Coarctation of the aorta: usefulness of MR and MDCT aortography

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Learning objectives

1. To present the MR and MDCT angiographic protocols in aortic coarctation in pediatric and adult patients.

2. To describe and illustrate the imaging appearances of all aortic coarctation types underlying collateral arterial pathways and coarctation-associated cardio-vascular lesions.

Background

Definition. Coarctation of the aorta or aortic coarctation refers to a narrowing of the aortic lumen. It is a congenital condition whereby the aorta narrows in the area where the ductus arteriosus or ligamentum arteriosum (after regression) inserts [1,2].

It was first described by Morgagni at autopsy in 1760. The word "coarctation" comes from the latin term coarctare, to contract [1].

Incidence. Aortic coarctation represents 7% of congenital heart disease. It has a male predominance (male-to-female ratio, 1.5:1) [2] and affects caucasians even times more than other races [17].

Localisation. The stenotic segment frequently develops in a juxtaductal location but may show extension into the aortic arch and isthmus, even in the abdominal aorta.

Classification. The previous classification into preductal (infantile) and postductal (adult) is less commonly used because aortic coarctation is always periductal [3]. Three type of aortic coarctation are described: preductal (infantile type) - the narrowing is proximal to the ductus arteriosus; ductal -the narrowing occurs at the insertion of the ductus arteriosus; postductal (adult type)- the narrowing is distal to the insertion of the ductus arteriosus (Fig. 1.)

Etiopathogeny. The exact mechanism by which aortic coarctation is produced is unknown, but a haemodynamic hypothesis and a ductal hypothesis have been proposed [4]. The first postulates that there is decreased blood flow into the aorta secondary to left heart obstruction in utero, which leads to under-development of the aorta at the isthmus. The second postulates that abnormal ectopic ductal tissue in the aortic wall causes constriction when ductal tissue constricts after birth. However, ductal tissue has not been observed at the site of all coarctation of aorta [17].
**Hemodynamics.** Collateral circulation arises in patients with aortic coarctation because of perfusion demands below the level of coarctation. Normally, the intercostal and internal mammary arteries are a low-pressure, low-flow system, and blood flow is greater in the proximal than in the distal part of the aorta. However, in patients with moderate to severe aortic coarctation, the normal physiologic flow patterns are reversed, and blood flow is greater in the distal aorta. Additional blood is forced through the internal mammary arteries; blood flow is retrograde via the intercostal arteries, sometimes producing the appearance of rib notching on chest radiographs; and, finally, reaches the distal descending aorta and the lower body. Thoracic collateral pathways in cases of aortic stenosis are illustrated in Fig.2., Fig.3. and Fig.4.(A, B). In patients affected by abdominal aorta coarctation, collateral parietal arteries typically develop to connect the thoracic aorta and the abdominal aorta. The most common collateral circulatory pathway is as follows [10] (Fig.4.B): subclavian artery - internal mammary artery - superior epigastric artery - inferior epigastric artery - external iliac artery. When the celiac trunk or superior mesenteric artery is obstructed, retrograde flow comes through the superior and inferior mesenteric arteries (Fig 4.A and B) by the following pathway: inferior mesenteric artery - meandering mesenteric artery - superior mesenteric artery - pancreaticoduodenal arcades - celiac trunk. In case of obstruction of the renal arteries, the following collateral circulatory pathway may develop: lower intercostal arteries - lumbar arteries - ureteral, adrenal, and gonadal arteries - renal arteries.

**Associated lesions.** Aortic coarctation occurs as a solitary lesion in 82% of cases but has multiple associations, including bicuspid aortic valve (in 22%-42% of cases), intracardiac malformations (ventricular and atrial septal defect, and Shone complex, truncus arteriosus), Turner syndrome, [2], intracranial aneurysms (10% of cases) [3,5]. Aortic coarctation may also be associated with aortic hypoplasia: isolated isthmic hypoplasia, isolated aortic arch hypoplasia, or isthmic and aortic arch hypoplasia [1].

**Clinical issue.** The clinical features are dominated by systemic arterial hypertension in the upper extremities, a systolic murmur and absent or diminished femoral pulses.

**Imaging studies.**

**Radiographs** findings vary with the clinical presentation of the patient. In coarctation diagnosed early in life, chest radiograph shows cardiac enlargement and pulmonary venous congestion. Associated cardiac defects may mask these findings. In older children, chest radiographs findings are usually normal. Two classic radiologic signs associated with aortic coarctation are the figure-of-three sign and the reverse figure-of-three sign. The aortic segment affected by coarctation has a shape that resembles the number 3 on frontal chest radiographs (Fig.5.). The number 3 is formed by dilatation of the left subclavian artery and aorta proximal to the site of coarctation, indentation of the site, and dilatation of the aorta distal to the site. This sign is seen in 50%-66% of adults with aortic coarctation [11]. The reverse figure-of-three sign, a mirror image of the number 3, is observed on the left anterior oblique view during barium esophagography in
patients with aortic coarctation (Fig.6.). The dilated and tortuous intercostal vessels form deep grooves on the undersurfaces of the ribs, a process known as rib notching (Fig.5.), usually the third or fourth through the eighth ribs. Since the first two intercostal arteries are supplied by the costocervical trunk instead of by the descending thoracic aorta, the first two intercostal arteries do not serve as collateral pathways, and therefore the first and second ribs do not demonstrate notching.

**Doppler echocardiography** is currently the first imaging modality used, identifying the location and the severity of the coarctation and has the advantage of a noninvasive estimation of the pressure gradient across the narrowing. But it is sometimes difficult to obtain good visualization of the site of coarctation because of a poor acoustic window and the long distance between the transducer and the isthmic region [16].

**Conventional angiography.** Because of its ability to provide both anatomic and hemodynamic information, conventional angiography remains the gold standard for pretherapeutic workup of patients with coarctation. It allows pressure gradient measurement across the coarctation, visualization of the collaterals, and assessment of associated cardiac malformations. However, this technique is invasive and enhances the risk for complications imposed by the coarctation [15].

**MDCT angiography.** Recently, multidetector computed tomographic (MDCT) angiography has become a principal imaging modality for the evaluation of thoracic vascular anomalies because of its short acquisition time and high spatial resolution (3). MDCT angiography with multiplanar and three-dimensional techniques is the noninvasive method of choice for assessing the morphology of coarctation of the aorta, particularly to characterize the location, degree, and length of the narrowing; presence of collateral circulation; relationship to the left subclavian artery; and associated cardiovascular abnormalities. It is important to have accurate information about each of these parameters to devise surgical or interventional repair (4, 5).

**MR angiography** of the thoracic aorta, combined with postprocessed 3D reformations, provides accurate and reproducible angiographic-like images that enable precise measurements of the stenosis. It also shows clearly the spatial relationship between the aortic narrowing and the origin of the major arch vessels and the collateral vessels bypassing the stenosis [2]. Visualization of collateral vessels indicates the presence of a significant gradient. Multiplanar reformations enable measurements of the maximal point of narrowing (Fig.9.).

Before the introduction of MDCT technology, magnetic resonance imaging was frequently used for the assessment of congenital thoracic vascular anomalies because of its multiplanar capability. Contrast-enhanced MR angiography is, for the most part, sufficient for evaluation of the aorta and its branches, whereas cine MRI and phase-contrast MRI allow assessment of the hemodynamic significance of the coarctation, as well as cardiac and valvular function. When multiplanar and three-dimensional postprocessing techniques became available, the role of CT in the assessment of thoracic vascular...
anomalies changed. MDCT has changed not only the imaging evaluation approach to thoracic aortic anomalies but also challenged the role of conventional angiography.

**Prognosis.** Nontreated aortic coarctation has a poor prognosis, with a reported mortality of 75% by 46 years of age. Congestive heart failure is the most common cause of death (25.5% of cases), followed by aortic rupture (21%), complications of endocarditis (18%), and finally intracranial hemorrhage (11.5%) [6]. During pregnancy there is a risk for aortic dissection or intracranial haemorrhage. Maternal mortality may be as high as 3-8% [17], even in those who have undergone repair. Thus all pregnancies should be treated as high risk. Continuing significant stenosis, whether native, residual or recurrent is a contraindication to pregnancy.

**Treatment.** A variety of surgical approaches for coarctation have been used in the last 30 years, including resection with primary end-to-end anastomosis, patch aortoplasty with prosthetic material homograft or autologous subclavian artery, and bypass grafting with a prosthetic tube or autologous vascular grafts. The most common technique in current use is resection with end-to-end anastomosis. Balloon dilation with stent insertion for native aortic coarctation or recoarctation is being used increasingly as an alternative to surgery and, in some centers, has replaced surgery as the primary management strategy [12]. Lifelong surveillance of patients with a patch repair for the detection of aneurysm formation is mandatory [14]. The two most common complications after coarctation repair are late recoarctation and aneurysm formation at the repair site. Recurrent coarctation is more common when the coarctation is initially repaired in infancy. Aneurysm formation may develop at the repair site or at the ascending aorta and usually located at the opposite side of the patch. The risk of progressive aneurysmal dilatation and subsequent rupture is high in cases in which the ratio between the caliber of the dilated aorta and the diaphragmatic aorta is higher than 1:1.5 [13].

**Images for this section:**
Fig. 1: Schematic drawing of alternative locations of a coarctation of the aorta, relative to the ductus arteriosus (from wikipedia).
Fig. 2: Illustrations of thoracic collateral pathways in coarctation of aorta from The Netter Collection of Medical Illustrations.
Fig. 3: Thoracic collateral pathways in coarctation of aorta: maximum intensity projection (MIP) of the thoracic aorta based on the magnetic resonance angiogram.
**Fig. 4:** Diagram of systemic thoracic (A and B), thoracoabdominal (B), and abdominal (C and D) collateral pathways in cases of aortic stenosis (from Carmen Sebastia´, MD; Sergi Quiroga, MD Aortic Stenosis: Spectrum of Diseases Depicted at Multisection CT1, RadioGraphics 2003; 23:S79-S91 Published online 10.1148/rg.23si035506).

- A - the thoraco-acromial and descending scapular arteries
- B - the internal mammary
- C - the inferior intercostal arteries
- D - the lumbar arteries
**Fig. 5:** Chest radiographic aspects of coarctation of aorta. Frontal view (a, c the same as a with a superimposed 3) and close-up frontal view (c) obtained in a young man show the figure-of-three sign formed by prestenotic and poststenotic dilatation of the aorta, with an intervening indentation at the site of coarctation and with bilateral rib notching (b) caused by pressure from intercostal blood vessels.
**Fig. 6:** Radiographic aspects of coarctation of aorta. Left anterior oblique view of the chest, obtained with barium esophagography (b the same as a with a superimposed reversed 3), shows the reverse figure-of-three sign - an indentation in the esophageal contour because of pressure from the coarctated aorta.
**Role of Noninvasive Imaging Modalities in Patients With Coarctation**

**Transthoracic echocardiography:**
- widely available;
- assesses valvular and ventricular function;
- quantitative coarctation gradient;
- ascending thoracic aorta well seen;
- arch and descending aorta not well seen; stent not well seen.

**TEE**
- descending thoracic aorta well seen; stents can generally be imaged;
- ideally suited for intraoperative use;
- limited view of aortic arch; blind spot of ascending aorta;
- abdominal aorta not seen.

**CT**
- entire aortic tree visualized; less affected by stent artifact;
- oblique view of arch;
- valvular function difficult to assessed;

**MRI**
- entire aortic tree;
- can assess valvular and ventricular function;
- high-resolution oblique and sagittal planes;
- contraindicated in patients with metallic prosthesis, obscured by stent artifact;

A. Kinsara et al. Chest 2004;126;1016-1018

**Fig. 7:** Role of noninvasive imaging modalities in patients with coarctation of the thoracic aorta.
Coarctation of the aorta

- **infantile preductal type- tubular** hypoplasia of the aorta: involve a long segment distal to the origin of BCA +/- high grade stenosis of the descending aorta proximal to the ligamentum arteriosum.
- **MRI** is preferred for this application-absence of exposure to ionizing radiation
- **CTA** is used for the follow-up after surgical repair.

- **adult postductal type**: localized constriction of the aorta distal to the level of ligamentum arteriosum.

**Fig. 8:** Competition between MRA and CTA
Imaging findings OR Procedure details

Patients:

Retrospective study along 11 years including 68 patients aged 3 to 60 years (mean age 23 years) with clinical suspicion of aortic coarctation (65 patients), or after chirurgical correction (3 cases of which only one evaluated before and after chirurgical correction), who were evaluated in our imaging department by CT and/or by MRI angiography.

The symptoms of the patients were dyspnea on exertion, chest pain, leg weakness on exertion, palpitation, headache and epistaxis.

Techniques:

MDCTA. MDCT angiography examinations were performed with a 16-row MDCT system. 12 patients were examined while supine, and images extending from base of the neck to the diaphragm were acquired during a single breathhold. The imaging data was acquired during an intravenous injection of iodinated contrast agent (1.5ml/kg) at a rate of 3 ml/s. The scanning delay was determined with a bolus tracking technique. For MIP and three-dimensional image reconstruction, the volumetric CT data sets were processed on a separate workstation with multiplanar reformatting, curved planar reformatting, maximum intensity projection, and volume rendering (Fig.9.).

MRI. All MR imaging was performed with a 1.5-T equipment using TORSOPA coil. First 3 planes locating sequences were sampled, afterward respiratory gating axial/coronal-oblique/sagittal-oblique black-blood SE T1, coronal T1 FSPGR after and post-contrast, 3D FSPGR T1 FS gadolinium-enhanced MR angiography multiphase sequences (0.1ml/kg Gd-BOPTA) with MIP reconstructions (FIG.10.). Cine-RM acquisitions were made in aortic valves and left ventricle planes.

Images analysis. All images were evaluated for the site, degree and length of the coarctation, the presence of additional cardiac defects, such as patent ductus arteriosus and bicuspid aortic valve and associated vascular anomalies such as double superior vena cava. The presence of an associated aneurysm and dissection of the thoracic aorta was assessed. The origin, visibility, and course of collateral vessels were also evaluated. Coarctation of the aorta was defined as greater than 25% decrease in vessel diameter. The degree of stenosis was considered severe if the ratio of the coarctation diameter to the distal descending aortic diameter was less than 50%. The length of the coarctation was considered short if the length of the narrowed aortic segment was less than 5 mm and long if the length of the narrowed aortic segment was more than 5 mm.

Imaging findings:
• **Post-ductal** (adult type) coarctation characterised by a stenosis of the post-ductal aorta and was present in our study in almost all cases (98.5%) with a male predominance (male-to-female, 34:30). The patients were evaluated by CT and/or by MRI angiography, 3 with both. In 70% of cases the narrowing was considered severe and short, In our study population, almost all cases (96%) had collateral vessel formation, and the origin and course of collateral vessels were very well displayed with three-dimensional MDCT angiography (Fig. 9.) or multiplanar reformations based on MR angiography (Fig.11.). We found in our cases associated cardiac defect as bicuspid aortic valve and double superior vena cava (Fig.12.).

• **Pre-ductal** (infantile type) coarctation characterized by diffuse hypoplasia or narrowing of the aorta from just distal to brachiocephalic artery to level of ductus arteriosus, was found in 2 cases, one with tubular hypoplasia of the transverse segment of aortic arch which consists the emergence of the left internal corotide artery and post-stenotic dilatation. Other case is a 14 years old boy with severe coarctation of the aorta high located and cardiac failure (Fig.13.)

**Particular aspects.**

**Coarctation of the abdominal aorta**, also known as middle aortic syndrome or mid-aortic dysplastic syndrome, is a clinical condition caused by segmental narrowing of the abdominal or distal descending thoracic aorta secondary either to a congenital anomaly in the development of the abdominal aorta or to one of several acquired conditions. Acquired conditions include neurofibromatosis, retroperitoneal fibrosis, fibromuscular dysplasia, mucopolysaccharidosis, and Takayasu’s arteritis, all of which may result in narrowing of the abdominal aorta and other vessels. However, midaortic dysplastic syndrome cannot be distinguished from late-phase type II Takayasu arteritis on the basis of radiologic findings alone. The two disease entities can be differentiated only by histopathologic exclusion of inflammatory change, which is present in Takayasu arteritis but not in midaortic dysplastic syndrome [9]. In our study we performed a CT angiography of an 24 year old women with abdominal aorta coarctation (Fig.14.) starting at a level of celiac trunk, with punctiform lumenal caliber at the left renal artery emergence and normal appearance at the level of inferior mesenteric artery emergence. The length of narrowing was estimated to be 65 mm.

**Double coarctation of aorta.** In (Fig.15.) we present an unusual case of aortic coarctation with severe narrowing of thoracic aorta, at 4 cm distal to left subclavian artery, followed by 1 cm tortuous lumen and finished with a second coarctation at a transversal plane which crosses the inferior left pulmonary vein.

**Coarctation associated with Stanford type B dissection.** We describe a case of acute type B dissection associated with coarctation of the aorta, a rare pathological combination. A 39 years old women with history of antihypertension medication. She performed MR angiography which shows severe narrowing at the thoracic aorta distal to
the sublavian artery and the entry of the dissection was just below the coarctation, extending to the abdominal aorta (Fig. 15).

**Coarctation associated with postcoarctation aortic aneurysm.** Is the case of a 14 year old female with coarctation of the thoracic aorta, associated with sacular aneurysm just beyond the coarctation. The aneurysm is compressing to the left pulmonary artery (Fig. 17.)

**Postcorrection assessment.** In our study 3 patients were evaluated after chirurgical correction, 2 without complication (Fig. 14. b,c). An 24 year old women present late recoarctation, with double narrowing and formation of and inters- stenotic sacular aneurysm (Fig. 14. a).

**Differential diagnostic.**

**Pseudocoarctation.** Aortic coarctation should be distinguished from pseudocoarctation due to an elongated aorta in atherosclerotic patients. Pseudocoarctation of the aortic arch is a rare congenital anomaly characterized by one or more stenoses of the descending thoracic aorta immediately distal to the origin of the left subclavian artery. This condition is differentiated from true coarctation of the aorta by the absence of significant hemodynamic obstruction, the stenosis instead produces elongation of the aorta. Kinking and buckling are often used to describe the radiologic appearance of the aortic arch in patients with this condition [7]. Pseudocoarctation is usually asymptomatic and benign, but aneurysmal dilatations may develop in the affected areas and must be monitored and treated. Anomalies associated with pseudocoarctation include bicuspid aortic valve, patent ductus arteriosus, ventricular septal defect and corrected transposition. Anomalies of the left subclavian artery may also be present. We present the MR imaging of a 22 years old women with pseudo-kinking of the descending thoracic aorta in the segment of left subclavian artery emergence (Fig. 18.) The ascending aorta is normal, but there is tortuosity of the upper descending aorta. No collateral circulation is seen, the great vessels arising from the aortic arch are normal, except left subclavian artery hypoplasia.

**Takayasu’s arteritis.** Various types of vasculitis produce aneurysms in many portions of the aorta and its branches, but Takayasu arteritis is the only type of aortitis that produces stenosis in the thoracic aorta [20]. Takayasu arteritis is a well-known systemic disease that affects the aorta and its major branches as well as the pulmonary artery. In the early phase of the disease, known as the systemic or prepulseless phase, CT scans and magnetic resonance images depict mural thickening and contrast enhancement changes that cannot be assessed by arteriography [21, 22]. Mural thickness decreases after steroid therapy. If transmural fibrosis is left untreated, chronic changes may ensue, including stenosis, occlusion, mural calcification, intraluminal thrombus, or aneurysmal dilatation of the aorta and its branches. This stage of the disease is called the late or occlusive phase.
**Hypoplastic left heart syndrome** (HLHS) is a complex combination of cardiac malformations that probably results from multiple developmental errors in the early stages of cardiogenesis and that, if left untreated, invariably proves fatal. A variety of chest radiographic findings are seen in patients with HLHS, including an enlarged cardiac silhouette (notably a prominent right atrium), pulmonary venous hypertension, an atrial septal defect, and valvular stenosis or atresia.

**Interrupted aortic arch** (IAA) is defined as a complete luminal and anatomic discontinuity between the ascending and descending aorta, as described by Steidele in 1778 [1]. IAA is rare, accounting for only 1% of congenital heart diseases. It may occur as a simple or complex anomaly. In simple IAA, only ventricular septal defect and patent ductus arteriosus are seen. The complex form is associated with truncus arteriosus, transposition of the great arteries, double-outlet right ventricle, aortopulmonary window, and functional single ventricle. Obstruction of the left ventricular outflow tract is also common [18].

**Hypoplasia of the aortic arch and descending aorta.**

We present a rare condition of aortic anomaly with hypoplasia of the aortic arch and severe, uniform narrowing of the descending aorta extended to the abdominal aorta. No collateral circulation is seen and the great vessels arising from the aortic arch are normal (Fig.20.).

**Images for this section:**
**Fig. 9:** Congenital post-ductal aortic coarctation. 6 year old boy with Contrast enhanced axial CT scan (a, b) shows severe narrowing of the thoracic aorta and enlarged internal mammary arteries, intercostal arteries. Saggital-oblique reformatted image (c) of the thoracic aorta accurately shows the location of coarctation below the left subclavian artery. In (d) volume rendered images (VRT) illustrates the collateral pathways and anastomosis between the internal mammary arteries and superior/inferior epigastric arteries (arrows).
Coarctation of the aorta

MRA provide informations concerning:

1. localization
2. type
3. length
4. collateral vessels
5. severity

**Fig. 10:** Post-ductal type of coarctation of the aorta - Sagital MIP reformatatted image MRA post Gd.
Fig. 11: Post-ductal type of coarctation of the aorta. Sagittal T1 SE black-blood images and MPR 3DT1 post Gd shows severe and short coarctation of the aorta distal to left subclavian artery.
Fig. 12: 14 year old man with post-ductal coarctation. MIP of the thoracic aorta based on the magnetic resonance angiogram show post-ductal coarctation (a) and presence of double superior vena cava (c) de cap de sageata. Oblique axial image of cine MRI obtained in systole (b) shows two-leaflets aortic valve and magnification (d) highlight the type 2 which is less frequent.
Fig. 13: 14 years old boy with severe coarctation of the aorta high located. MIP reformatations images after MRA post Gd shows significant fusiform dilatation of the ascendent aorta.
Fig. 14: Coarctation of abdominal aorta. Contrast enhanced axial CT scan (a, b, c) of an 24 year old women shows progressively narrowing of abdominal aorta, starting at a level of celiac trunk (a), with punctiform lumenal caliber at the left renal artery emergence (b) The lumenal calibre is normal at the inferior mesenteric artery (d). Oblic-saggital MPR (d) estimate the length of narrowing at 65 mm.
**Fig. 15:** An 56 year old women with double coarctation of thoracic aorta: MRP 3DT1 post Gd (a) and VRT reconstruction MR angiography (b) shows severe narrowing of thoracic aorta (arrow) at 4 cm distal to left subclavian artery, followed by 1 cm tortuous lumen and finished with a second coarctation (short arrow) at 5 cm beyond left subclavian artery.
**Fig. 16:** Aortic coarctation and poststenotic fusiforme aneurysm with Stanford type B dissection in a 39 year old patient. Axial T1 black blood images (a, b) shows an aneurysm and intimal flap (arrows) in the descending aorta, extending to the abdominal aorta. MPR after MRA +Gd (c, d) shows narrowing of ascendent aorta followed by coarctation distal to left subclavian artery with collateral pathways and Stanford type B dissection just below the coarctation.
Fig. 17: Aortic coarctation in a 14 year old F combined with postcoarctation aortic aneurysm. Axial T1 black blood SE images (a, b) shows coarctation of aorta associated with sacular aneurysm just beyond the coarctation. Axial (c) and saggital MIP (d) obtained from MR angiography shows that narrowed aortic segment starts immediately distal to origin of dilated left subclavian artery and aneurysm is compressing to the left pulmonary artery.
**Fig. 18**: Postoperative assessment. MIP projection image (a) obtained from MR angiography performed after surgical correction for coarctation shows double narrowing of thoracic aorta with inter-stenotic sacular dilatation. MIP projection image (b, c) obtained from MR angiography performed to an 10 year old boy with coarctation of thoracic aorta distal to left subclavian artery. Before correction (b) the aortic arch has an angulated aspect, unviewed after surgery (c).
Fig. 19: 22 years old women with pseudocoarctation of the aorta. Gadolinium-enhanced MR angiogram (a) shows kinking appearance of the aortic arch, in the segment of left subclavian artery emergence. Sagital-oblic VRT reconstruction (b) shows discrete narrowing and hypoplasia of left subclavian artery. Note the absence of a significant reduction in luminal diameter and without collaterals, which makes this a case of pseudocoarctation.
Fig. 20: MIP reformatation images after MRA post Gd shows hypoplasia of the aortic arch and descending aorta.
Conclusion

- MDCT aortography and MR aortography allows excellent evaluation mapping of the aortic narrowing, associated cardio-vascular anomalies before and after surgery. Three-dimensional and MIP reconstructions provides angiographic-like images that enable precise measurements of the stenosis length.
- Compared with MR angiography, MDCT angiography has the advantage of the ability to acquire high spatial resolution in a shorter acquisition time. In addition, volume rendered and multiplanar reconstructions are better for MDCT angiography data display than MRI.
- Identification of collateral circulation is of importance before surgery to avoid ischemic medullary injury. In our study population, almost all cases (96%) had collateral vessel formation, and the origin and course of collateral vessels were very well displayed with three-dimensional MDCT angiography.
- At our institution, we prefer MDCT angiography in adult patients and MRI in pediatric patients. Because axial images may be insufficient for evaluation of short coarctations, multiplanar and three-dimensional images are needed in the assessment of coarctation of the aorta.

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