Outcome of aortic arch reconstruction in infants with coarctation: Importance of operative approach

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ABSTRACT

Objectives: Coarctation with hypoplastic aortic arch can be treated with resection and extended end-to-end anastomosis (REEEA) as well as end-to-side anastomosis (ESA). The aim of the study was to review our experience with these techniques in newborns and infants and to assess mid-term outcome with regards to morbidity, mortality, and reintervention rate in relation to operative access and technique.

Patients and Methods: Retrospective review of hospital charts and surgical reports from 183 consecutive newborns and infants with coarctation and hypoplastic aortic arch with or without ventricular septal defect between 1996 and 2013. Median age at surgery was 15 days (0-345). Lateral thoracotomy was used as operative access in 111 patients; 72 patients had a median sternotomy, 71 of them with cardiopulmonary bypass (ESA n = 30, REEEA n = 41). Fifty-two patients (28.4%) had an additional ventricular septal defect closure. Follow-up data were available for 75.96% with a median follow-up of 6.3 years (0.2-18.16 years).

Results: Thirty-day mortality was 0.54% with no late mortality occurring during follow-up. There was 1 severe complication: paraplegia and cerebral hypoxemia after REEEA. Freedom from mortality and reintervention at 10 years was 99.27% and 90.12%, respectively. Lateral thoracotomy as operative access was a risk factor for recurrent obstruction ($P = .03$).

Conclusions: REEEA and ESA were safe and effective treatments in newborns and infants. In borderline cases, aortic arch reconstruction should be performed through a median sternotomy on bypass. (J Thorac Cardiovasc Surg 2016;152:1506-13)

Aortic coarctation with hypoplastic transverse arch; surgery through a median sternotomy.

Central Message

Aortic arch reconstruction through a median sternotomy on bypass was associated with lower rates for recurrent obstruction.

Perspective

In neonates and infants with borderline hypoplastic aortic arch, the surgical approach and the operative technique are crucial factors considering recurrent obstruction. The surgical approach through a median sternotomy via bypass was as safe as a lateral thoracotomy but superior regarding recurrent obstruction, especially in patients with a proximal transverse aortic arch z score of less than -4.59.

See Editorial page 1475.

Coarctation of the aorta associated in the newborn and infant period can be treated by different surgical techniques such as simple end-to-end anastomosis, subclavian flap aortoplasty, or patch aortoplasty.^{1,2} Here, the surgical repair focuses mainly on the excision of the coarctation site³; however, associated hypoplasia of the aortic arch frequently is present and if not sufficiently addressed may lead to relatively high rates of restenosis. Techniques such

as resection and extended end-to-end anastomosis (REEEA) or the end-to-side anastomosis (ESA) of descending aorta and proximal aortic arch effectively address associated transverse aortic arch hypoplasia.⁴ Although ESA always requires cardiopulmonary bypass (CPB), REEEA can be performed either through a lateral thoracotomy avoiding CPB but with limited access to the proximal part of the arch or also through a median sternotomy via CPB. In the newborn and infant period, however, arch repair on CPB has potential risks, especially regarding neurologic

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Abbreviations and Acronyms

CPB	= cardiopulmonary bypass
ESA	= end-to-side anastomosis
Q	= quartile
REEEA	= resection and extended end-to-end anastomosis
VSD	= ventricular septal defect

complications. These procedures either require periods of deep hypothermic circulatory arrest in the patient, selective antegrade cerebral perfusion, or, as recently described, a double arterial perfusion technique.⁵ Data regarding outcome especially after procedures in the newborn or infant period are still sparse.

The aim of this study was to review our experience with ESA and REEEA in newborns and infants with coarctation and associated hypoplasia of the aortic arch and to evaluate the midterm-outcome with focus on mortality, morbidity, and rate of reintervention in relation to operative access and technique.

PATIENTS AND METHODS

Between 1996 and 2013, 183 consecutive newborns and infants with coarctation of the aorta +/- outlet ventricular septal defect (VSD) underwent either REEEA or ESA +/- VSD closure in our center (Figure 1). Preoperatively, the proximal transverse aortic arch was measured between the innominate artery and the left common carotid artery by echocardiography. Almost all patients had at least some degree of associated proximal transverse aortic arch hypoplasia as defined with

a z score of less than -2. Patients with interrupted aortic arch, Williams-Beuren syndrome, or Shone complex with a hypoplastic left ventricle were excluded.

Demographic data of the study populations are listed in Tables 1-3 and Table E1. The decision among ESA on bypass, REEEA with access through a median sternotomy on CPB, and REEEA through a lateral thoracotomy without CPB was made by an experienced pediatric cardiologist together with a pediatric cardiac surgeon, based on the size and anatomy of the proximal transverse aortic arch. Cut-off values used were diameters of the proximal transverse arch of 4 mm or less in newborns and young infants in the earlier study period and z scores of -4.5 or less in recent years.

One hundred twenty patients (65.57%) were neonates; 153 of 183 patients (83.6%) had coarctation repair with REEEA, 42 of them through a median sternotomy on CPB, and 30 of 183 patients (16.4%) underwent ESA (Table 2) (time distribution of ESA between 1996 and 2013: 1996 and 2001, n = 0; 2002 and 2005, n = 5; 2006 and 2009, n = 15; 2010 and 2013, n = 10). A total of 71 of 183 patients (38.79%) underwent aortic arch repair on CPB with or without intracardiac VSD closure (Table 3). During CPB, 2 of 71 patients had deep hypothermic circulatory arrest, 13 of 71 had selective cerebral antegrade perfusion, and 56 of 71 patients had antegrade cerebral perfusion together with lower body perfusion through cannulation of the descending aorta. A total of 44 of 183 patients (24.04%) were lost to follow-up, mostly because they were referred from other countries and we were not able to get sufficient follow-up information.

After approval from the institutional review board (TA-12-13), a retrospective analysis of patient's charts was performed. Charts were reviewed for type of surgery and operative access, demographics, operative details, perioperative events, need for prostaglandins, in-hospital mortality, postoperative complications, evidence of arch restenosis, and the need for reintervention. Echocardiographic measurements of the proximal transverse arch were performed from digitally stored data (Echopac; GE Healthcare, Wauwatosa, Wis) and the original videotapes. One single investigator (A.T.) did all the assessment of follow-up.

FIGURE 1. Overview of the study population. REEEA, Resection and extended end-to-end anastomosis; ESA, end-to-side anastomosis.

TABLE 1. Demographic data of all newborns and infants (n = 183) with coarctation and hypoplastic aortic arch and the 2 subgroups who had isolated arch repair or arch repair together with VSD closure

	Total, n = 183	Isolated arch repair, n = 131	Arch repair with VSD closure, n = 52	P value
Age at surgery, d				
Median (quartiles: Q1-Q3)	15 (6.5-50)	16 (6-53)	13.5 (8-37.5)	.09
n = available data	n = 183/183			
Weight, kg				
Median (quartiles: Q1-Q3)	3.42 (2.85-4.22)	3.5 (2.9-4.54)	3.21 (2.7-3.8)	.03*
n = available data	n = 183/183			
Height, cm				
Median (quartiles: Q1-Q3)	50 (48-54.75)	51 (48.25-55)	50 (47-53)	.07
n = available data	n = 183/183			
Sex, male/female, %	57.9/42.1 (106/77)	63.4/36.6 (83/48)	44.2/55.8 (23/29)	
PGE1, %	50.8 (93/183)	45.8 (60/131)	63.5 (33/52)	.0312*
n = available data	n = 183/183			
Proximal transverse aortic arch z score				
Median (quartiles: Q1-Q3)	-3.91 (-2.85 to -4.46)	-3.77 (-2.84 to -4.35)	-4.16 (-3 to -4.71)	.28
n = available data	n = 149/183	n = 109/131	n = 40/52	
In-hospital stay, d				
Median (quartiles: Q1-Q3)	15 (11-22)	13 (10-18.5)	21.5 (16.3-29)	<.0001*
n = available data	n = 183/183			
ICU stay, d				
Median (quartiles: Q1-Q3)	3 (1-5)	2 (1-4)	5 (3-7)	<.0001*
n = available data	n = 166/183	n = 116/131	n = 50/52	
Aberrant RSA (%)	3.83 (7/183)	3.82 (5/131)	3.85 (2/52)	

VSD, Ventricular septal defect; PGE1, prostaglandin E₁; ICU, intensive care unit; RSA, right subclavian artery. *P value = .05 or lower.

Surgical Techniques

Resection and extended end-to-end anastomosis. A left thoracotomy through the fourth intercostal space was performed. After dissection and mobilization of the aortic arch, head vessels, and proximal descending aorta is completed, the arterial duct is doubly ligated and

divided. The aortic arch is controlled proximal to the left carotid artery. The distal clamp is placed distal to the coarctation area. After all the coarctation and ductal tissue is resected completely, the undersurface of the transverse aortic arch is incised up to the segment between brachiocephalic artery and left common carotid artery and the extended end-to-end

TABLE 2. Demographic data of the study population divided into REEEA and ESA groups

	REEEA, n = 153	ESA, n = 30	P value
Age, d			
Median (quartiles: Q1-Q3)	17 (7-52)	8.5 (6.25-14.5)	.16
Weight, kg			
Median (quartiles: Q1-Q3)	3.5 (2.83-4.4)	3.19 (2.92-3.64)	.13
Height, cm			
Median (quartiles: Q1-Q3)	51 (48-55)	50 (47-51)	.21
Sex, male/female	58.2/41.8 (89/64)	56.7/43.3 (17/13)	
PGE1, %	44.4 (68/153)	83.3 (25/80)	.00008*
Proximal transverse aortic arch z score			
Median (quartiles: Q1-Q3)	-3.58 (-2.77 to -4.27)	-4.99 (-4.44 to -6.36)	<.0001*
n = available data	n = 125/153	n = 24/30	
In-hospital stay, d			
Median (quartiles: Q1-Q3)	14 (10.5-20)	22 (20-28.75)	.0002*
ICU stay, d			
Median (quartiles: Q1-Q3)	3 (1-4.5)	7 (3.25-8)	<.0001*
n = available data	n = 136/153	n = 30/30	
Aberrant RSA (%)	3.3 (5/153)	6.7 (2/30)	

REEEA, Resection and extended end-to-end anastomosis; ESA, end-to-side anastomosis; PGE1, prostaglandin E₁; ICU, intensive care unit; RSA, right subclavian artery. *P value = .05 or lower.

TABLE 3. Demographic data of the study population divided by operative access (median sternotomy with CPB vs lateral thoracotomy)

	Median sternotomy + CPB, n = 71	Lateral thoracotomy, n = 111	P value
Age, d			
Median (quartiles: Q1-Q3)	11 (7.5-35)	17 (6-57.5)	.06
Weight, kg			
Median (quartiles: Q1-Q3)	3.21 (2.85-3.8)	3.5 (2.85-4.67)	.029*
Height, cm			
Median (quartiles: Q1-Q3)	50 (47-53)	51 (48.25-55)	.12
ESA/REEEA	30/41	0/111	
Deaths	1	0	
Re-Interventions	1	10	.03*
Proximal transverse aortic arch z score			
Median (quartiles: Q1-Q3)	−4.46 (−3.4 to −5.21)	−3.47 (−2.62 to −4.04)	<.0001*
n = available data	n = 58/71	n = 90/111	
In-hospital stay, d			
Median (quartiles: Q1-Q3)	21 (16-28)	12 (9-17)	<.0001*
ICU stay, d,			
Median (quartiles: Q1-Q3)	5 (3-8)	2 (1-4)	<.0001*
n = available data	n = 69/71	n = 96/111	
Aberrant RSA, %	7 (5/71)	1.8 (2/111)	

CPB, Cardiopulmonary bypass; ESA, end-to-side anastomosis; REEEA, resection and extended end-to-end anastomosis; ICU, intensive care unit; RSA, right subclavian artery. *P value = .05 or lower.

anastomosis is created with absorbable monofilament suture material in continuous suture technique.

REEEA on CPB. Surgical approach was through a median sternotomy on CPB. Until 2003, selective cerebral perfusion was used. Since October 2003, double arterial perfusion was the almost exclusively used bypass technique (Video 1). It was introduced to minimize end-organ failure and the risk of paraplegia in aortic arch reconstruction by providing sufficient perfusion to these organs and had no impact on the used type of aortic arch repair. With the introduction of double arterial cannulation, we cool down to 28°C in biventricular cases in which no period of circulatory arrest is necessary for other reasons. Bicaval cannulation was only used if additional intracardiac repair was necessary. After dissection and mobilization of aortic arch and head vessels is completed, the arterial duct is doubly ligated and divided. The descending aorta is mobilized widely. Tourniquets are applied to control the head vessels, and a clamp is placed distal to the coarctation area. The extended end-to-end anastomosis is then created in the same way as through a lateral thoracotomy.

ESA of descending aorta and proximal aortic arch. This surgical technique was first described by Karl and colleagues⁶ in 1992. Operative access and cannulation techniques, as well head vessel and descending aorta control, were the same as in performing REEEA on CPB. The coarctation and ductal tissue is removed completely and the aortic arch is closed by suture directly after the origin of the left subclavian artery. No intercostal arteries are divided. Usually the first 2 to 3 pairs are mobilized. To facilitate the anastomosis of both ends, the supra-aortic vessels are mobilized extensively. An incision is made into the undersurface of distal ascending aorta and proximal aortic arch and the ESA of descending aorta and proximal aortic arch is created with absorbable monofilament suture material in continuous suture technique.

Statistical Analysis

For statistical analysis, *t* tests were used for comparing study populations and for evaluating risk factors for reintervention and mortality. Mortality (early and late), actuarial survival rates, and freedom from reintervention due to recurrent coarctation were analyzed by Kaplan-

Meier curves. Receiver operating curve analysis was used for the calculation of cut-off values. Cut-off values were chosen based on the Youden index. The level of statistical significance was set at *P* ≤ .05. Z scores of proximal transverse aortic arch and aortic isthmus diameters were obtained with a program (Cardio Z; UBQO, Evelina Children's Hospital, London, UK), which uses regression equations for the calculations.⁷

RESULTS

Early Outcomes

Isolated coarctation with associated hypoplastic aortic arch. One hundred thirty-one patients underwent isolated repair of coarctation of the aorta with associated

VIDEO 1. Cannulation of the descending aorta in aortic arch repair. Video available at: [http://www.jtcvsonline.org/article/S0022-5223\(16\)31057-1/addons](http://www.jtcvsonline.org/article/S0022-5223(16)31057-1/addons).

FIGURE 2. Overview of the follow-up population. REEEA, Resection and extended end-to-end anastomosis; ESA, end-to-side anastomosis.

hypoplastic aortic arch; in 116 patients surgical repair was performed with REEEA and in 15 patients with ESA. There was no in-hospital death in this group. One patient needed an early reintervention: he underwent an ESA of descending aorta and proximal aortic arch because of a residual hypoplasia of the transverse aortic arch 11 days after primary repair by extended end-to-end anastomosis through a left thoracotomy. This results in a 30-day mortality rate of 0% and an early reintervention rate of 0.76% for this group and 0.55% for the whole study cohort. A severe neurologic complication was observed in 1 patient (0.55% of the study population); this patient with an additional aberrant right subclavian artery developed permanent paraplegia and transient seizures after REEEA through a left thoracotomy.

VSD with hypoplastic aortic arch. Fifty-two patients underwent closure of a VSD with associated hypoplastic aortic arch; in 37 patients arch repair was carried out with REEEA and in 15 patients with ESA. There was one

in-hospital death in this group, due to sepsis and cardiorespiratory failure.

Patients with additional lower-body perfusion. There were 56 patients who underwent reconstruction of the aortic arch with additional lower-body perfusion; 25 of them underwent reconstruction by ESA. Of these, 2 patients who needed peritoneal dialysis postoperatively due to acute renal failure: 1 patient in the REEEA group and 1 patient in the ESA group. The median creatinine levels for all patients of this cohort directly after surgery and on the third postoperative day were 0.43 mg/dL (quartile [Q] 1: 0.39-Q3: 0.48) and 0.48 mg/dL (Q1: 0.37-Q3: 0.65), respectively. The median lactate levels directly after surgery and after 6 hours were 1.9 mmol/L (Q1: 1.23-Q3: 3) and 1.45 mmol/L (Q1: 1.03-Q3: 2.3). There was no significant difference between the REEEA and the ESA group regarding the incidence of acute renal failure, creatinine levels, lactate levels, and the length of in-hospital stay.

FIGURE 3. Kaplan-Meier curve calculation for freedom from mortality.

FIGURE 4. Kaplan-Meier curve calculation for freedom from reintervention.

Mid-term outcomes. Follow-up was available from 139 patients (75.96%) with a median follow-up duration of 6.3 years (range 0.2-18.16 years; 1004.37 patient years) (Figure 2).

Mortality. There were no late deaths. The calculated freedom from mortality (early and late) at 10 years for the entire group was 99.27% (Figure 3).

Procedure-related complications. In none of the patients of the follow-up population did we notice any signs of permanent left laryngeal nerve injury, bronchial compression, or left pulmonary artery stenosis.

Reinterventions on the aortic arch. During the study period, reintervention had been performed in 11 of 139 patients of the follow-up population; 10 of these 11 patients had undergone primary repair with REEEA through a lateral thoracotomy. A significant obstruction was defined as presence of a typical coarctation Doppler flow pattern with increased systolic and end-diastolic velocities and/or a difference of more than 15 mm Hg in systolic blood pressure at rest between upper and lower limbs. A total of 9 of 11 patients (81.8%) needed a reintervention within the first postoperative year, 3 of 11 patients (33.3%) underwent a reoperation (2 ESA and 1 patch aortoplasty), and 8 of 11 patients (66.7%) had an intervention by cardiac catheterization. In 2 of these stents were placed in the area of the aortic isthmus whereas the other 6 patients underwent a balloon angioplasty only. The median duration between the operation and the reintervention was 3.84 months (range 0.12-94.44 months). The calculated freedom from reintervention at 10 years was 90.12% for the entire group (Figure 4). Univariate analysis indicated that only primary repair using extended end-to-end anastomosis through a left thoracotomy was a risk factor for the need of reintervention in our study ($P < .05$). A retrospective analysis of the patients of the reintervention group, which underwent primary repair through a left thoracotomy, and of the asymptomatic group showed that the preoperative z scores of the proximal transverse aortic arch differed significantly ($P < .0001$) from the asymptomatic group, which underwent aortic arch repair through a left thoracotomy. The median preoperative z score of the proximal transverse aortic arch in the reintervention group was -5.7 (Q1: -4.96 to Q3: -5.72) and -3.3 (Q1: -2.59 to Q3: -3.96) in the asymptomatic group. Receiver operating curve analysis was used for the examination of sensitivity and specificity in terms of prediction of the outcome reintervention with z scores of the proximal aortic arch. The ideal cut-off value based on Youden index is a z-score of the proximal aortic arch of -4.59 with a sensitivity of 100% (95% confidence interval, 66.4-100.0) and a specificity of 98.77% (95% confidence interval, 93.3-100.0).

DISCUSSION

This retrospective study on newborns and infants with aortic coarctation and associated hypoplastic aortic arch, who underwent repair with REEEA or ESA, showed that both techniques could be performed with a low perioperative mortality and morbidity as well as a low rate for recurrent obstruction in the aortic arch with a freedom from reintervention at ten years of 90.12%. Access through a median sternotomy with the use of CPB was superior to a lateral thoracotomy in terms of necessary reinterventions.

Arch Repair with REEEA

Regarding the outcome of REEEA, similar results were reported from other centers.^{3,8-13} The reported rate for recurrent obstructions in the aortic arch was between 4% and 12%. Rates for mortality were between 0% and 26%.

In a recent study by Kaushal and colleagues,³ 201 patients underwent coarctation repair with REEEA. The rates for overall mortality and recurrent obstruction with the need for reintervention were 4.4% and 4.3%, respectively. In this study cohort, 78% of the patients underwent repair of coarctation through a left thoracotomy. Although our study population was younger (median 15 days vs 23 days; 65% vs 53% newborns) and association with intracardiac defects was more than twice prevalent (28.41% vs 13.93%), we were able to report comparable low rates of recurrent obstruction and even lower rates of mortality.

Arch repair with ESA. In 1996 Rajasinghe and colleagues¹⁴ published their data using ESA on CPB for aortic arch repair in 23 patients (19 neonates and 4 infants) with 3 patients, who had an additional VSD closure. There was only 1 late death and no reinterventions after a relatively short follow-up of median 16 months. Nevertheless, this study demonstrated that this surgical technique may offer good results with a low overall mortality. In our study, 30 patients with aortic coarctation and associated hypoplasia of the aortic arch underwent ESA on CPB. After a follow-up of now median 3.5 years, we so far had no deaths, no neurologic complications, and no reinterventions, which indicates that in this group of patients ESA on one hand provides very good results regarding the need for reinterventions during growth and on the other hand seems to be a relatively save procedure regarding complications. During the ESA procedure all of our children had antegrade cerebral perfusion and most of them additionally lower body perfusion through cannulation of the descending aorta. This could have also contributed to the favorable outcome.

Reinterventions. The rate for freedom from reintervention at 10 years in our study was 90.12% and thus comparable to earlier published studies. In 9 of 11 patients reintervention was performed within the first postoperative year. In this study low operative weight or young age at the time of primary repair could not be linked to an increased risk for recurrent obstruction. This fits well to the results published by other centers, who reported recurrent obstruction to occur within the first postoperative year, irrespective of the used operative technique, young age, or low operative weight.^{3,6,15-18}

The only risk factor that we could identify by univariate analysis was an arch repair by REEEA with an access through a left thoracotomy. In fact this is not surprising, because the left lateral thoracotomy provides only a limited operative access, making it difficult or even impossible to sufficiently enlarge the proximal transverse aortic arch. Especially in the earlier period, we tried to avoid CPB and used a lateral approach even in borderline cases. A retrospective analysis of the proximal transverse aortic arch z scores measurements of the reintervention group indicated that they all had z scores of -4.5 or less. Kotani and colleagues¹⁸ recommended REEEA through a left thoracotomy only if the proximal aortic arch z score was greater than -6 or had a diameter in millimeters that is equal to body weight in kilograms; however, they used different z scores, which most likely is responsible for the difference to our findings.

Complications. We did not notice any concerning neurologic events like cerebral bleeding, seizures, or cerebral palsy in the group who underwent repair on bypass, even in very small neonates; however, the follow-up period is still short and detailed long-term observations are necessary to confirm this. In addition to the first 2 cases that were performed with the patient in deep hypothermic circulatory arrest, all other patients had selective antegrade cerebral perfusion and since 2003 a double arterial cannulation technique to minimize the risk for adverse events during aortic arch reconstruction on CPB. The only severe complication, a permanent paraplegia, in fact was in a case in which arch repair was carried out by REEEA without CPB through a lateral thoracotomy. This patient had an aberrant right subclavian artery, which we think contributed to the severity of spinal cord ischemia. So these patients should be candidates for repair on CPB.

Limitations

Limitations of this study are the retrospective design and the still limited follow-up period. The fact that 24.04% of the study population was lost to follow-up due to referrals from foreign countries is a further limitation,

because some cases of later complications, late deaths or reinterventions could have been missed.

CONCLUSIONS

REEEA and ESA are safe and effective treatments in newborns and infants with coarctation and associated hypoplasia of the aortic arch. In patients with proximal transverse aortic arch, z scores of less than -4.59 arch repair should be performed through a median sternotomy using CPB rather than through a lateral thoracotomy to reduce the risk for recurrent arch obstructions.

Conflict of Interest Statement

Authors have nothing to disclose with regard to commercial support.

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coarctation of the aorta through a left thoracotomy. *Ann Thorac Surg*. 2014;98:1386-93.

Key Words: aortic arch reconstruction, hypoplastic aortic arch, coarctation of the aorta, congenital heart disease

TABLE E1. Demographic data of the study population divided by present or absent follow-up data

	All patients, n = 183			Isolated arch repair, n = 131			Arch repair with VSD closure, n = 52		
	FU, n = 139	Lost to FU, n = 44	P value	FU, n = 99	Lost to FU, n = 32	P value	FU, n = 40	Lost to FU, n = 12	P value
Age at surgery, d									
Median	13 (7-49)	18 (6-51.25)	.52	12 (6-51.5)	25.5 (6-76.5)	.29	14 (8-41.5)	12.5 (8.25-19)	.20
(quartiles: Q1-Q3)									
n = available data									
Weight, kg									
Median	3.4 (2.85-4.1)	3.55 (2.94-4.36)	.85	3.4 (2.9-4.2)	3.65 (2.96-4.6)	.74	3.21 (2.68-3.81)	3.3 (2.91-3.65)	.66
(quartiles: Q1-Q3)									
n = available data									
Height, cm									
Median	50 (48-54)	51 (49-55.25)	.72	50.5 (48-54)	51 (49-57)	.64	50 (47-53.25)	51 (48.75-53)	.82
(quartiles: Q1-Q3)									
n = available data									
Sex, male/female, %	57.6/42.4 (80/59)	59/41 (26/18)	.86	61.6/38.4 (61/38)	68.8/31.2 (22/10)	.47	(19/21)	(4/8)	.39
PGE1, %									
n = available data	51.1 (71/139)	50 (22/44)	.90	47.5 (47/99)	40.6 (13/32)	.50	60 (24/40)	75 (9/12)	.35
Proximal transverse aortic arch z score									
Median	−3.86 (−2.85 to −4.59)	−3.95 (−3.1 to 4.35)	.90	−3.86 (−2.83 to 4.38)	−3.58 (−2.94 to −4.03)	.64	−3.95 (−3 to −4.73)	−4.2 (−4.03 to −4.46)	.63
(quartiles: Q1-Q3)									
n = available data	n = 114/139	n = 35/44		n = 84/99	n = 25/32		n = 30/40	n = 10/12	
In-hospital stay, d									
Median	16 (11-23)	13 (9-20.25)	.11	14 (10.5-18.5)	11 (9-18.25)	.10	21 (16.25-29.75)	22 (16.5-24.5)	.35
(quartiles: Q1-Q3)									
n = available data									
ICU stay, d									
Median	3 (1-5.5)	3 (1.25-5)	.37	2 (1-4)	2 (1-4.75)	.73	5.5 (3.25-7.75)	3.5 (3-6.25)	.36
(quartiles: Q1-Q3)									
n = available data	n = 124/139	n = 42/44		n = 86/99	n = 30/32		n = 38/40	n = 12/12	
Aberrant RSA (%)	3.6 (5/139)	4.55 (2/44)	.75	3 (3/99)	6.3 (2/32)	.39	5 (2/40)	0 (0/12)	.43

VSD, Ventricular septal defect; FU, follow-up; PGE1, prostaglandin E₁; ICU, intensive care unit, RSA, right subclavian artery.