ROLE OF CONTRAST ENHANCED MR ANGIOGRAPHY IN AORTIC COARCTATION

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INTRODUCTION

- Coarctation of the aorta account for approximately 5-7% of all congenital heart disease and is defined as a congenital narrowing of the aorta. The narrowing is most commonly located just distal to the origin of the left subclavian artery\(^1\).

- MRI is a recognized method for the diagnosis and follow-up of patients with coarctation of the aorta (CoA). Its images provide detailed 2D and 3D anatomic and functional information about the site of the CoA and the aortic vessel wall \(^2\).
• Decision of treatment planning either balloon angioplasty or surgery depends on the length & diameter of the stenotic segment, collateral vessels and associated anomalies, as well as functional assessment of pressure gradient across the narrowed segment. Contrast enhanced MRA (CE-MRA) are used for evaluation of aortic coarctation. 3-4.
Aim of this work is to demonstrate the role of contrast-enhanced MRA in detection, assessment of aortic coarctation, its type as well as evaluation of enlarged collaterals. Also, we correlate the MRA findings with Doppler echocardiography and that during surgery or catheterization.
Patients & Methods: Forty patients (25 M, 15 F aged 1m-15 years; mean=6.5 ys) with aortic coarctation examined on 1.5 tesla MR unit (Symphony; Siemens). All patients undergone contrast-enhanced MRA & echocardiography. Angiogram & balloon dilatation was done for 10 patients. Angiogram with aortic stent for 4 patients. Operative correction was done for 6 patients. Correlation of MR findings with Doppler echocardiogram and angiogram have been done.
Patients & Methods:

- 40 patients (25 M, 15 F.)
- Age: 1m-15 years (mean=6.5 ys).
- CE-MRA (40 patients).
- Echocardiography (40 patients).
- Angiogram (18 patients).
- Balloon dilatation (10 patients).
- Surgical correction (6 patients).
- Aortic stent (4 patients).
- Conservative ttt & follow up (16 patients).
- No follow up (4 patients).
CE-MRA

- **MR Machine:**
  - 1.5 tesla MR unit (symphony-Siemens).
- **Pulse sequence:** 3D fast Gradient-Echo
- **TR/TE:** 4.5/1.5msec, **FA:** 30°
- **FOV:** 40-60cm, **NEX:** 1
- **Matrix:** 512 X 256.
- **Slice:** 0.8mm, **gap:** 1mm.
- **acquisition time:** 40 sec.
• **Test bolus**: determine the scanning delayed time.

• **Pre contrast series**: serve as a mask for subtraction.

• **CM Injection**: Gad DTPA (0.2 mmol/Kg) at rate of 4 mL/sec followed by 20 cc saline

• **Post contrast series**: Multiple series taken.

• **Subtraction**: pre contrast from post contrast data sets.

• **Post processed** with MIP to produce 3D images.
Results: CE-MRA revealed short segment (n=35/40) or diffuse tubular segment (n=5/40) of coarctation. Hypoplastic distal aortic arch (n=16/40), dilatation of the ascending aorta (n=24/40) and patent ductus arteriosus (n=4/40). CE-MRA was superior to Doppler echocardiogram in delineation of collaterals that detected in 22/40 patients. There was good correlation between the narrowed segment measured on CE-MRA & Doppler echocardiography & angiography (r value=0.96).
Short segment in 35 patients.
Long segment in 5 patients.
Collaterals in 22 patients.
Hypoplastic distal aorta in
Bicuspid aortic valves in
Role of CE-MRA in Coarctation

Native coarctation:
- Narrowed segment
- Collateral vessels
- Associated anomalies

Treated coarctation:
- Re-stenosis
- Aneurysm
- Dissection
- Follow up
I-Native coarctation
Native Coarctation

- CE-MRA determines accurately the stenotic segment and measures its diameter & length. Also, it depicts the diameter of the distal arch, the course of the collateral vessels and relationship of arch vessels to the stenotic segment. These information are important for pre-operative planning.
I-Narrowed segment

- **Site:** at the aortic isthmus (segment of aorta between the left subclavian artery origin and ductus arteriosus).
- **Degree:** varies from slight to severe stenosis.
- **Length:** It may be short or long segment.
- There is significant correlation between CE-MRA & angiocardiology in measurement of length & diameter of narrowed segment.
II-Collaterals

- **Types:** Dilated intercostals arteries.
  hypertrophied internal mammary arteries.

- **Value:** -extent of collateral denote severity of narrowing.
  -plan operative repair as cross clamping of aorta in patient with insufficient collateral result in cord ischemia.

- **CE-MRA** was superior to angiography in delineation of collaterals especially in paraspinal region.
III-Associated anomalies

- **Patent ductus arteriosus (PDA)** (15%): originate from pulmonary artery & insert into aorta opposite origin of left subclavian artery.
- **Bicuspid aortic valve** (10%): Aortic valve formed of 2 cusps instead 3 cusps with dilated ascending aorta.
- **Hypoplastic arch** denoting bad prognosis in follow up after treatment.
• **Origin of left subclavian artery** may be pulled inferiorly from distal aortic arch toward coarctation segment.

• **Ventricular septal defect (VSD)** 40%.

• **Aberrant subcalvian artery.**

• **Abdominal coarctation.**

• **Part of syndrome** as Turner syndrome, Noonan syndrome & neurofibromatosis.
Fig.(1): *Short segment coarctation with multiple collaterals.* CE-MRA of the thoracic aorta shows short segment aortic coarctation (small arrow) with multiple collaterals (large arrows)
Fig.(2): Short segment coarctation with multiple collaterals. CE-MRA of the thoracic aorta shows short narrow segment at the aortic isthmus (small arrow) with multiple collaterals (long arrows) with dilated intercostal arteries on left side of the figure and hypertrophied internal mammary arteries on RT. side.
Fig. (3): Long segment coarctation with multiple collaterals. CE-MRA of the thoracic aorta shows long narrowed segment (small arrow) with multiple dilated collaterals (large arrows).
Fig. (4): Aortic coarctation with hypoplastic distal aortic arch. CE-MRA of the thoracic aorta revealed short narrowed segment (short arrow), hypoplastic distal aortic arch (long arrow) & multiple dilated collaterals.
Fig.(5): Aortic coarctation with pulled origin of left subclavian artery. CE-MRA of the thoracic aorta shows discrete aortic coarctation with pulling up origin of the left subclavian artery (arrow).
Fig. (6): Short segment aortic coarctation before & after aortic stent.

A) CE-MRA revealed short segment aortic coarctation (short arrow) with collaterals (long arrows).

B) Conventional angiography revealed short segment (short arrow) with collateral (long arrow).

C & D) CE-MRA after 1.5 year after aortic stent revealed the stent (short arrow) with marked improvement of the collaterals.
Post angioplasty aneurysm

Aneurysm may develop at the repair site or at the ascending aorta, in 5.4% of patients who had a patch aortoplasty using synthetic patch and is usually located at the opposite side of the patch\textsuperscript{3}.

*Fig. (9): Post angioplasty aneurysm.* MRA shows aneurysm is seen in the upper part of the ascending aorta after angioplasty.
Conclusion: Gd-enhanced MRA provides an accurate assessment of the anatomic characteristics of aortic coarctation and collaterals vessels. It has the potential to replace all other imaging modalities as the sole pre-operative examination of aortic coarctation. In addition, it can used for follow up of these patients after management.
References

