

# Transcatheter Therapy for Coarctation of Aorta: Analysis of 150 Cases

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## Abstract:

**Keywords:**  
Hypertension,  
Coarctation of  
aorta,  
Angioplasty.

**Background:** This study was conducted to analyze the outcome of transcatheter intervention of Coarctation of aorta carried out on 150 patients.

**Methods:** This was a retrospective study, conducted in Pediatric Cardiology Unit, Combined Military Hospital Dhaka and Lab Aid Cardiac hospital from January 2007 to December 2015. Data were collected by chart review.

**Results:** Age of the patient varies from 7 days to 28 years. Sixty six (44%) patients were female and rest were male. Native coarctation was 138 (92%) and post surgical re-coarctation was 12 (8%). Neonatal critical Coarctation was 60 (40%). Thirty six (24%) cases were detected when they were investigated for hypertension. Abdominal coarctation was found in 18 cases (12%). Multiple coarctation was found in 9 (6%) cases. Six cases (4%) had balloon angioplasty twice and 12(8%) cases had stenting after recoarctation as they had body weight above 15 kg. Aneurysm and aortic dissection was observed in one (0.66%) case. Thrombophlebitis observed in 3(2%) cases and temporary pulse loss in 9 (6%) cases. No mortality was noticed.

**Conclusion:** Balloon angioplasty for coarctation of aorta and stenting in suitable cases is a safe and effective measure to treat coarctation of aorta.

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## Introduction:

Coarctation of Aorta is a common congenital defect which comprises about 8% of all congenital lesions. Most of the cases are detected in childhood and treated accordingly but some of the cases may also be detected in adolescents and adults in the context of investigation for hypertension.<sup>1</sup> Coarctation varies considerably in its anatomy, physiology, clinical presentation, treatment-options and outcome. Though it is usually a discrete lesion, coarctation may consist of a long segment stenosis, may be associated with tubular hypoplasia of transverse arch or may be abdominal in location.<sup>2</sup> In some rare cases more than one coarctation area may be found along the course of aorta. Critical coarctation at the level of isthmus typically presents in infancy and is a medical emergency. The natural history of untreated coarctation is that of premature death from stroke and coronary heart disease or sudden death. Relief of anything more than mild obstruction is usually indicated.<sup>1,2</sup> Balloon angioplasty and Stenting of coarctation of aorta is an alternative, minimally invasive and well accepted treatment option for coarctation of aorta.

## Methods:

**Study design:** Retrospective study which was carried out in Paediatric Cardiology unit of Combined Military Hospital (CMH) Dhaka and Lab aid cardiac hospital from January 2007 to December 2015. **Indication for intervention:** Any patient with diagnosis of discrete coarctation of aorta by echocardiography or MRI and a resting systolic gradient by sphygmomanometer between the upper and lower limbs of >20 mm Hg were offered balloon angioplasty as an alternative to surgery. Neonates and young infants were also included in the study as pediatric surgical facility in full range is not yet available in our center. In re coarctation cases after balloon angioplasty, stenting was offered if weight was more than 15 kg. **Exclusion criteria:** coarctation of aorta associated with other lesions which cannot be managed non surgically. Long segment coarctation and hypo plastic transverse arch were also excluded.

**Procedure:** Informed consent was taken before the procedure. All the patients were sedated with injection ketamine and midazolam. After proper

draping, right heart catheterization was performed. An end hole catheter was introduced through retrograde approach and exchanged with pigtail catheter placing the tip of the catheter in the ascending aorta. Aortogram was performed in left anterior oblique (15° - 20°) and lateral view to visualize the area of coarctation. Pressure gradient between ascending aorta and RFA was measured in all cases. A 0.035 mm x 260 cm wire was exchanged with pigtail catheter keeping the tip just above the aortic valve. Patients were heparinized with 100 u/kg heparin immediately after vascular entry. Balloon and stent diameter initially chosen was equal or up to 2 mm more than the size of the aorta at the level of subclavian artery and not greater than the diameter of aorta at the level of diaphragm. Short inflation time utilized and repeated for 2/3 times. An aortogram was repeated to check the lesion and pressure gradient measured again between ascending aorta and RFA. If no significant change noticed than next larger balloon was used in similar manner. Eighty percent increase in diameter of coarctation area and pressure gradient of less than 20 mm Hg was considered as successful intervention. For stenting a 0.35 wire was placed in ascending aorta through a multipurpose catheter. A Mullin sheath as per recommendation of stent size was placed crossing coarct segment. Balloon mounted stent was forwarded over the wire to coarct segment, Mullin sheath pulled downward to expose the stent and inflated up to required ATM to dilate it up to expected diameter. Post inflation pressure above and below the isthmus was measured. It was not significant if it is less than 20 mm hg after procedure.

Data collection: Pressure of the aorta above and below the level of Coarctation was measured before and after balloon angioplasty. Diameter of aorta at various levels was measured.

Aortic Arch measurement: Transverse arch was measured between brachiocephalic and left common carotid artery. Isthmus, coarctation segment and diameter at the level of diaphragm were also measured.

If duration of procedure was long, then additional 75 u/kg heparin was given. Pedal pulse and blood pressure of the patients were monitored at 15 minutes interval in first hours, 30 minutes interval in next two hours and hourly interval in next 6 hours. If pedal pulse was found absent after one hour, heparin infusion was started at the rate of 15u/kg/hrs after a bolus dose of 75 u/kg/dose.

Follow up: Patients were followed up at regular interval depending on their clinical status. Echocardiography was performed immediately after the procedure and before discharge. Most of the patients were discharged 24 hours after the procedure. Only neonates and stenting cases were discharged 72 hours after the procedure. Patients were followed up at 1, 3, 6, 12 months of intervention and yearly thereafter for three years.

### Results:

Fig I showed sex distribution of patient. Fifty six percent of the patients were male and 44% were female.

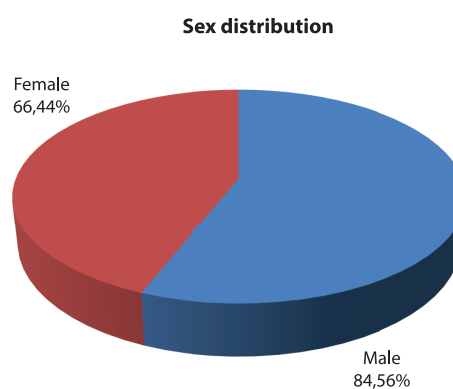


Fig.-1: Sex distribution of the patients (n=150).

Fig II showed age distribution of the study cases. Thirty eight percent cases were neonates, 8% cases were infants, 18% were in less than 5 years age group, 26% were in more than 5 years to 15 years age group and 10 percent of the patients were in more than 15 years age group.

Fig III showed mode of presentation. Forty percent of the patients were presented with feature of

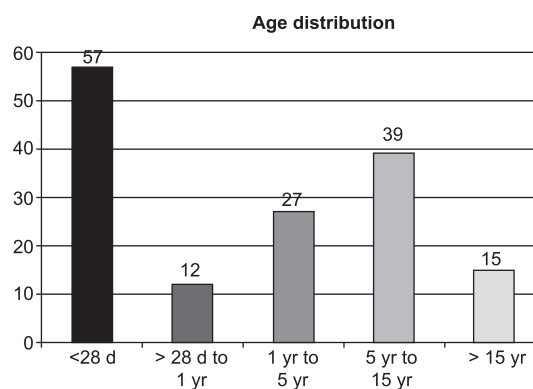


Fig.-2: Age distribution of the patients (n= 150).

congestive heart failure or acute renal failure in the neonatal period. Twenty eight percent patient had incidental finding of murmur when they referred to doctor for other illness. Twenty four percent patients had headache or hypertension or history of convulsion for which they were investigated and discovered as coarctation of aorta. Eight percent of the cases were post-surgical re-coarctation cases and they were identified as re-coarctation during follow up.

Table-I showed site of coarctation in Aortography. Seventy eight percent cases had coarctation near

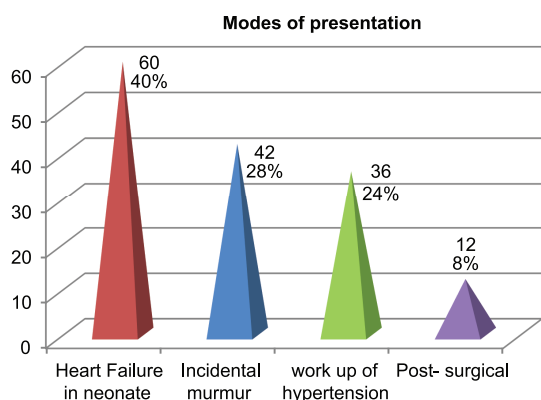


Fig.-3: Modes of presentation (n=150).

the origin of subclavian artery; six percent had coarctation in the thoracic aorta just above the diaphragm. Twelve percent of the cases had coarctation in the abdominal aorta and 4% (06) had coarctation in multiple sites which were located in thoracic and abdominal aorta. These six cases were investigated and later diagnosed as Takayasu disease.

Fig.-IV showed pressure gradient across coarct segment during angiography. Fifteen (10%) patient had pressure gradient between 20-30 mm Hg, 72 (48%) patient had pressure gradient of 30-50 mm Hg and 63 (42%) patient had pressure gradient more than 50 mm Hg.

Fig.-V showed balloon diameter used for various age group. Minimum balloon size was 4mm and maximum was 22 mm.

Fig.-VI showed outcome of the cases. In 144 (96%) cases, pressure gradient reduced to below 20 mmHg after balloon angioplasty. In six (4%) cases pressure gradient dropped to below 30 mm Hg. Aneurysm formation and dissection was observed in one each of the cases. In two cases there was re-stenosis after 6 months of intervention and balloon dilatation was repeated. Pedal pulse loss was encountered in 9 (6%) cases and heparin infusion was given.

Table-I

Site of Coarctation in Aortogram (n=150).

Site	Near the origin of left subclavian artery (at the insertion of ductus arteriosus)	In Thoracic aorta	Multiple Coarctation	In Abdominal Aorta
Number	107	9	6	18
Percentage	78	6	4	12

Note: All multiple coarctation cases had Takayasu disease

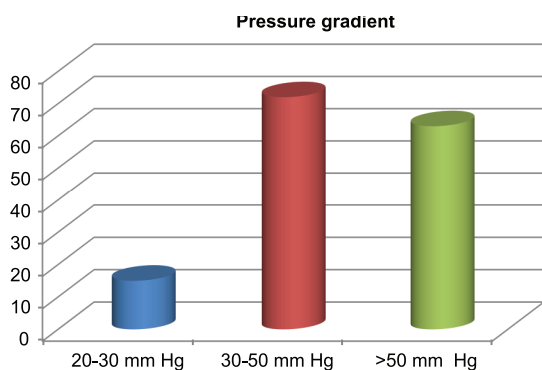


Fig.-4: Pressure gradient range across Coarctation segment (n=150).

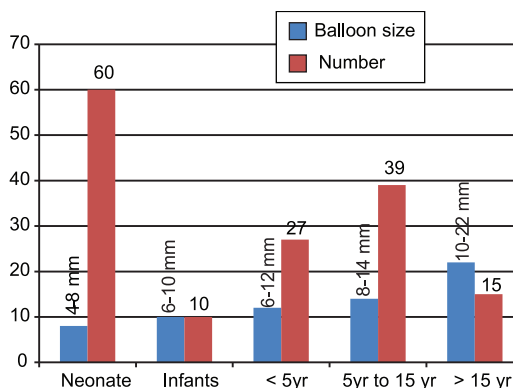
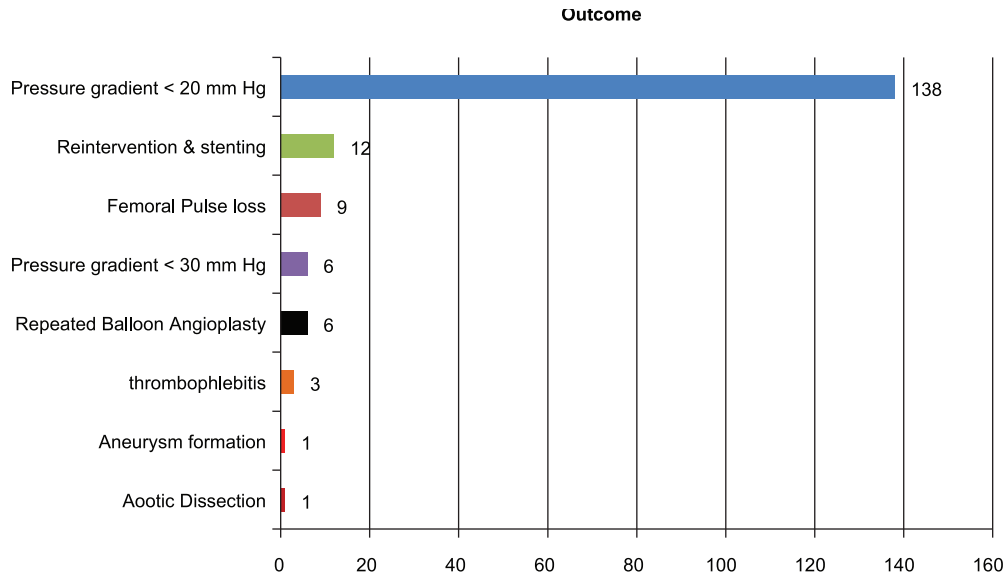
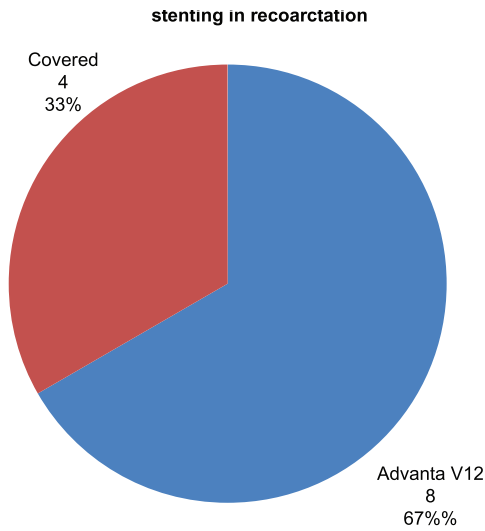


Fig.-5: Showed balloon diameter used for the cases (n=150).



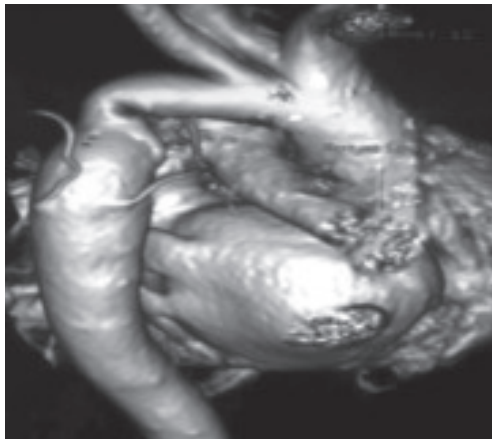
**Fig.-6:** Outcome of the cases (n=150).



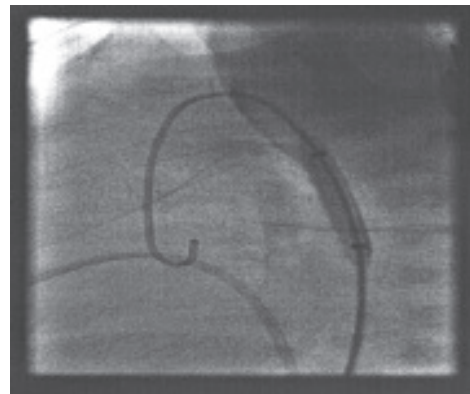
**Fig.-7:** Type of stents in recoarctation cases (n=12).



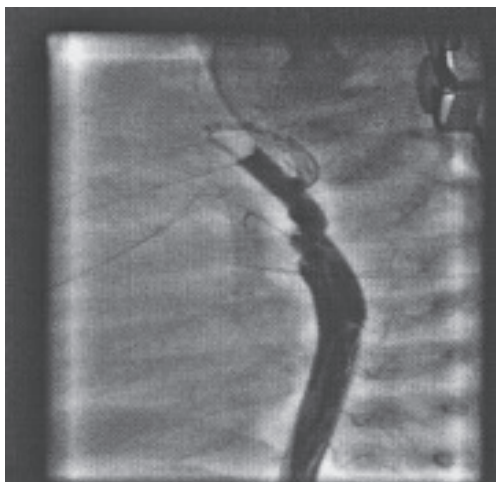
**Fig.-9:** Aortogram showing severe Coarctation of aorta.



**Fig.-8:** MRI showing severe Coarctation of the aorta.



**Fig.-10:** Balloon angioplasty procedure with inflated balloon inside the coarctation segment.



**Fig.-11:** Aortogram after balloon angioplasty procedure.



**Fig.-12:** Aortogram after implantation of stent.

Thrombophlebitis was noticed in 3 (2%) cases and was treated accordingly. Twelve (8%) patient required stenting after recoarctation with atrium V12 and CP stent of various sizes. Fig VII showed distribution of type of stent used.

#### Discussion:

Coarctation of aorta accounts for 5%-8% of congenital heart disease.<sup>3</sup> Coarctation of aorta was the first congenital heart defect to be repaired surgically in 1945 by Crawford.<sup>4</sup> Balloon angioplasty for coarctation was first reported in 1982.<sup>5</sup> Both treatment modalities had major drawbacks, including re coarctation, residual hypertension, aortic wall injury causing dissection, and aneurysm formation. To overcome some of these limitations, intravascular balloon-expandable stent therapy was

introduced in the 1990s.<sup>6,7</sup> Balloon angioplasty for coarctation was first performed in our center in the year 2000 which was the first reported case in Bangladesh.<sup>2</sup> Coarctation is more common in male than female.<sup>2,8</sup> Our study also showed male preponderance. The management of patient presenting with neonatal coarctation is revolutionized by invention of prostaglandin E and its use to restore the patency of the ductus.<sup>9</sup> We found 60 (40%) cases of coarctation in neonates as neonatal cardiac care has improved a lot in our country and early detection of the cases are possible now a days. Forty two cases were completely asymptomatic and were identified incidentally when they reported to pediatricians/physicians for other reasons. Majority of the cases were asymptomatic older children, adolescents and adults found in some other study.<sup>10,11</sup> Most common site of coarctation is aortic arch which correlates with our study also.<sup>2,3</sup> Pressure gradient across coarctation depends on severity and if it is more than 20 mm Hg than it is significant. The indications for balloon angioplasty of aorta / stenting are

1. Native or recurrent obstruction with gradient > 20 mm Hg.
2. Coarctation where there is left ventricular hypertrophy or systemic hypertension or extensive collaterals. Balloon diameters are individualized and it depends on size of the aorta at the level of subclavian artery and aorta above the level of diaphragm.<sup>2-4</sup>

We have performed balloon angioplasty for post surgical re-Coarctation in 12 cases. One study showed excellent outcome of balloon angioplasty of re-coarctation which was published in 2008.<sup>9</sup> Another study in Yale university school of medicine showed good outcome of balloon angioplasty of surgical re-coarctation.<sup>12</sup> In this study outcome was excellent. Re-intervention was required in two cases only 6 months after the first intervention. In a study carried out in hospital for sick children Toronto, Canada showed good outcome and concluded the study by saying that balloon angioplasty is a safe and effective treatment for native Coarctation of aorta.<sup>13,14</sup> Major drawback of the procedure is that it may cause recoil of the vessel wall and restenosis.<sup>13</sup> Balloon angioplasty may cause aortic wall dissection in 1-4% cases and aneurysm formation in 4-11.5% cases.<sup>15-17</sup> In our study one

patient had aneurysm formation and one patient had dissection. Coil embolization of dissected part was performed immediately with 5 cook detachable coil. Twelve cases developed recoarctation in follow up and they were stented with covered stent of various length of CP and advanta V12. Stent is an intraluminal graft made of stainless steel wire that allows dilatation of the stenotic lesion and provides an endoprosthesis to prevent recoil of the arterial wall. It was first developed and tested in dog arteries by Palmaz et al.<sup>18,19</sup> Dr. Mullin was the first to use intravascular stents (IS) in pulmonary arteries and systemic veins.<sup>20</sup> This was soon followed by studies demonstrating its ability to be re-expanded in a swine model aorta, with eventual use of the stent to treat native and recurrent coarctation of the aorta.<sup>21,22</sup> Since the mid-1990s, with its first use in an infant and followed by a small series in adults,<sup>23,24</sup> this therapy for COA has gained acceptance as a primary option for treating native and recurrent COA in adolescents and adults.<sup>24</sup> To provide a stable track to advance and deploy the balloon/stent segment, an exchange-length Amplatzer extra- or super-stiff (St. Jude Medical, St. Paul, MN) wire is positioned in the ascending aorta or right subclavian artery. The stent is hand-crimped on the balloon catheter, with the extremely low profile balloons requiring inflation to 0.6 atmosphere to allow for adequate stent/balloon traction, thereby preventing stent slippage during advancement through the long sheath. Balloon-in-balloon is by far the preferred delivery balloon when initial stent dilation is e" 18 mm as it provides controlled stent expansion, the ability to adjust stent position following inner balloon expansion, and decreased stent foreshortening. For stents that are initially deployed on d" 16 mm balloon catheters, the Z-MED II™ balloon catheters (NuMed Inc., Hopkinton, NY) are the most widely used. For optimal stent positioning, we cover the proximal balloon with the delivery sheath and slowly expand the distal stent to its full size. We then pull the sheath off of the balloon catheter and deploy the remainder of the stent across the Coarctation segment. For optimal stent delivery and to prevent stent malposition and migration, right ventricular pacing may be performed. In our cases we used RV pacing in two occasions. Stent implantation is considered successful if a gradient < 10 mm Hg and improvement in vessel caliber > 80% of the normal adjacent aortic arch is achieved.<sup>25</sup>

In our series 12 cases had history of balloon Coarctoplasty earlier. Later they were treated with stenting for recoarctation. As stent is expensive it was not considered as first option in any of the cases.

### Conclusion:

Transcatheter therapy for native and recurrent coarctation is effective with good short and intermediate term outcome. Our study supports the previous studies showing that balloon dilatation and stenting is safe and effective treatment for native as well as post surgical coarctation of aorta in children adolescents and adults. Even infantile coarctation has good outcome and it is a safe and effective procedure for the centers where surgical help is not available.

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### Conflict of Interest - None.

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