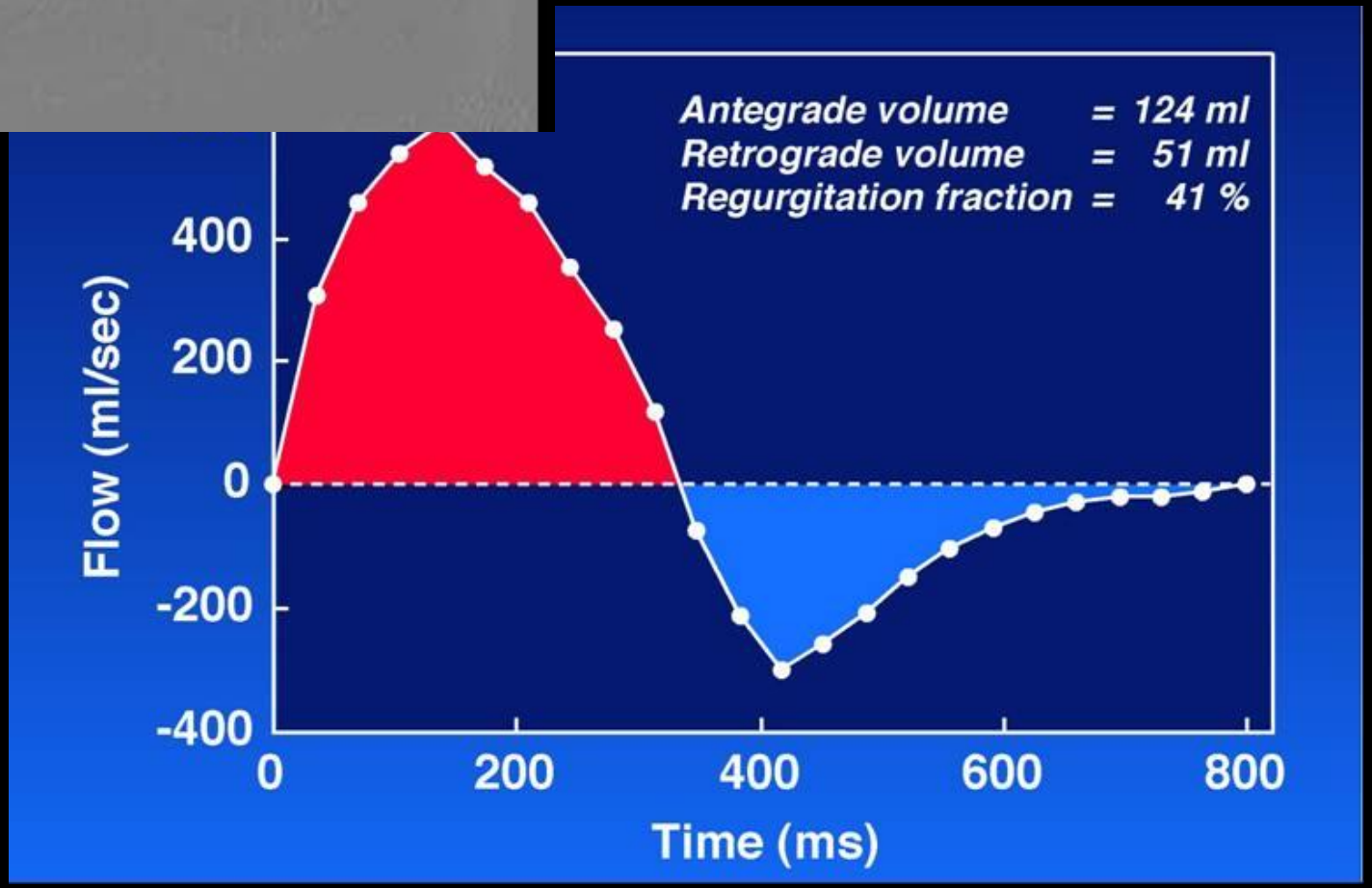
28-Sep-2005

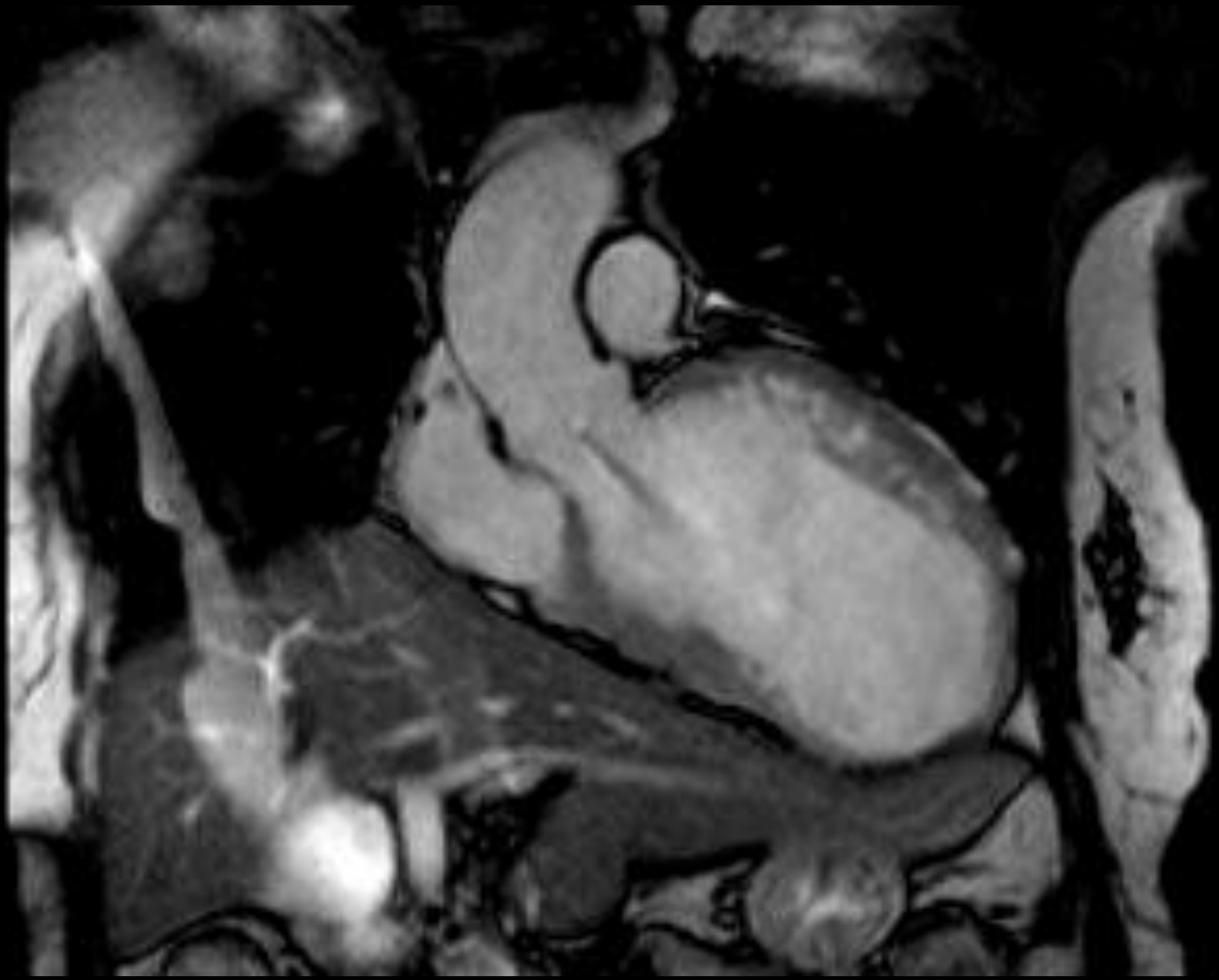

E / FFE/M
2 ms



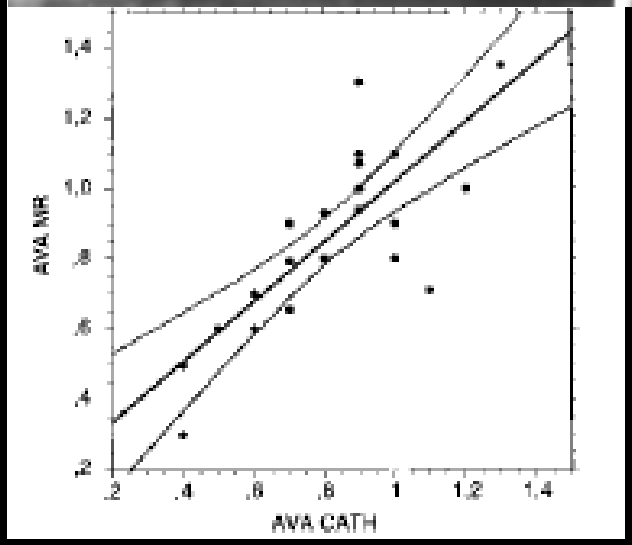


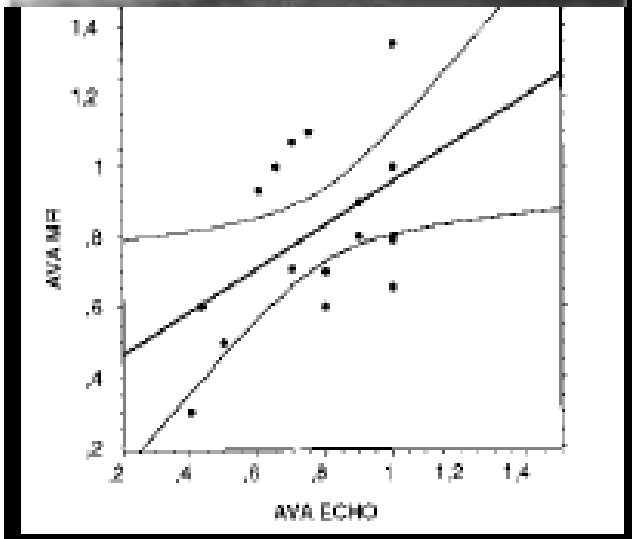
Velocity Encoding
PC velocity





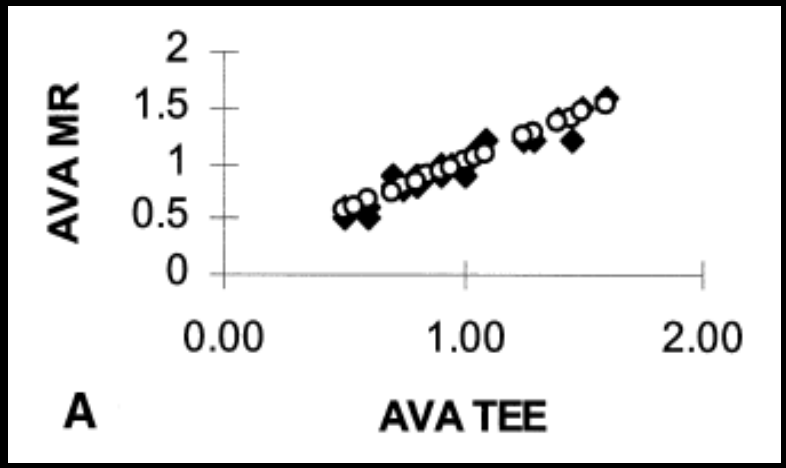
Aortic valve stenosis quantification

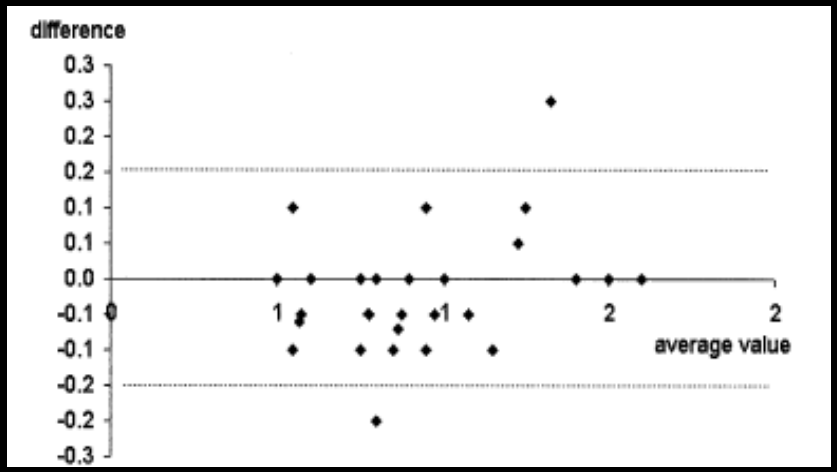




Friedrich et Al. Am Heart J 2002

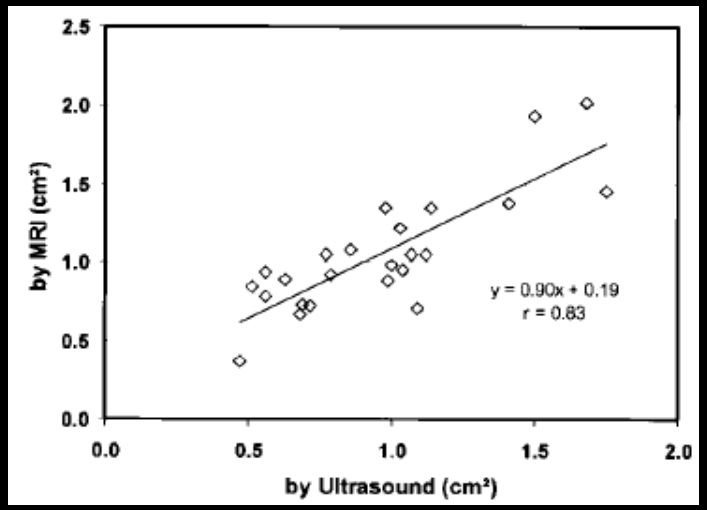
Aortic valve stenosis quantification

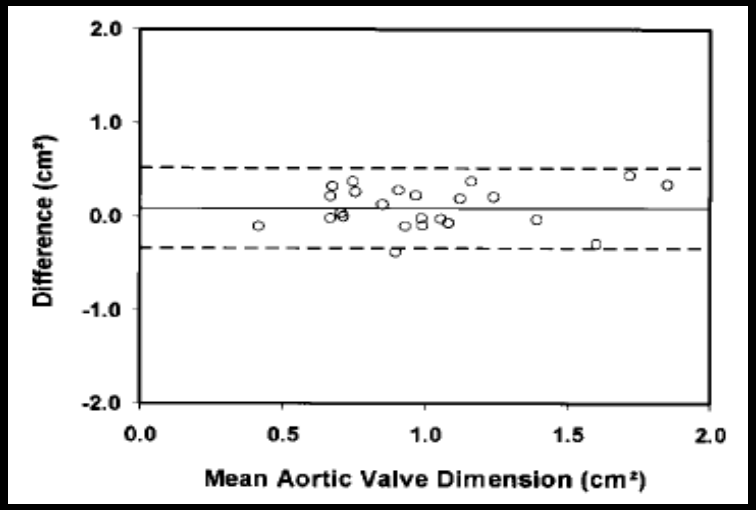




John AS et Al. JACC 2003

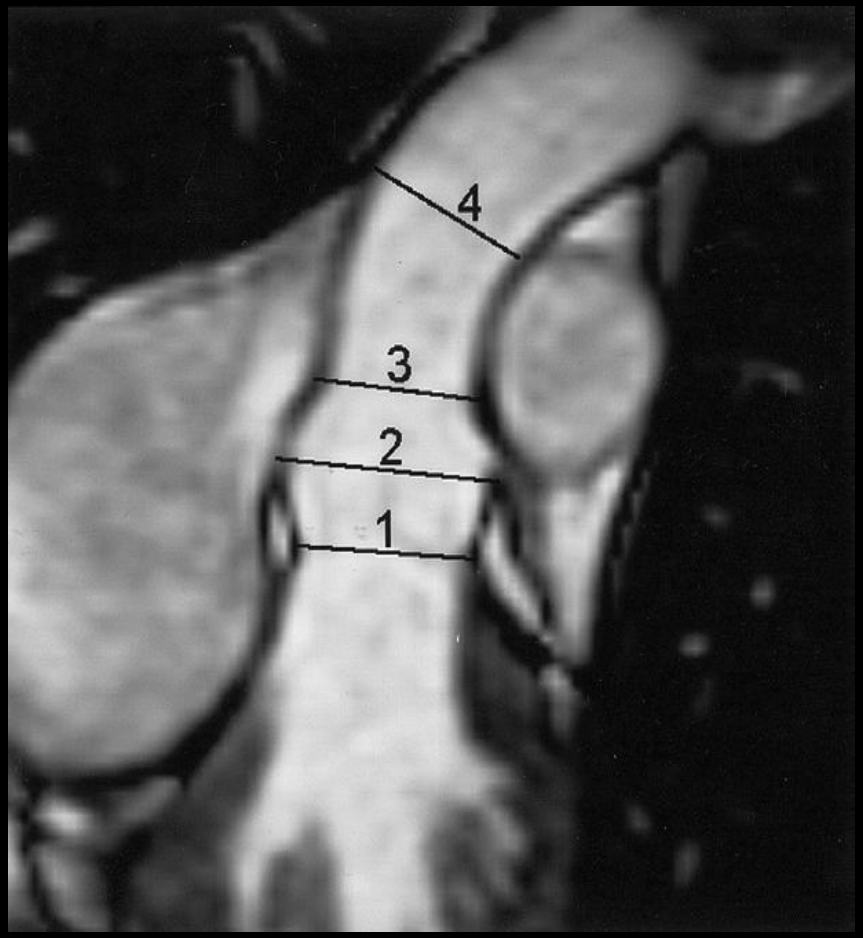
Aortic valve stenosis quantification

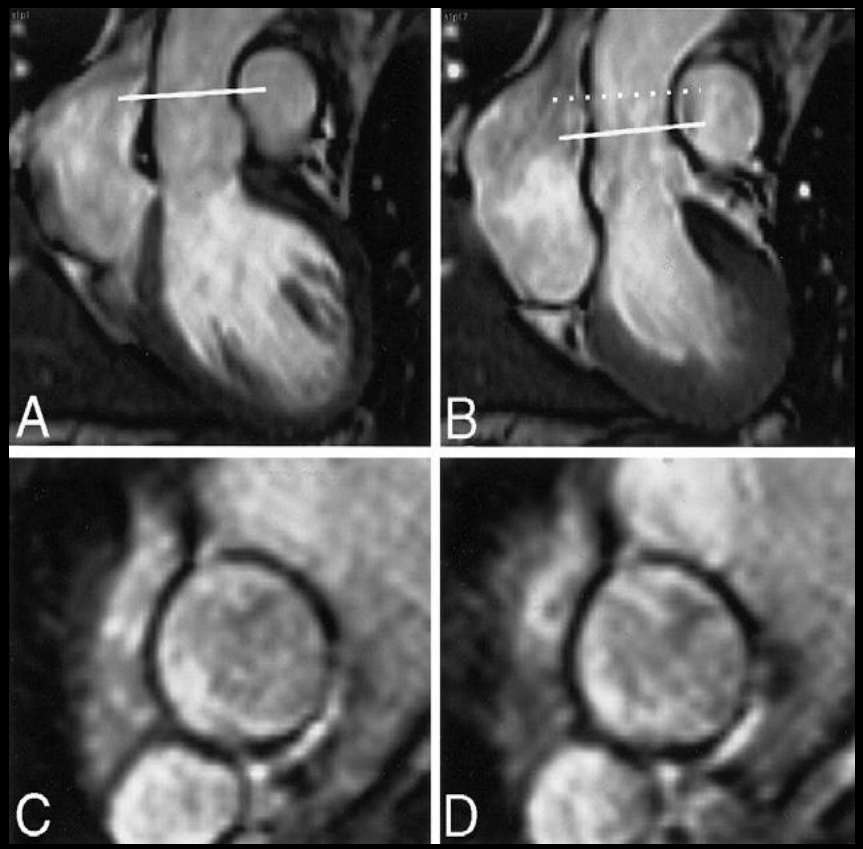




Carutherset *Al.* ***Circulation*****. 2003;108:2236-2243**

Elasticity evaluation of the aortic root components





Grotenhuis HB et Al. JACC 2007

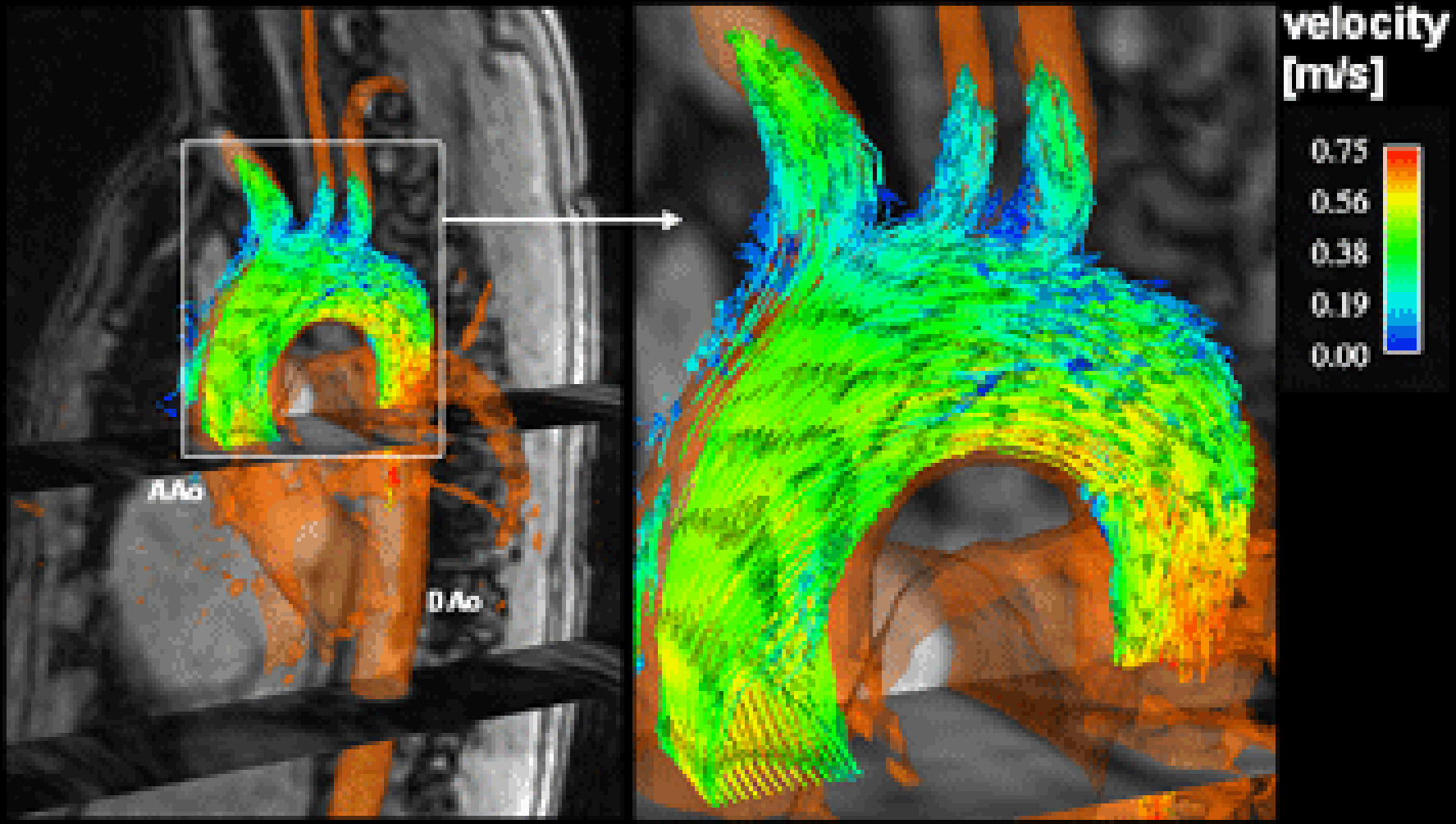
Elasticity of the aortic root in bicuspid valve disease

Results in 20 BAV Patients and 20 Age- and Gender-Matched Healthy Subjects

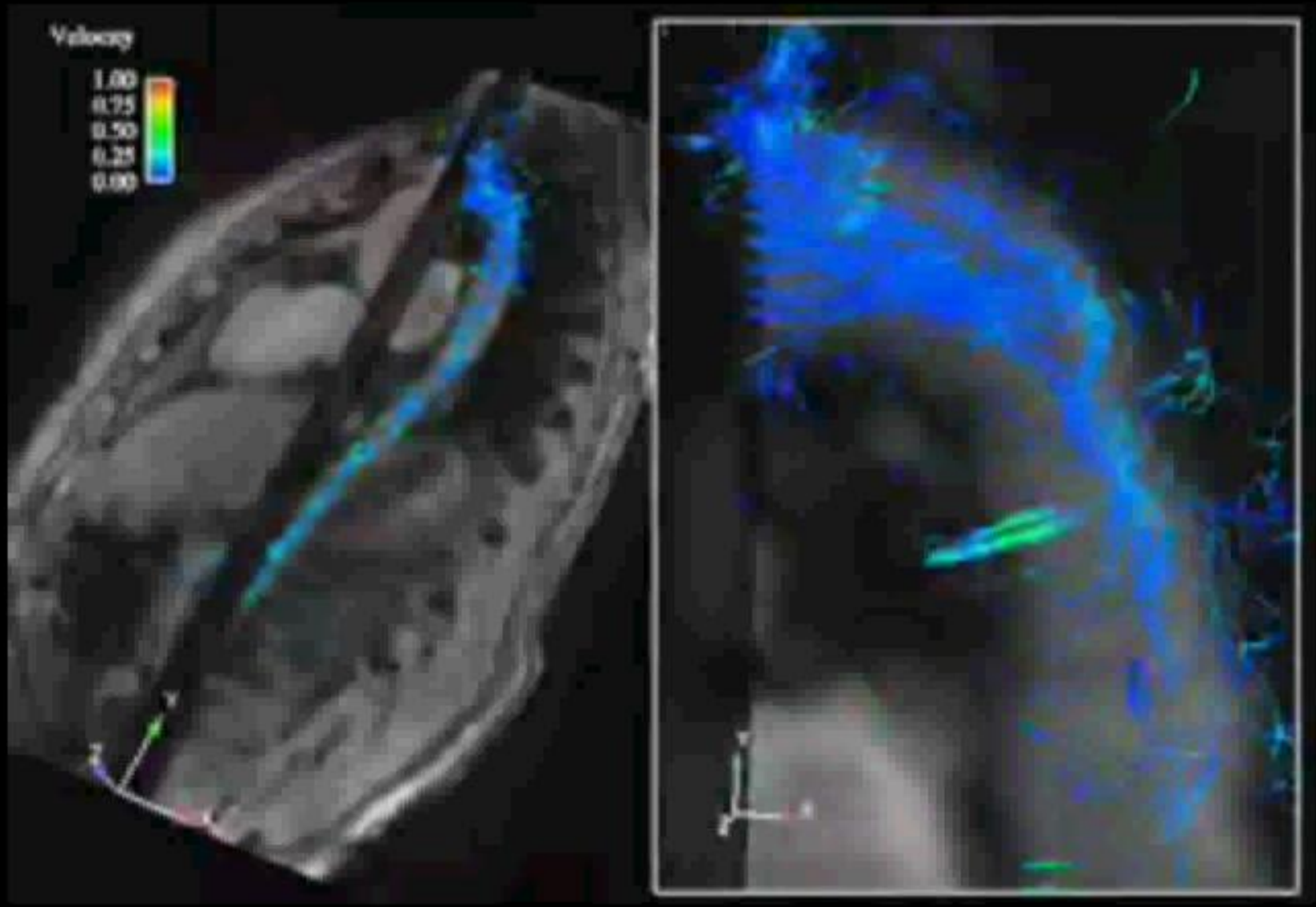
Parameters	Patients	Healthy Subjects	p Value	Mean Difference
Annulus diameter (mm)	30.1 ± 6.9	26.2 ± 3.3	0.03	3.9
Annulus area (cm^2)	7.4 ± 3.5	5.5 ± 1.4	0.03	1.9
Sinus of Valsalva diameter (mm)	33.4 ± 5.7	29.2 ± 3.2	<0.01	4.2
Sinus of Valsalva area (cm^2)	9.0 ± 3.4	6.8 ± 1.5	<0.01	2.2
Sinotubular junction diameter (mm)	30.4 ± 6.2	26.8 ± 3.4	0.04	3.6
STJ area (cm^2)	7.5 ± 3.5	5.7 ± 1.5	0.04	1.8
Ascending aorta diameter (mm)	30.0 ± 6.3	25.7 ± 3.1	<0.01	4.3
Ascending aorta area (cm^2)	7.4 ± 3.4	5.2 ± 1.3	<0.01	2.1
Distensibility (in 10^{-3} mm Hg^{-1})*	3.1 ± 1.2	5.6 ± 3.2	<0.01	
PWV aortic arch (m/s)	5.6	4.5	0.01	
PWV descending aorta (m/s)	5.2	4.3	0.03	
Aortic regurgitation fraction (%)	6 ± 8	1 ± 1	<0.01	
Peak-flow velocity at STJ (m/s)	1.68 ± 0.26	1.67 ± 0.33	0.97	
LV EF (%)	55 ± 8	56 ± 6	0.61	
LV EDV (ml/m^2)	101 ± 22	93 ± 16	0.29	
LV ESV (ml/m^2)	46 ± 17	41 ± 8	0.36	
LV mass (g/m^2)	54 ± 12	46 ± 12	0.04	

Grotenhuis HB et Al. JACC 2007

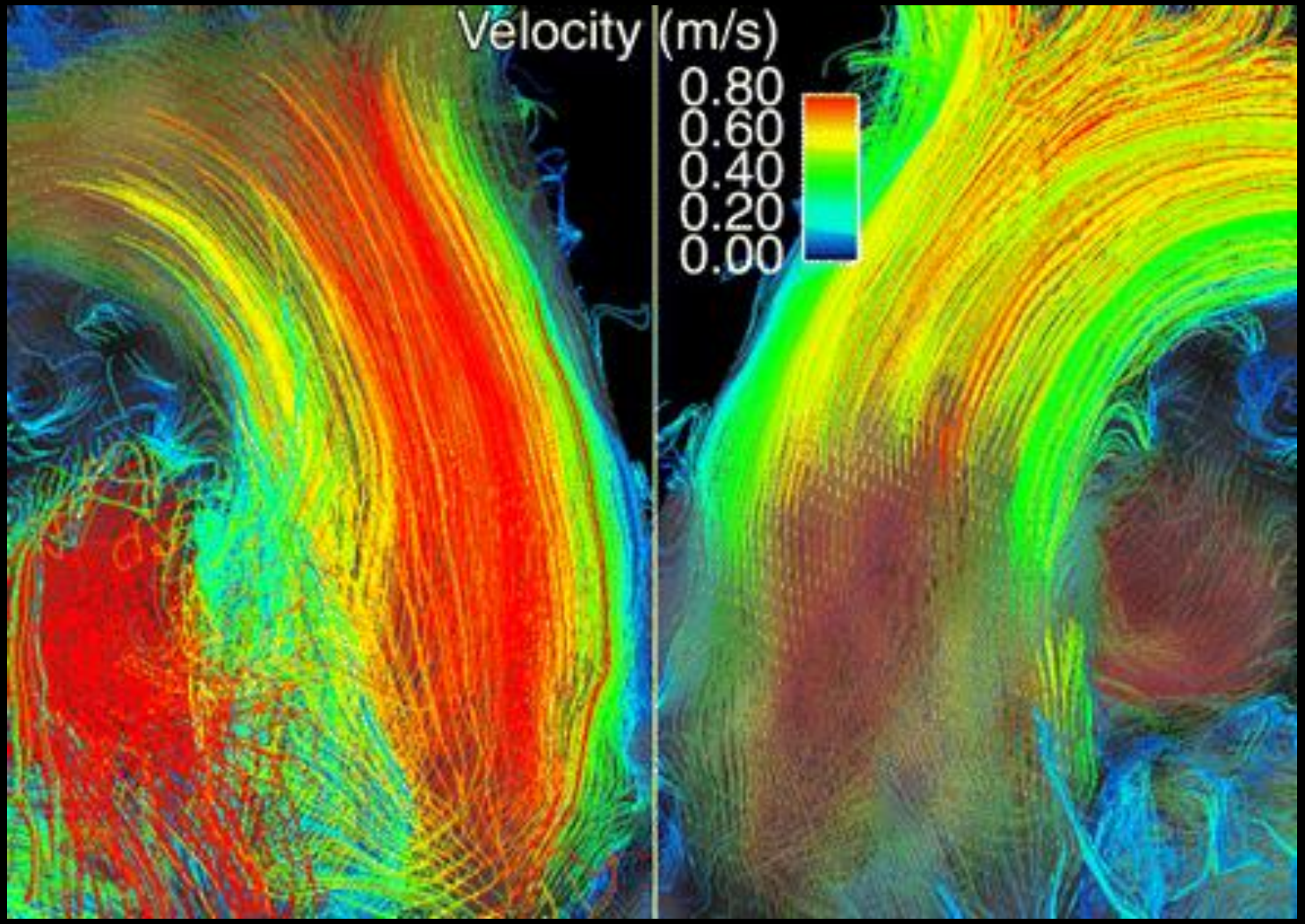
3D spatial encoding combined with flow sensitive MRI



Frydrykovich et al. Interact CardioVasc Thorac Surg 2006;5:340-342

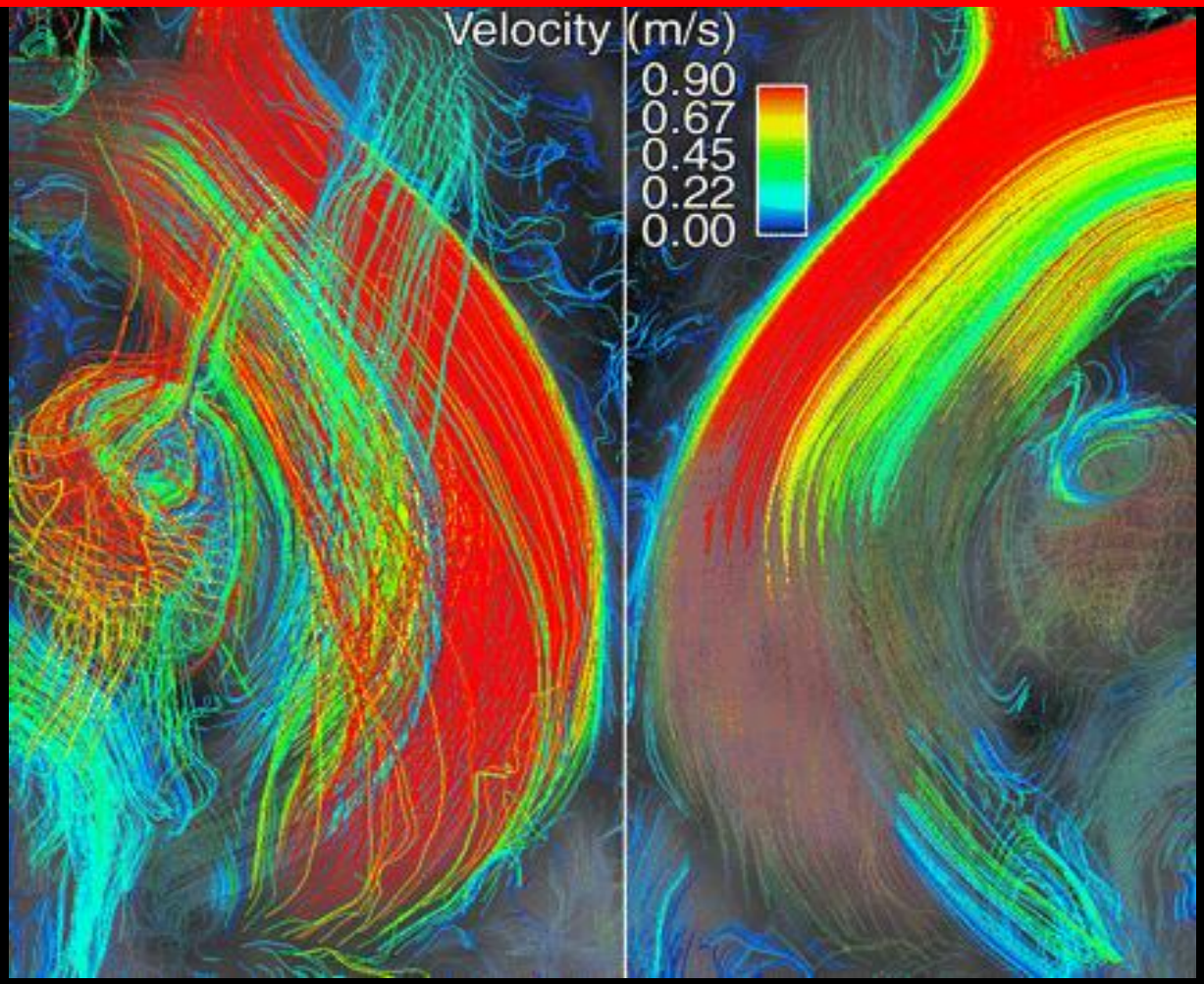

Velocity
1.00
0.75
0.50
0.25
0.00

Bicuspid Aortic Valve: Four-dimensional MR Evaluation of Ascending Aortic Systolic Flow Patterns



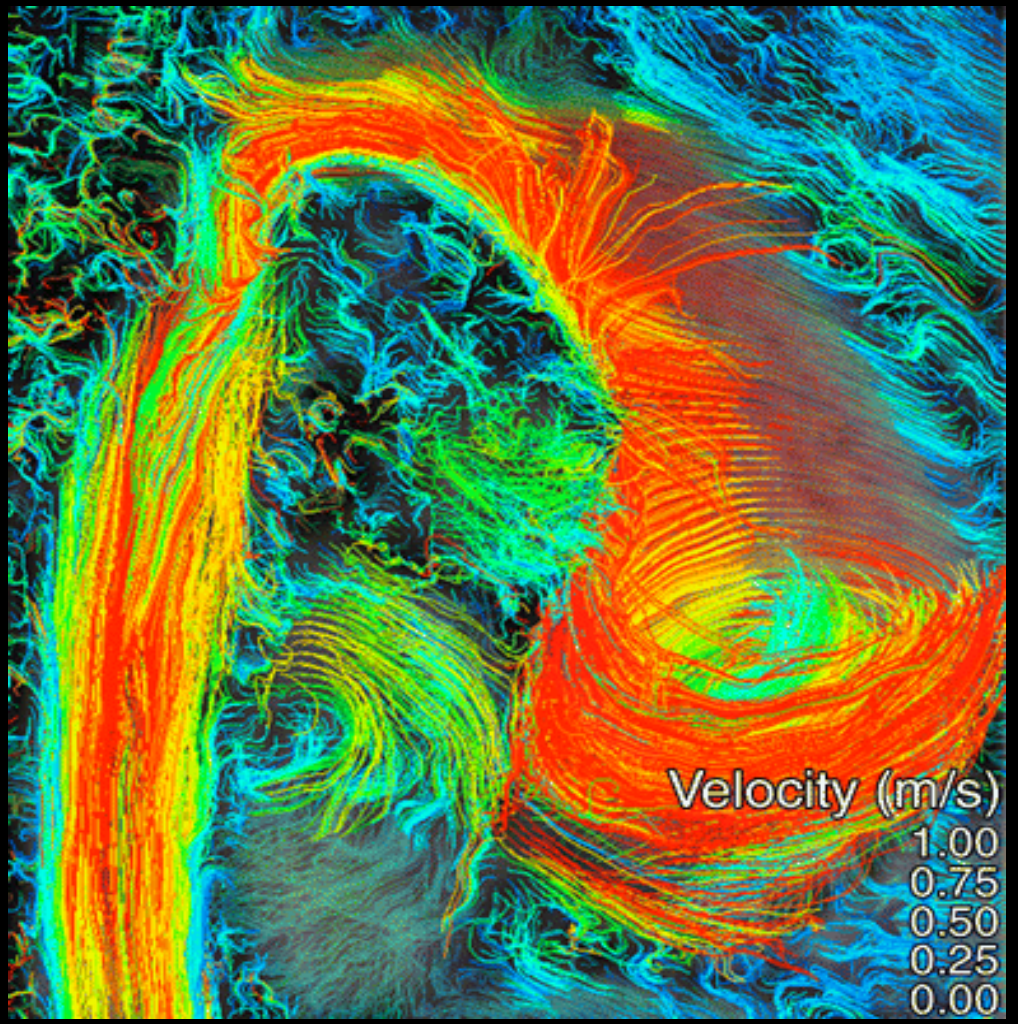
Hope et Al. Radiology 2010

Bicuspid Aortic Valve: Four-dimensional MR Evaluation of Ascending Aortic Systolic Flow Patterns

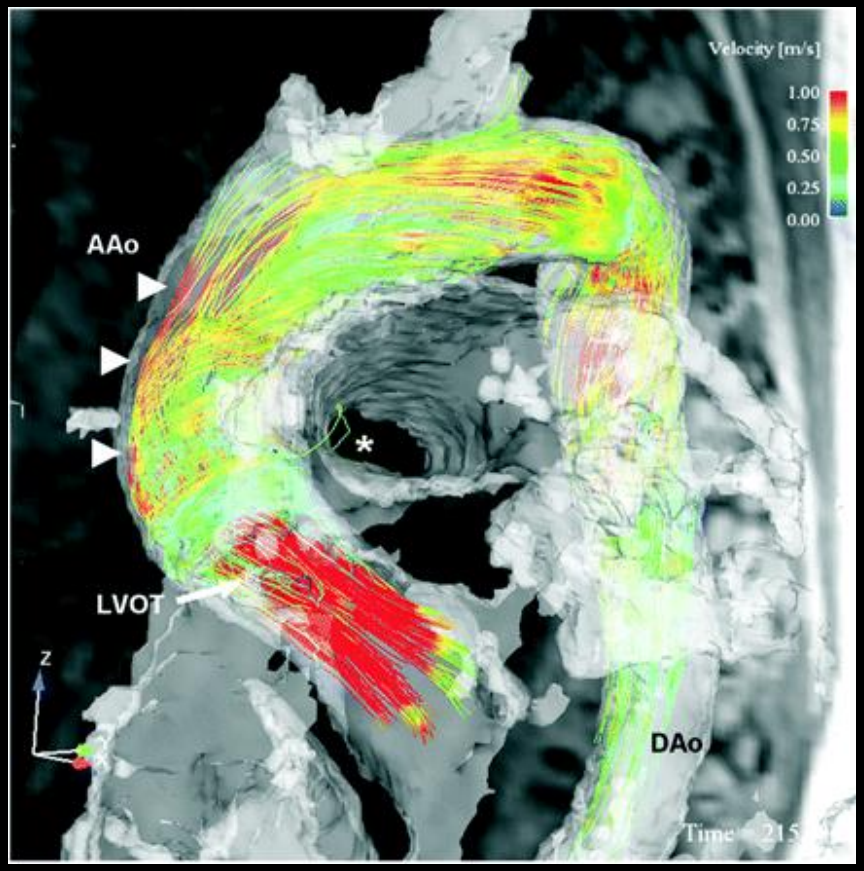


Hope et Al. Radiology 2010

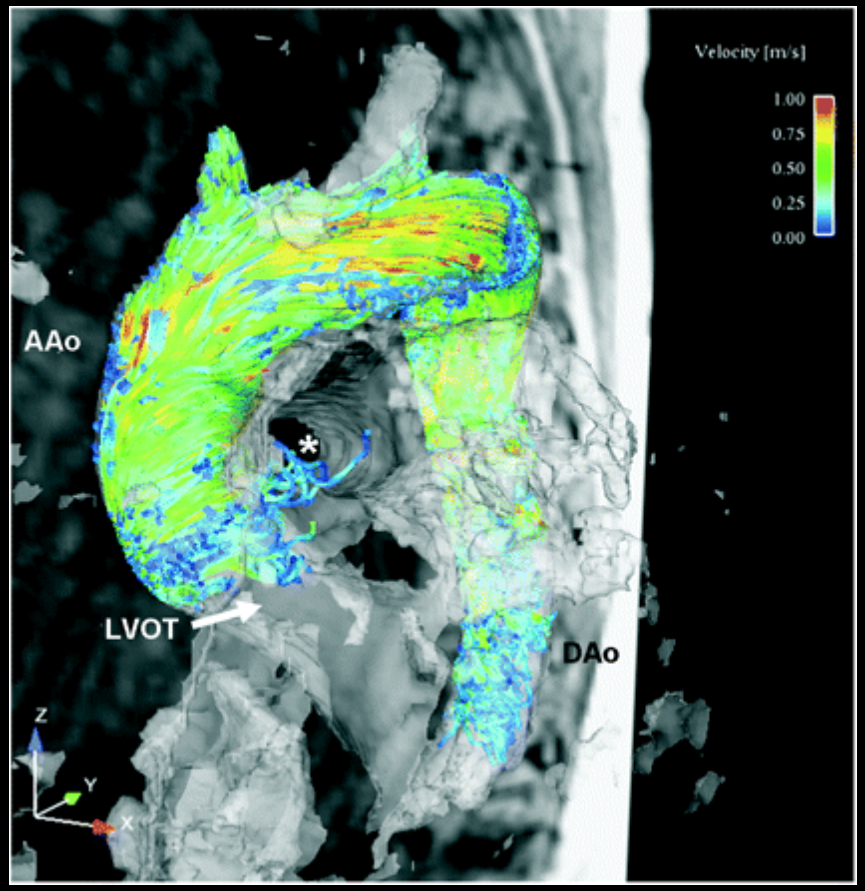
Bicuspid Aortic Valve: Four-dimensional MR Evaluation of Ascending Aortic Systolic Flow Patterns



Hope et Al. Radiology 2010



Normal volunteer
Peak Systole



Tiron David I procedure
Peak Systole

Frydrykovich et al. Interact CardioVasc Thorac Surg 2009

Journal of the American College of Cardiology
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Published by Elsevier Inc.

Vol. 58, No. 21, 2011
ISSN 0735-1097/$36.00
doi:10.1016/j.jacc.2011.09.010

FOCUS ISSUE: STRUCTURAL HEART DISEASE

Clinical Research

Multimodality Imaging in Transcatheter Aortic Valve Implantation and Post-Procedural Aortic Regurgitation

Comparison Among Cardiovascular Magnetic Resonance, Cardiac Computed Tomography, and Echocardiography

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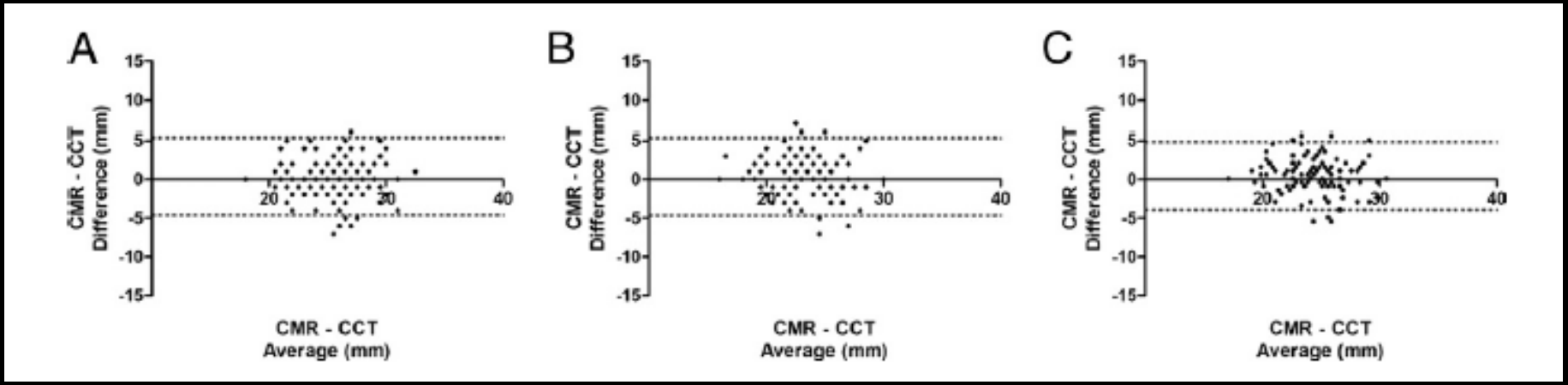
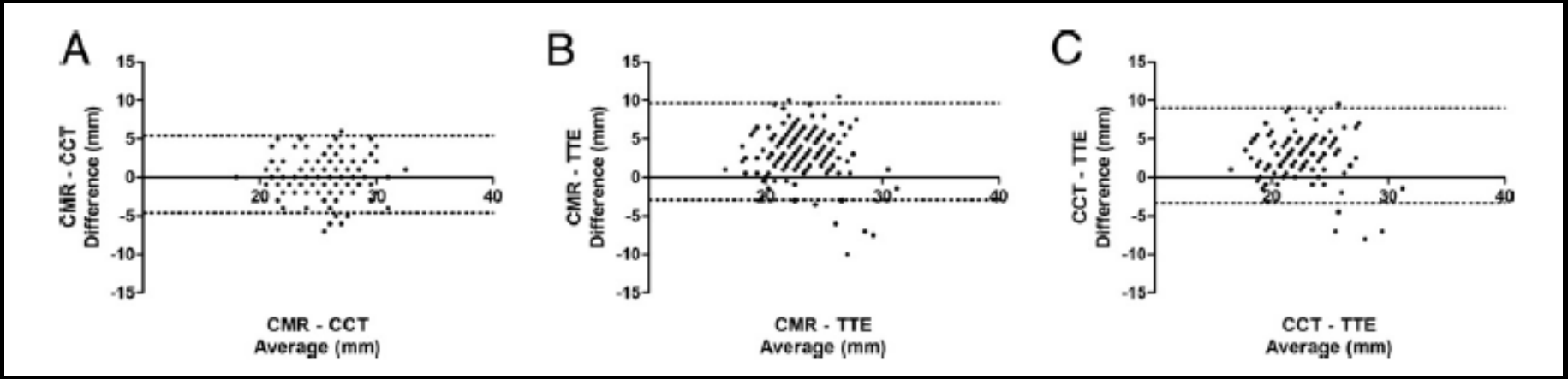
Ankur Gulati, MBBCh,*† Isabelle Roussin, MBBCh,*† Francisco Alpendurada, MD,*†
Bradley Park, MSc,* Francois Okoroafor,* Anita Asgar, MD,* Sarah Barker, MSc,* Simon Davies, MD,*
Sanjay K. Prasad, MD,*† Michael Rubens, MBBS,* Raad H. Mohiaddin, MD, PhD*†

London, United Kingdom

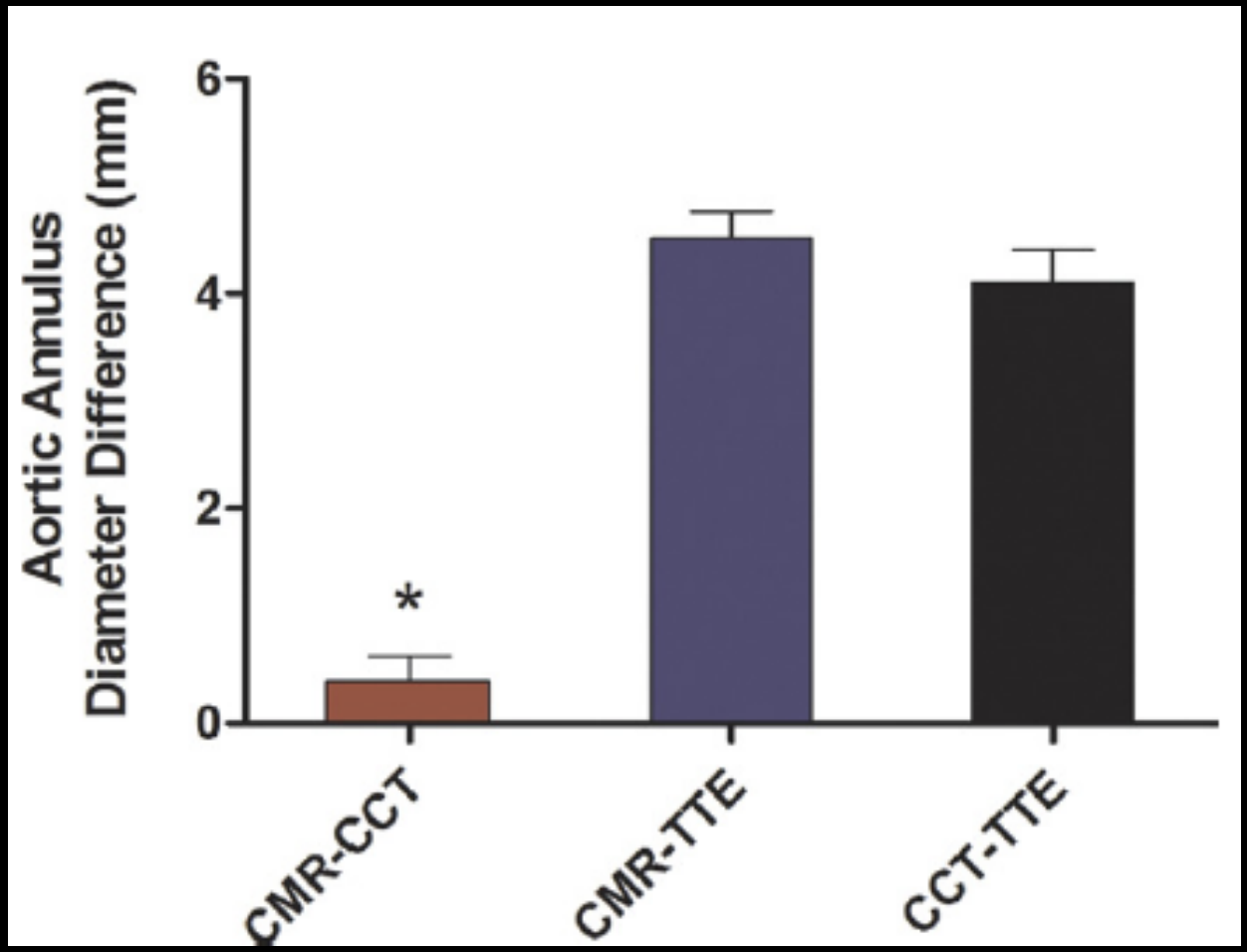
Bland-Altman Plots Comparing the Largest CMR-, CCT-, and TTE-Derived AV Annulus Measurements



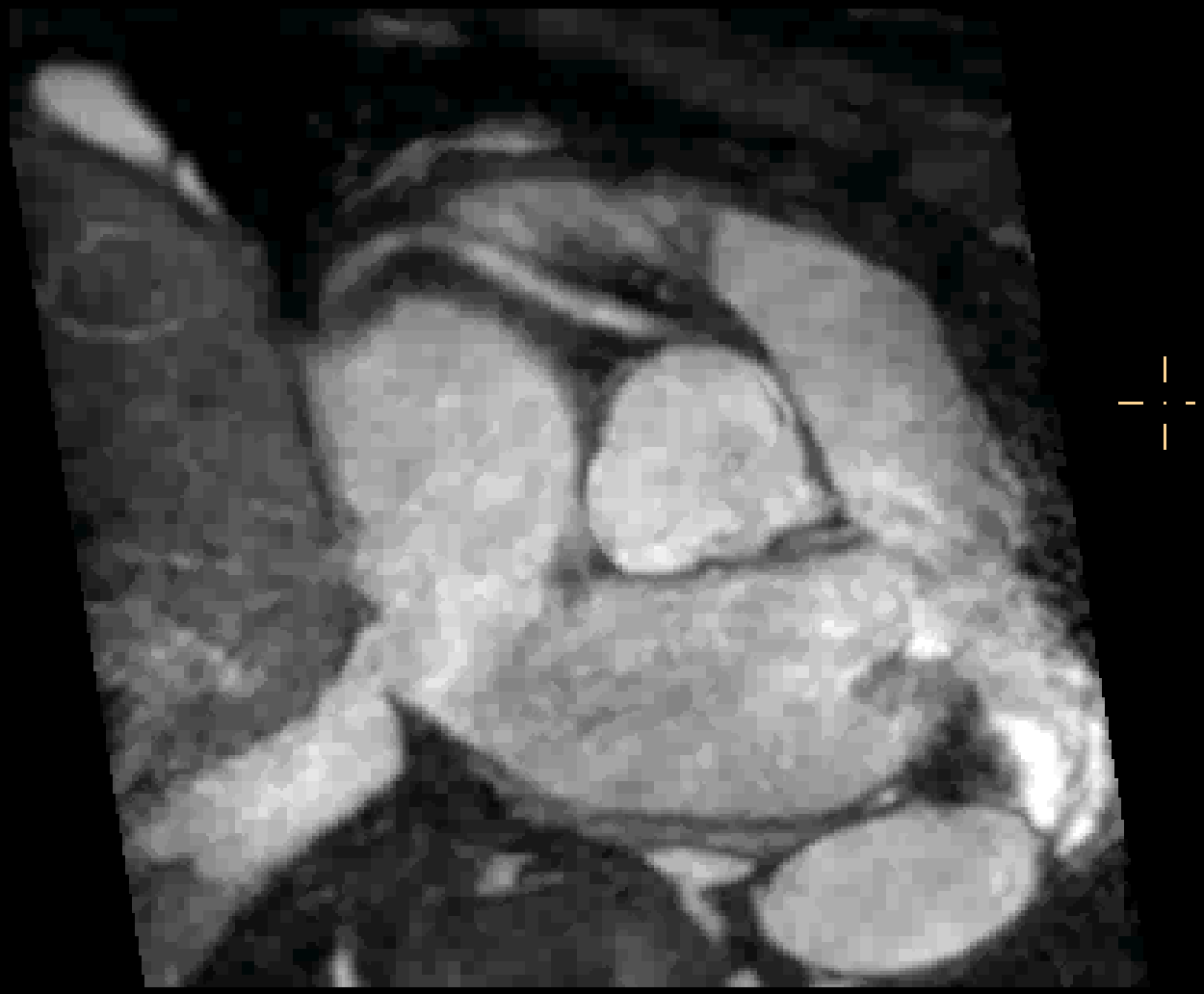


Jabbour et al. JACC 2011

Comparison of Bias Among Imaging Modalities



Jabbour et al. JACC 2011



Conclusions

- CMR is a powerful tool to evaluate patients with ascending aortic dilation
- It can precisely assess all the relevant aspects necessary to plan a correction
- Can provide further peculiar information that can be useful in selected cases