

# HOW SHOULD WE FOLLOW PATIENTS AFTER AORTIC ARCH INTERVENTIONS?

International Symposium on 3D Imaging for  
Interventional Catheterization in CHD (3DI3 Conference)

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The Congenital Heart Collaborative



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- ▶ None pertinent to this talk

# DISCLOSURES



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- ▶ European Society of Cardiology (ESC) Guidelines

# ESC Guidelines for the management of grown-up congenital heart disease (new version 2010)

The Task Force on the Management of Grown-up Congenital Heart Disease of the European Society of Cardiology (ESC)



European Heart Journal (2010) 31, 2915–2957  
doi:10.1093/eurheartj/ehq249

**ESC GUIDELINES**

## GUIDELINES



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► European Society of Cardiology (ESC) Guidelines

# Recommendations for cardiovascular magnetic resonance in adults with congenital heart disease from the respective working groups of the European Society of Cardiology

Philip J. Kilner<sup>1\*†</sup>, Tal Geva<sup>2</sup>, Harald Kaemmerer<sup>3‡</sup>, Pedro T. Trindade<sup>4‡</sup>, Juerg Schwitter<sup>5†</sup>, and Gary D. Webb<sup>6‡</sup>



European Heart Journal (2010) 31, 794–805  
doi:10.1093/eurheartj/ehp586

**SPECIAL ARTICLE**

## GUIDELINES



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## ▶ ACC/AHA 2008 Guidelines

**ACC/AHA 2008 Guidelines for the Management of Adults With Congenital Heart Disease: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Develop Guidelines on the Management of Adults With Congenital Heart Disease) Developed in Collaboration With the American Society of Echocardiography, Heart Rhythm Society, International Society for Adult Congenital Heart Disease, Society for Cardiovascular Angiography and Interventions, and Society of Thoracic Surgeons**

Carole A. Warnes, Roberta G. Williams, Thomas M. Bashore, John S. Child, Heidi M. Connolly, Joseph A. Dearani, Pedro del Nido, James W. Fasules, Thomas P. Graham, Jr, Ziyad M. Hijazi, Sharon A. Hunt, Mary Etta King, Michael J. Landzberg, Pamela D. Miner, Martha J. Radford, Edward P. Walsh, and Gary D. Webb

*J. Am. Coll. Cardiol.* 2008;52:e1-e121; originally published online Nov 7, 2008; doi:10.1016/j.jacc.2008.10.001

# GUIDELINES



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▶ CCISC Study

# Comparison of Surgical, Stent, and Balloon Angioplasty Treatment of Native Coarctation of the Aorta

An Observational Study by the CCISC  
(Congenital Cardiovascular Interventional Study Consortium)

Vol. 58, No. 25, 2011  
ISSN 0735-1097/\$36.00  
doi:10.1016/j.jacc.2011.08.053

## GUIDELINES



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CONGENITAL HEART DISEASE

# The adult with repaired coarctation of the aorta

Eric Krieger,<sup>1</sup> Karen Stout<sup>2</sup>

Heart 2010;96:1676e1681. doi:10.1136/hrt.2010.195065

## GUIDELINES



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- ▶ Current guidelines do not differentiate intervention from surgery
- ▶ No consensus statement about following COA post transcatheter therapy

# GUIDELINES



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- ▶ Hypertension
- ▶ Recurrent coarctation
- ▶ Aneurysms
- ▶ In-stent stenosis
- ▶ Endoleak

# WHAT ARE WE LOOKING FOR?



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- ▶ Prevalence 25-68% (median 32.5%)
- ▶ Risk factors
  - ▶ Older age at repair
  - ▶ Older age at time of follow-up
  - ▶ Recurrent coarctation??
  - ▶ Subclavian flap repair

# HYPERTENSION



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- ▶ Recommendations
  - ▶ ESC Guidelines
    - ▶ Follow-up at least every 2<sup>nd</sup> year
  - ▶ ACC/AHA Guidelines
    - ▶ Yearly follow-up with ACHD
  - ▶ Miscellaneous
    - ▶ Consider ambulatory BP screening
    - ▶ Consider exercise testing
      - ▶ Especially if considering low-moderate level dynamic sports or weight lifting
    - ▶ Lipid and CAD screening

# HYPERTENSION



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- ▶ Recurrent anatomic aortic narrowing associated with P-P gradient of  $\geq 20$  mmHg
- ▶ Prevalence
  - ▶ Surgical
    - ▶ Neonatal repair: 2.4-5.5%
    - ▶ Older age at repair: <1%
    - ▶ ~12% re-obstruction in CCISC study
  - ▶ Balloon Angioplasty Prevalence 32 (7-36)%
  - ▶ Stent Prevalence 1.8% in CCISC study

## RECURRENT COARCTATION



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## ▶ Recommendations

### ▶ ESC

- ▶ BP screening at least every 2<sup>nd</sup> year
- ▶ Cross sectional imaging with intervals determined by baseline pathology

### ▶ ACC/AHA

- ▶ BP screening annually
- ▶ Cross sectional imaging every 5 years or less

### ▶ Miscellaneous

- ▶ Echo especially if associated cardiac anomalies
  - ▶ Continuous anterograde diastolic flow in the abdominal aorta
  - ▶ Notable flow acceleration through CoA site
  - ▶ Narrowing seen on color Doppler mapping
- ▶ Four limb supine blood pressure measurements

# RECURRENT COARCTATION



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## ▶ Aneurysm

- ▶ Surgical prevalence 9-20%
  - ▶ Prevalence of 12.5% in CCISC study
    - ▶ Dacron patch aortoplasty
    - ▶ Transverse arch hypoplasia
- ▶ Balloon Angioplasty ~7% (43% in CCISC study)
- ▶ Stenting ~5% in CCISC study (up to 17% in earlier studies)
  - ▶ Risk factors: balloon:coarctation ratio of >4 and performance of pre-stent BA

# ANEURYSM



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From: Comparison of Surgical, Stent, and Balloon Angioplasty Treatment of Native Coarctation of the Aorta: An Observational Study by the CCISC (Congenital Cardiovascular Interventional Study Consortium)

J Am Coll Cardiol. 2011;58(25):2664-2674. doi:10.1016/j.jacc.2011.08.053

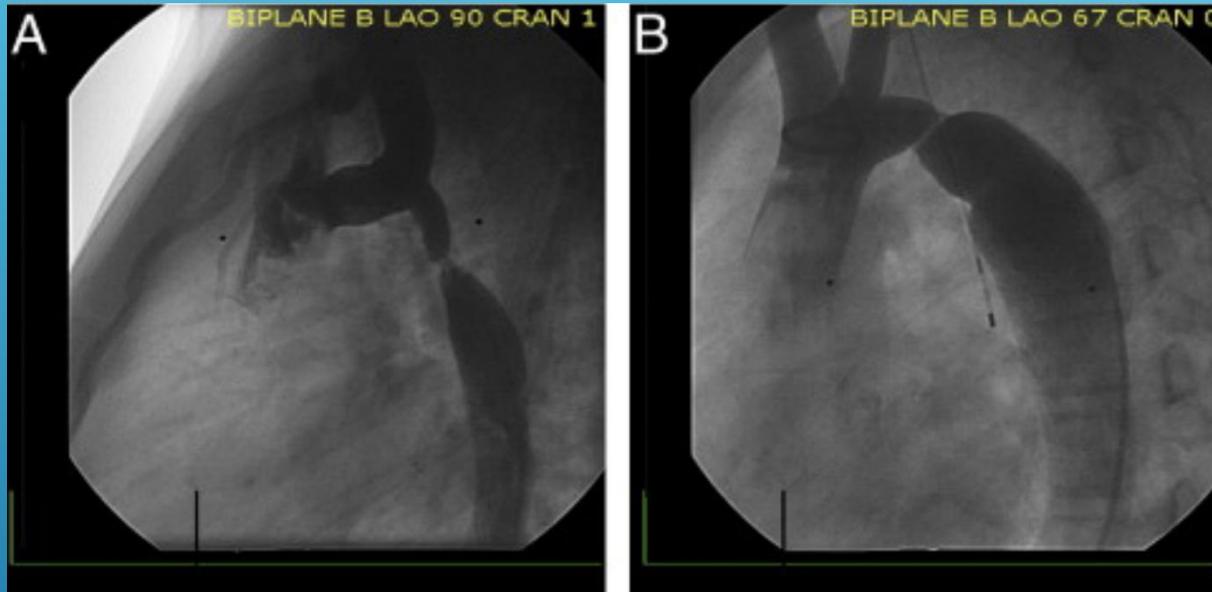


Figure Legend:

Pre-Surgical Native Coarctation of the Aorta and Post-Surgical Aneurysm

(A) Pre-surgical coarctation segment in a 3-year-old child is shown. Severe discrete coarctation with isthmus hypoplasia is observed. Numerous intercostal collaterals are present, with no post-stenotic dilation of the descending aorta observed. (B) Angiogram shows aneurysm formation 3.5 years out from the surgery, with the repair site measuring 2.7 cm, and the aorta at the level of the diaphragm measuring 1.8 cm. There was recoarctation at the distal transverse aorta, which was subsequently stented at this catheterization.





MRA image in a patient that has developed a fusiform aneurysm at the site of surgical repair of coarctation (arrow).

MRI in adult patients with aortic coarctation: diagnosis and follow-up  
Shepherd, B., Clinical Radiology, Volume 70, Issue 4, 433-445

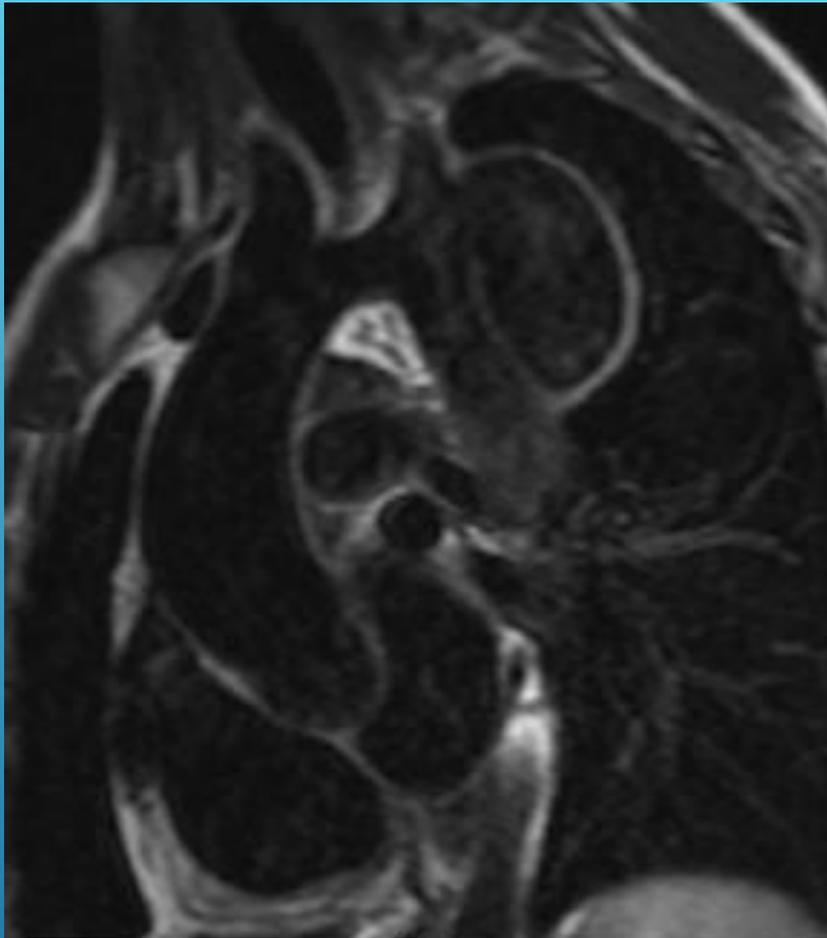
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(a)



(b)

Black blood image (a) and MR A (b) in a patient with a large false aneurysm at the site of coarctation repair (arrow).

MRI in adult patients with aortic coarctation: diagnosis and follow-up  
Shepherd, B., Clinical Radiology, Volume 70, Issue 4, 433-445

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## ▶ Recommendations

### ▶ ESC

- ▶ Cross sectional imaging with intervals determined by baseline pathology
- ▶ **Patch repairs (e.g. Dacron) should be imaged on a regular basis**

### ▶ ACC/AHA

- ▶ Cross sectional imaging every 5 years or less

### ▶ Miscellaneous

- ▶ Contrast-enhanced aortic CT scan at 3–6 months or earlier if there is any significant procedural complication
- ▶ If platinum stent, consider MRI with Multiplanar spin echo or 'black blood' imaging

# ANEURYSM



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- ▶ Secondary to neointimal proliferation and stent fracture
- ▶ Prevalence of 11% (Forbes et al. CCI 2007)
- ▶ Prevalence of 10.4% in CCISC study
  - ▶ Neointimal proliferation in 6 patients
  - ▶ Stent fracture (Genesis XD) in 2 patients

## IN-STENT STENOSIS



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## ▶ Recommendations

### ▶ ESC

- ▶ Cross sectional imaging with intervals determined by baseline pathology

### ▶ ACC/AHA

- ▶ Cross sectional imaging every 5 years or less

### ▶ Miscellaneous

- ▶ CT better for detecting in-stent stenosis
- ▶ MRI showing increase in flow velocity distal to the stent as determined by phase contrast imaging is suggestive

# IN-STENT STENOSIS



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- ▶ TEVAR used more frequently, especially ACHD population with calcified aorta
- ▶ Self-expanding ePTFE nitinol framed endografts
- ▶ Gore TAG, Medtronic Talent, and Cook Zenith TX2 currently available
- ▶ Type I Endoleak prevalence of ~10% in patients with TAA.

# ENDOLEAK



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- ▶ Recommendations
  - ▶ Early CT or MRI imaging is recommended
  - ▶ MRI useful for nitinol stents
  - ▶ MRI somewhat limited with elgiloy (alloy of cobalt, chromium, and nickel)

# ENDOLEAK



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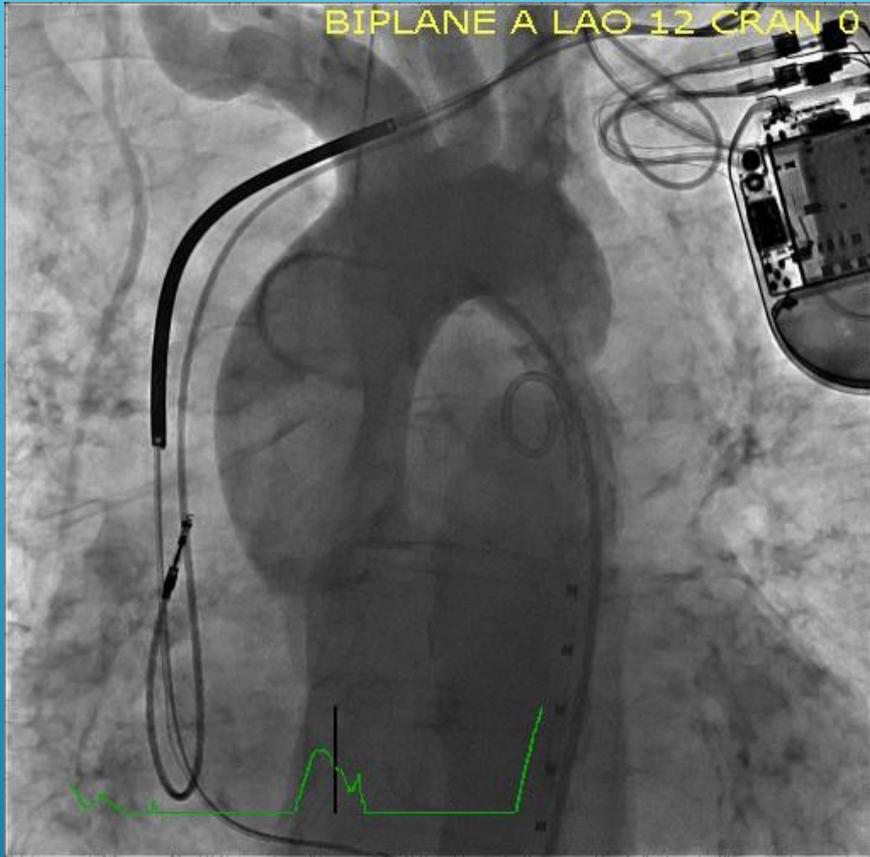


## The Congenital Heart Collaborative

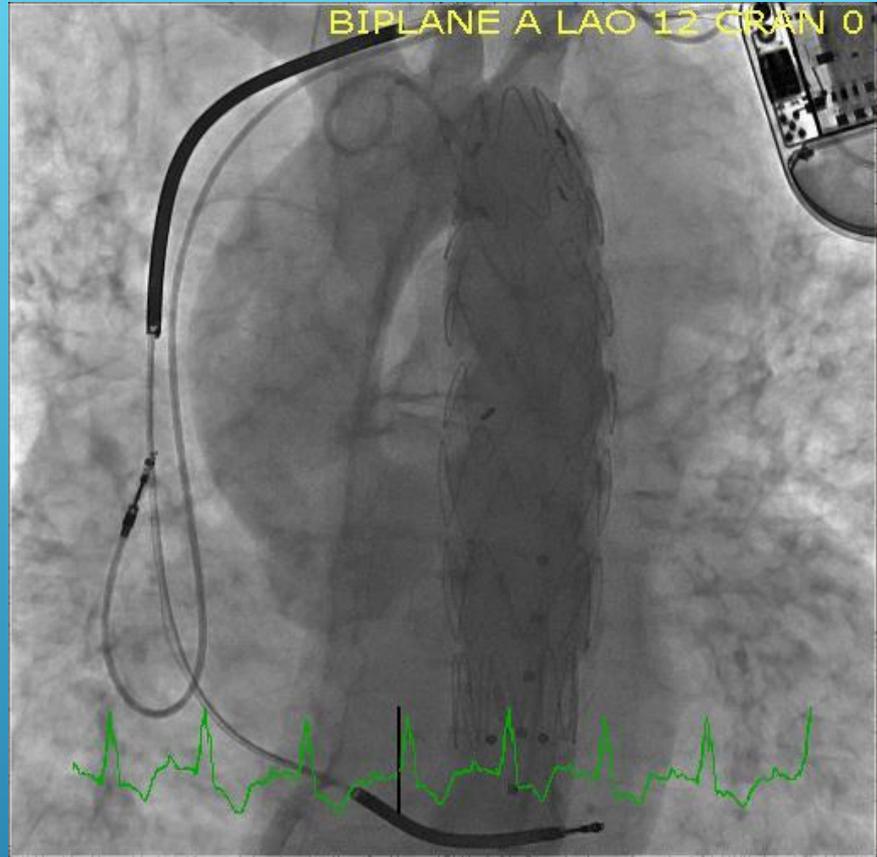
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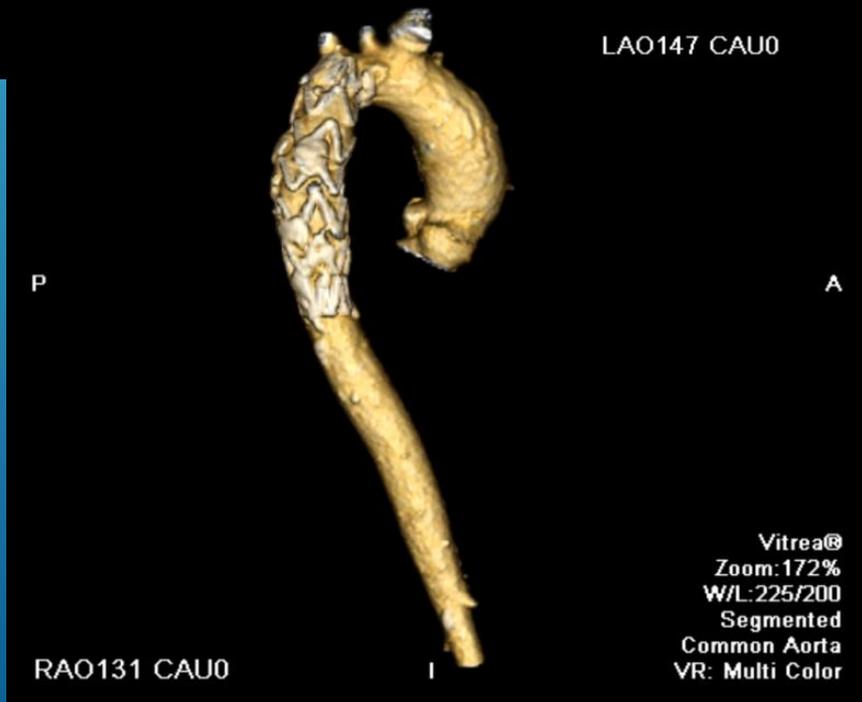
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Vitrea®  
Zoom: 172%  
W/L: 225/200  
Segmented  
Common Aorta  
VR: Multi Color

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**Table 1** Suggested follow-up for patients with repaired coarctation

	<b>Baseline</b>	<b>Annual</b>	<b>2–5 years</b>	<b>Situational</b>
History and physical examination	X	X		
Blood pressure	X	X		
ECG	X			X
CT or MRI	X		X	X
Exercise testing				X
Cardiac catheterisation				X

Krieger E, Stout K. Heart 2010;96:1676e

## SUMMARY RECOMMENDATIONS



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- ▶ Recommendations
  - ▶ MRI/MRA for surgical and balloon angioplasty
    - ▶ Baseline and then q3-5 years
    - ▶ Aneurysm, dissection, recurrent coarctation
    - ▶ No ionizing radiation
    - ▶ Does not require IV access

## MRI VS CT



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- ▶ What about after stent therapy?
  - ▶ CT commonly performed to image aorta
  - ▶ CT extremely quick
  - ▶ CT demonstrates aneurysm, dissection, re-coarctation
  - ▶ CT can demonstrate more easily in-stent stenosis and stent fracture
  - ▶ Ionizing radiation limits number of repeat studies

## MRI VS CT



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# Optimal imaging after coarctation stenting

Eric Rosenthal, Aaron Bell

*Heart August 2010 Vol 96 No 15*

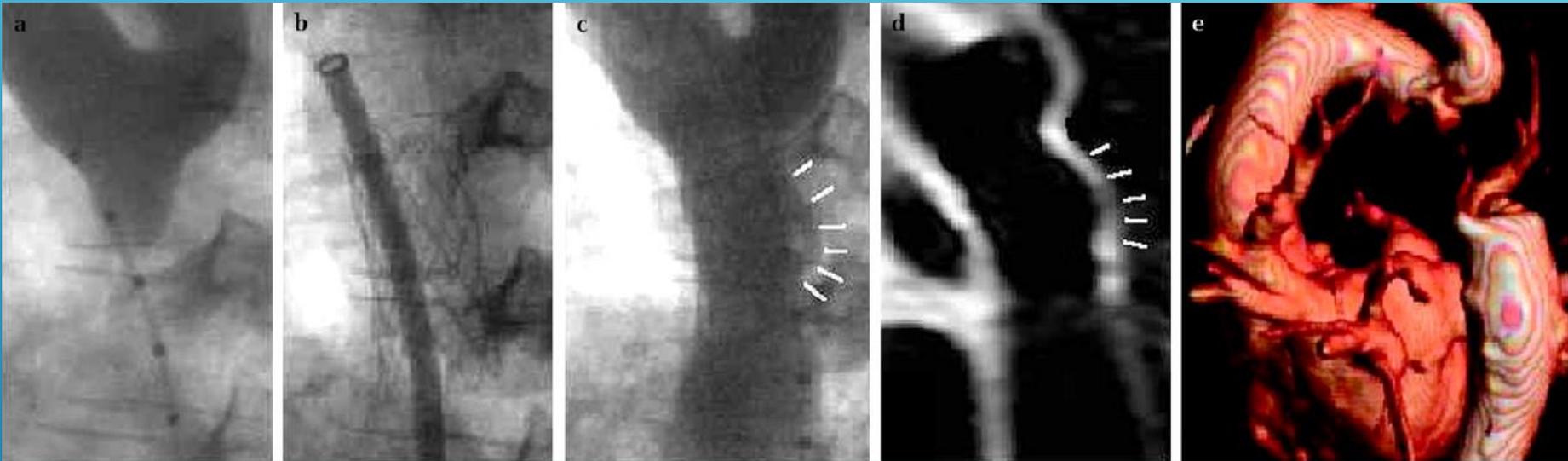
## MRI VS CT



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Near occlusive native coarctation in an adult (a), with stainless steel stent implantation (b) produces a widely patent aorta (c) with a 'protrusion' of the aortic wall at the top end of the stent (arrows)—before the advent of covered stents.



Eric Rosenthal, and Aaron Bell Heart 2010;96:1169-1171

Heart



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# Gadolinium reconstructed 3-D view of aortic arch showing a severe native coarctation in an adult (a).



Eric Rosenthal, and Aaron Bell Heart 2010;96:1169-1171

Heart



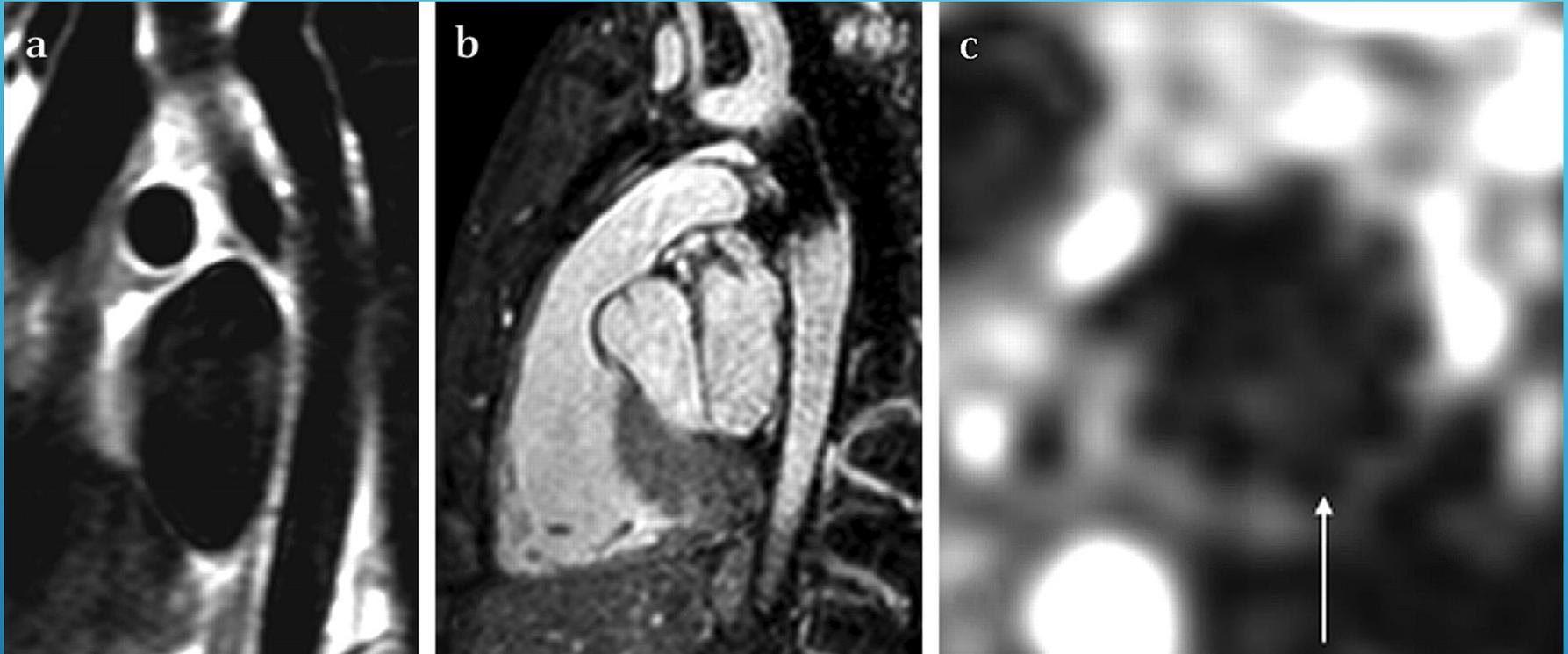
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**MRI scan 6 weeks after implantation of a platinum stent in a native coarctation.**



**Eric Rosenthal, and Aaron Bell Heart 2010;96:1169-1171**



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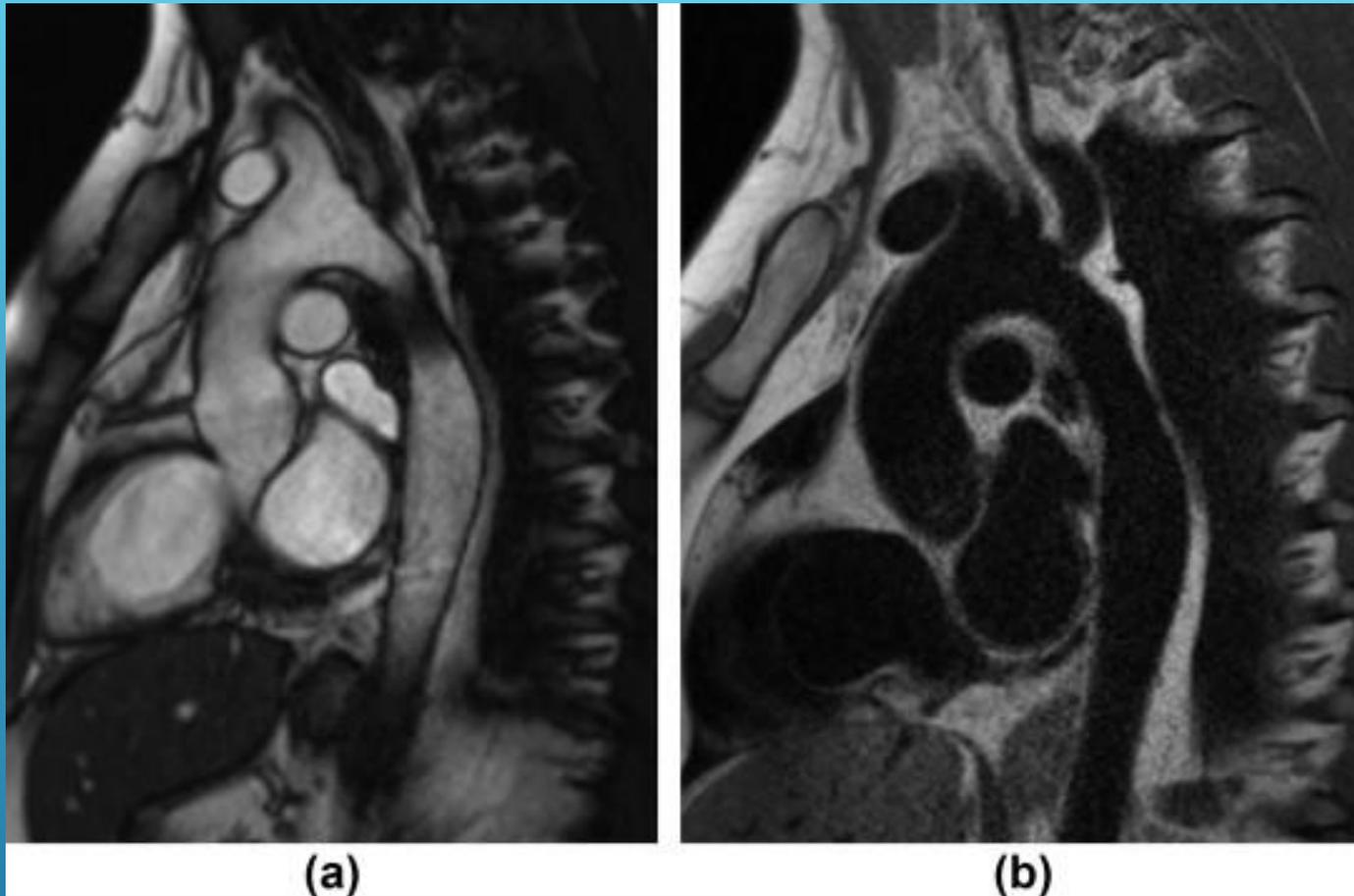


Image from (a) an SSFP cine sequence and (b) a black blood image in a patient treated with a percutaneous stent for coarctation. Note the moderate metal artefact from the stent on the SSFP image and the excellent image quality of the black blood sequence.

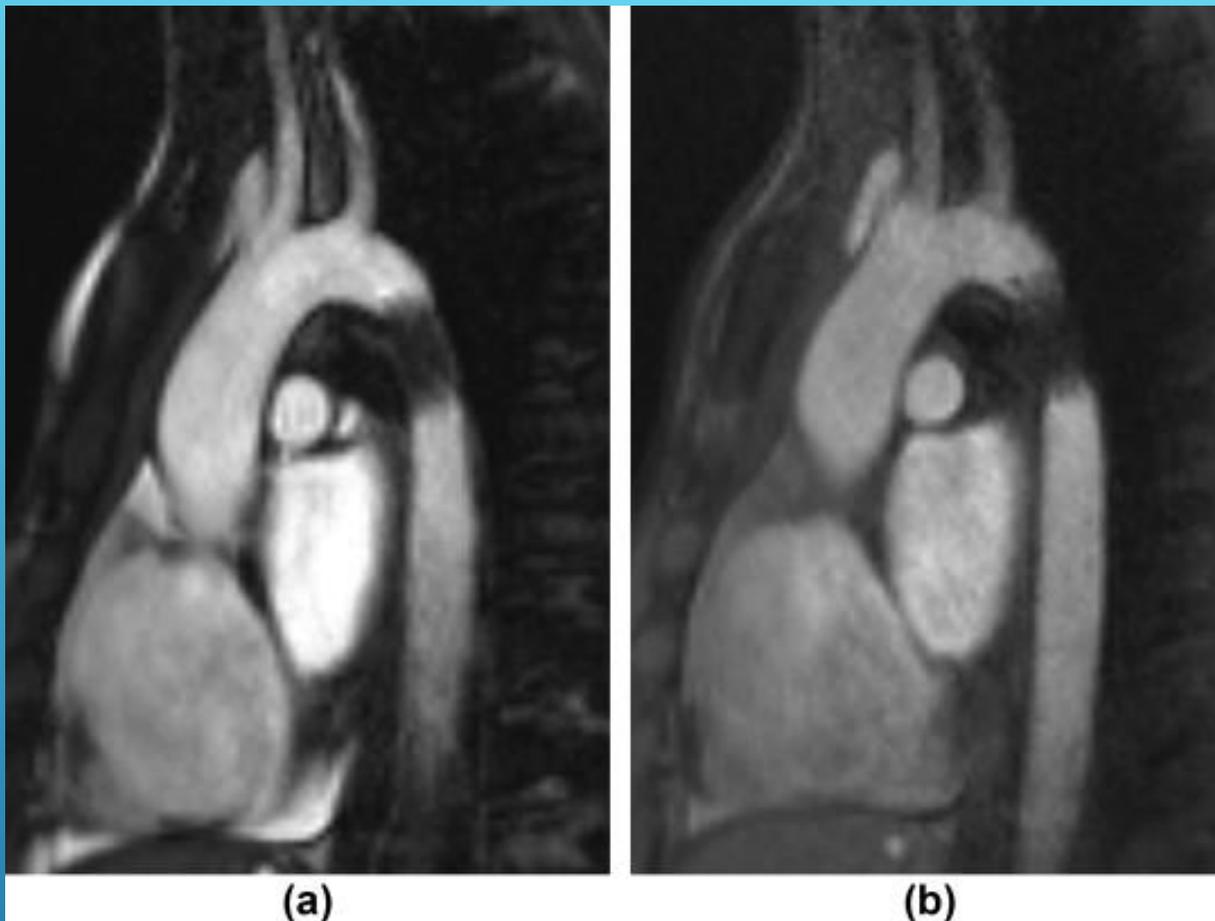
MRI in adult patients with aortic coarctation: diagnosis and follow-up  
 Shepherd, B., Clinical Radiology, Volume 70, Issue 4, 433-445

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Static images from (a) an SSFP cine sequence and (b) and gradient-echo cine sequence. There is moderate metal artefact as a result of the stent but this is less marked on the gradient-echo image.

MRI in adult patients with aortic coarctation: diagnosis and follow-up  
Shepherd, B., Clinical Radiology, Volume 70, Issue 4, 433-445

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- ▶ Recommendations for stented patients
  - ▶ CT is useful to follow long term, but should only be used when experienced MR cardiologist/radiologist is unavailable
  - ▶ MRI/MRA “black blood” imaging should always be performed to show luminal and extraluminal blood
  - ▶ MRI should be performed at centers accustomed to performing dedicated MRI protocols
  - ▶ Use CT sparingly if PM/ICD or if in-stent stenosis is strongly suspected and not demonstrated on serial MRI
  - ▶ IF CT is required, weigh risk and benefits to determine appropriate interval for serial studies

## MRI VS CT



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