Chapter 69
Transcatheter Coarctoplasty

Ata Firouzi and Zahra Hosseini

Abstract Isolated aortic coarctation is a kind of localized aortic stenosis (usually post-ductal), which usually being missed in adulthood and actually is detecting incidentally. In every new hypertensive cases, at least in first visit, both upper limbs pressure and Radial-Femoral pulses should be checked. If not treated, these patients usually don't survive more than 50 years. In the past, the gold standard of treatment was surgical repair but in the last 2 decades, balloon angioplasty and finally stenting have perceived their roles and long term outcome trials showed, the safety and effectiveness of trans-catheter coarctoplasty in adulthood.

History

The patient was a 30 years old man, a case of hypertension, who was referred with exertional dyspnea since one year ago. In TTE, he was diagnosed to have Bicuspid Aortic Valve (BAV), severe AI, and localized coarctation. He scheduled for percutaneous coarctoplasty and Bentall surgery.

Coarctation of Aorta (CoA) is a congenital abnormality of the heart producing obstruction to blood flow through the aorta; it consists of a constricted aortic segment comprising localized medial thickening with some infolding of the media and superimposed neo-intimal tissue. It may be a shelf-like structure in the posterolateral aortic wall or a membranous curtain-like structure with an eccentric or a central opening. Most commonly it is located at the junction of the ductus arteriosus with the aortic arch, just distal to the left subclavian artery. CoA accounts for 5–8% of children born with congenital heart disease, which is often associated with other congenital cardiac anomalies like: VSD, PDA, hypoplastic aortic arch, Shone complex, and BAV. BAV is commonly associated with CoA and is present in more than half of CoA patients which can lead to AI, AS, or aortic dilatation

A. Firouzi (✉) · Z. Hosseini
Interventional Cardiology, Cardiovascular Intervention Research Center, Rajaie Cardiovascular Medical and Research Center, Iran University of Medical Sciences, Tehran, Iran

M. Maleki, A. Alizadehasl (eds.), *Case-Based Clinical Cardiology*,
https://doi.org/10.1007/978-1-4471-7496-7_69

and dissection. Intracranial aneurysms may also occur (2–10%). Adequate and timely diagnosis of CoA is crucial for a good prognosis, as early treatment is associated with lower risks of long-term morbidity and mortality. The natural history of the condition is dismal, with death ensuring on average in the fourth decade of life and three-quarters of patients dying before their fiftieth birthday. The most common cause of death is CHF, dissection, and rupture of the aorta, endocarditis, premature coronary artery disease, and ICH. In adults, the most common presentation is systemic hypertension, accounts for 0.2% of all hypertension cases in adults [1].

Diagnostic Work-Up

In all new cases of hypertension, coarctation should be rule out by checking the upper and lower limb pulses and pressures. Radial-Femoral pulse delay is evident unless significant AI coexists, as well as a differential systolic blood pressure of at least 10 mm Hg between brachial and popliteal artery pressure is also suggestive. An inter-scapular systolic murmur may also reveal in auscultation. In ECG, various degree of LVH is seen. In CXR, 3 configuration and rib notching are diagnostic. TTE is an ideal modality for the detection of the stenotic segment, gradients, high-velocity jet with diastolic tail, and slow upstroke velocity flow in the abdominal aorta. CMR is the gold standard tool for detecting the type of the arch, coarctation types, collateral vessels, and the size of the aorta in arch and at the level of the diaphragm and any other vascular or cardiac anomalies.

Indications for Coarctoplasty

Significant native or recurrent aortic coarctation has been defined as follows: upper extremity/lower extremity resting peak-to-peak gradient >20 mm Hg or mean Doppler systolic gradient >20 mm Hg; upper extremity/lower extremity gradient >10 mm Hg or mean Doppler gradient >10 mm Hg plus either decreased LV systolic function or AR; upper extremity/lower extremity gradient >10 mm Hg or mean Doppler gradient >10 mm Hg with the collateral flow. This should be coupled with anatomic evidence for CoA, typically defined by advanced imaging (CMR, CTA) [2].

Coarctation of the Aorta

Recommendations for Coarctation of the Aorta		
COR	LOE	Recommendations
Diagnostic		
I	B-NR	Initial and follow-up aortic imaging using CMR or CTA is recommended in adults with coarctation of the aorta, including those who have had surgical or catheter intervention.
I	C-EO	Resting blood pressure should be measured in upper and lower extremities in all adults with coarctation of the aorta.
IIa	C-LD	Ambulatory blood pressure monitoring in adults with coarctation of the aorta can be useful for diagnosis and management of hypertension.
IIb	B-NR	Screening for intracranial aneurysms by magnetic resonance angiography or CTA may be reasonable in adults with coarctation of the aorta.
IIb	C-LD	Exercise testing to evaluate for exercise-induced hypertension may be reasonable in adults with coarctation of the aorta who exercise.
Therapeutic		
I	B-NR	Surgical repair or catheter-based stenting is recommended for adults with hypertension and significant native or recurrent coarctation of the aorta.
I	C-EO	GDMT is recommended for treatment of hypertension in patients with coarctation of the aorta.
IIb	B-NR	Balloon angioplasty for adults with native and recurrent coarctation of the aorta may be considered if stent placement is not feasible and surgical intervention is not an option.

Treatment

Surgery

The standard treatment in infants and children is surgical repair. Surgical repair progressed steadily with the development of several techniques (End to End anastomosis, patch aortoplasty (which has the highest risk of aneurysm formation), subclavian flap angioplasty and tubular bypass graft). The risk of recoarctation is about 10%, also there is rare reports of pseudoaneurysm at the site of surgical repair [3].

Balloon Angioplasty

The selected balloon angioplasty catheter is positioned across the aortic coarctation and the balloon is inflated with diluted contrast material to approximately three to five atmospheres of pressure or higher, depending upon the manufacture's recommendations. The balloon is inflated for a duration of about 5 s. A total of two to four balloon inflations are performed 5 min apart. Then repeat aortography and measurement of pressure gradients across the CoA are performed. Recording of heart rate,

systemic pressure, and cardiac index prior to and fifteen minutes after balloon dilatation is made to assure that change in pressure gradient is not related to changes in patient status, but is, indeed related to balloon dilation. The size of the balloon chosen for angioplasty is two or more times the size of the coarcted segment, but no larger than the size of the descending aorta at the level of the diaphragm, as measured from a frozen frame of cineangiogram. Usually, a balloon that is midway between the size of the aortic isthmus (or transverse aortic arch) and the size of the descending aorta at the level of the diaphragm is chosen [4]. Aortic dissection, restenosis (15–25%) and aneurysm formation (10–15%) at the site of coarctation all have been documented.

Stenting

Primary stenting is the treatment of choice in native coarctation in older children and adults. It is superior to balloon angioplasty due to no elastic recoil and less aneurysm formation (By providing a scaffold for the weakened aortic wall, many believe that stent placement would decrease the likelihood of aneurysm formation). Nowadays, many balloon-expandable and self-expandable stents are available, which in multiple recent trials, there were no differences in midterm and long-term Major Adverse Cardiovascular Events (MACE) of patients based on the type of stent [5].

Procedural Technique

Under local anesthesia, after insertion of right femoral artery and vein sheaths (6F) (with fluoroscopic landmarks or ultrasonography guidance) and completed IV Heparin, (BP of the lower limb: 100/60). Femoral artery angiogram was done to evaluate the size of the Femoral and Iliac arteries and their capacity to pass large sheaths (Fig. 69.1). First, in AP and lateral projections descending aorta at the site of coarctation was injected with Pigtail catheter to characterize the residual segment, length, the distance to the left subclavian artery and the size of the aorta before and after the coarctation (Fig. 69.2). After crossing the stenotic segment with 0.035 inch wire and passing the Multipurpose catheter (BP of upper limb: 160/90, 60 mm Hg gradient), the wire exchanged with Amplatzer extra-stiff wire and positioned its tip in the ascending aorta. According to the size of the aortic arch (20 mm) and distal aortic size (24 mm), self-expandable stent 22*40 was chosen. After passing the delivery sheath (Cook 12) over the wire to the aortic arch, the delivery stent was passed through that to reach the tip of the sheath. In LAO view and angiography through the sheath, the correct position of the coarctation was confirmed. For optimal stent positioning, we covered the proximal stent with the delivery sheath and slowly expanded the distal stent to its full size, then by pulling the sheath off of the

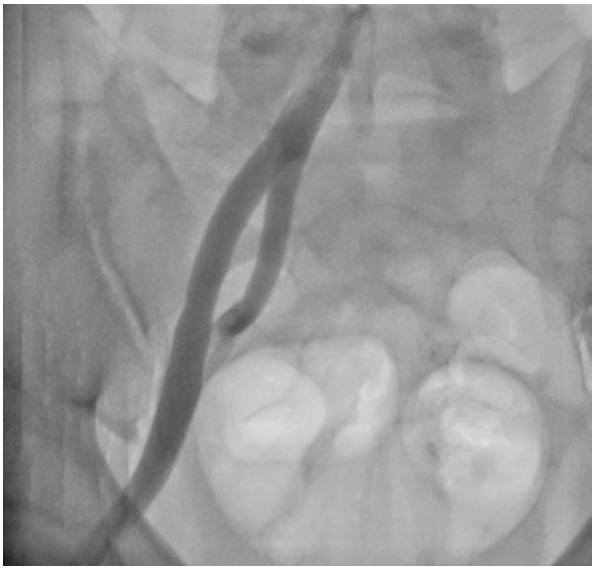

Fig. 69.1 Right CFA and CIA have an acceptable size

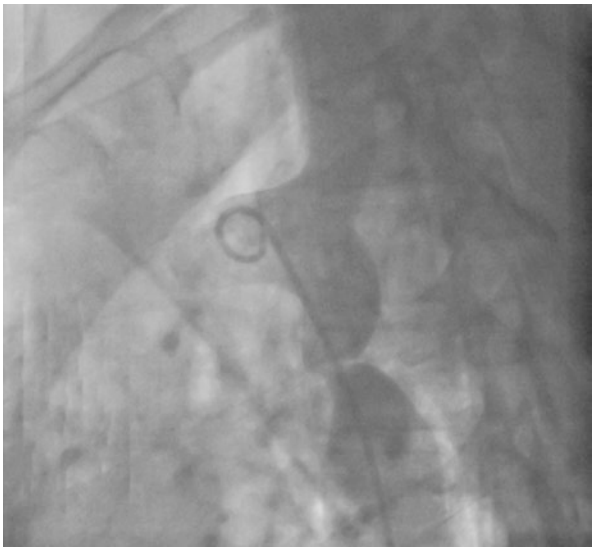

Fig. 69.2 Aortic arch injection showed significant narrowing after LSCA (50 mm Hg gradient) with post-stenotic dilatation

stent catheter, the remainder of the stent deployed across the coarctation segment (Fig. 69.3a, b). Following stent deployment, Pigtail catheter was passed to obtain simultaneous pressure measurements across the stent. Multiple angiograms was performed after stent deployment to rule out any complications (Fig. 69.4). Coarctoplasty is considered successful if the final gradient is less than 10 mm Hg and improvement in vessel caliber >80% of the normal adjacent aortic arch is achieved.

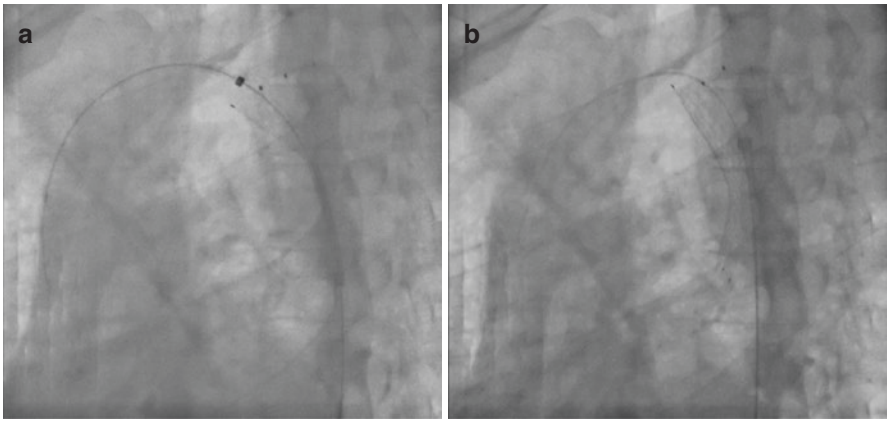

Fig. 69.3 (**a**, **b**) According to the size of the aortic arch (20 mm) and distal aortic size (24 mm), self-expandable stent 22*40 was chosen. The delivery stent was passed through the sheath to reach the tip of the sheath. In LAO projection and angiography through the sheath, the correct position of the coarctation was confirmed. For optimal stent positioning, we covered the proximal stent with the delivery sheath and slowly expanded the distal stent to its full size (**a**), then by pulling the sheath of the stent catheter back, the remainder of the stent deployed across, the coarctation segment (**b**)

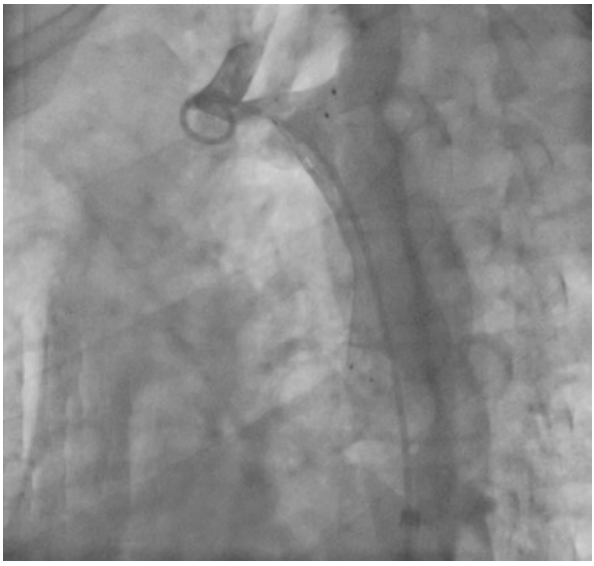

Fig. 69.4 Final aortic angiography showed, nice expansion of the device with residual gradient of 5 mm Hg without complications

Complications

During the procedure, major complications occur in approximately 15% of cases: Intimal tearing, dissection, perforation, stent migration, CVA, and the most important one, vascular complications. Late complications like: aneurysm and pseudoaneurysm formation, recoarct, and stent fracture are rare.

Conclusion

It is well established that stenting results in a marked improvement in aortic caliber. A successful procedure outcome is achieved in 98% of cases irrespective of whether it is native, recurrent, or its location. In one-third of patients, hypertension is ongoing, so lifetime follow-up of patients with coarctoplasty is mandatory for the evaluation of late complications and monitoring of blood pressure.

References

1. Hoimyr H, Christensen TD, Emmertsen K, et al. Surgical repair of coarctation of the aorta: up to 40 years follow up. Eur J Cardiothorac Surg. 2006;30:910–6.
2. Brown JW, Ruzmetov M, Hoyer MH, et al. Recurrent coarctation: is surgical repair of recurrent coarctation of the aorta safe and effective? Ann Thorac Surg. 2009;88:1923–30.
3. Matsui H, Adachi I, Uemura H, et al. Anatomy of coarctation, hypoplastic and interrupted aortic arch: relevance of intervention/surgical treatment. Expert Rev Cardiovasc Ther. 2007;5:871–80.
4. Rao PS, Galal O, Smith P. Five to nine year follow-up result of balloon angioplasty of native aortic coarctation in infants and children. JACC. 1996;27:462–70.
5. Firoozi A, Mohebbi B, Noohi F, et al. Self-expanding versus balloon- expandable stents in patients with isthmic coarctation of the aorta. Am J Cardiol. 2018;122(6):1062–7.