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Outcomes of Percutaneous Interventions for Aortic Coarctation: Experience from a Tertiary Care Center

ORIGINAL INVESTIGATION

ABSTRACT

Background: Coarctation of the aorta (CoA) is a congenital obstructive anomaly that may remain undiagnosed until adulthood, often presenting with systemic hypertension. While percutaneous interventions, including balloon angioplasty and stent implantation, are increasingly utilized in adults, real-world data on procedural outcomes, complications, and long-term mortality remain limited.

Objective: This study aimed to evaluate procedural outcomes, complication rates, and short- and long-term mortality associated with percutaneous interventions in adult patients with CoA.

Methods: A single-center, retrospective observational study was conducted, including adult patients with CoA who underwent percutaneous intervention between July 2017 and July 2023. Procedural success was defined as a residual peak systolic gradient ≤20 mmHg without major complications. Patient demographics, comorbidities, procedural details, complications, and follow-up outcomes were analyzed.

Results: Twenty-nine patients (median age 40 [29-45] years; 31% female) were included. Endovascular stent placement was performed in 89.7% of patients, 74% of whom were covered stents (mean length 39 mm). Balloon angioplasty alone was used in 10.3% of cases. The procedure was associated with a marked reduction in the peak systolic gradient, decreasing from a median of 57.5 mmHg [50.0-68.8] before the procedure to 9.0 mmHg [1.2-11.8] after the procedure. Complications occurred in 6.9%, including 1 aortic rupture and 1 access site bleeding. Recoarctation developed in 14% of patients at a median of 17.5 months. No in-hospital deaths occurred; out-of-hospital mortality was 6.9%, including 1 death of unknown cause and 1 following posterior mediastinal hematoma after aortic rupture.

Conclusions: Percutaneous interventions in adult CoA achieve favorable procedural success and low in-hospital mortality, while rare but serious complications underscore the necessity for meticulous management and lifelong follow-up.

Keywords: Aortic coarctation, balloon angioplasty, cover stent, endovascular intervention, recoarctation

INTRODUCTION

Coarctation of the aorta (CoA) is a congenital obstructive anomaly, most commonly involving a narrowing of the aortic segment distal to the left subclavian artery, with an incidence ranging between 0.06% and 0.08%.[1] It often presents solely with hypertension and may remain undiagnosed until late adulthood.[2] Untreated CoA has the potential to result in severe complications, including formation of aortic aneurysms, aortic dissection, premature coronary artery disease, ventricular dysfunction, and cerebrovascular pathology.[3,4] Surgical intervention, balloon angioplasty, and stent implantation have all been shown to provide effective therapeutic outcomes in patients with CoA. The optimal management strategy for CoA is largely determined by anatomical considerations and the morphological characteristics of the lesion.[5] While surgical repair is most commonly performed during childhood, percutaneous interventions are generally favored in adulthood.[6] In the management of adult CoA, endovascular options such as balloon angioplasty or stent placement are usually favored over surgical correction.

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However, as highlighted in several studies, long-term complications such as aneurysm formation and re-coarctation are significant adverse outcomes associated with percutaneous approaches. Although clinically significant, real-world evidence regarding the timing and type of intervention remains scarce.[3] While earlier studies have highlighted certain anatomical and procedural risk factors, large-scale analyses involving extensive patient populations are still lacking.[3,7-9]

This report assessed the impact of percutaneous interventions on procedural outcomes, complication rates, early and late mortality in cases of interrupted aortic arch or aortic coarctation in a tertiary referral hospital.

METHODS

Ethical Statement

This was a retrospective observational study, and no additional interventions beyond standard clinical care were performed for research purposes. Ethical approval for the study was granted by the Ethics Committee of the University of Health Sciences (document registration number: 23/431).

Study Population and Design

A single-center retrospective observational study analysis was conducted on patients admitted to the institution with aortic coarctation who underwent percutaneous intervention over a 6-year period between July 2017 and July 2023. All procedures performed in accordance with current indications during this period were included, and follow-up assessments focused on complications, procedural success, and their impact on mortality. Patients younger than 18 years were excluded from the study. Patient demographics, comorbid conditions, laboratory results, treatment details, follow-up information after discharge, and outcome-related clinical parameters were collected retrospectively from hospital records, the institutional electronic database, and national health registries, including the Turkish Ministry of Health's e-Nabız and Medula systems.

Hypertension was defined as a systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mm Hg, measured at the brachial artery after participants had rested for at least 5 minutes in a seated position.[10]

A diagnosis of CoA was confirmed in individuals with systemic hypertension accompanied by a systolic pressure difference of at least 20 mmHg between the upper and lower extremities, as validated by imaging modalities such as aortic computed tomography angiography (CTA), aortography, or echocardiography. All patients considered for inclusion underwent pre-procedural aortic CTA to ensure accurate diagnosis of CoA, detailed assessment of the aortic anatomy, and appropriate determination of stent and balloon dimensions.

Procedure

All interventions were carried out by 2 experienced operators under deep sedation with anesthetic support in the cardiac catheterization laboratory. Upon achieving femoral access, anticoagulation was initiated with heparin at a dose of 100 IU/kg, or 5000 IU in adult patients. In all participants, fluoroscopy guided the puncture of the common femoral artery, allowing placement of a 6-F introducer sheath. A right radial artery approach was additionally utilized to enhance visualization of the coarctation region and surrounding anatomy, facilitating accurate positioning of the device. A 0.035-inch hydrophilic guidewire was advanced across the coarctation with catheter support, typically using either a multipurpose or Judkins right catheter (Cordis Corporation, Florida). This was subsequently exchanged for a 0.035-inch Amplatz super-stiff guidewire (Cook Cardiology, Indiana) and the introducer sheath was upsized to 12-F. Prior to stent implantation, the peak systolic gradient was assessed using invasive hemodynamic measurements. For stent deployment, a balloon-in-balloon technique was used, which allowed controlled and precise expansion for both covered and non-covered stents. Stent diameter selection was based on the diameter of the descending thoracic aorta at the diaphragmatic level, which was used as the anatomical reference. Precise stent positioning was confirmed with aortography obtained in several projections to optimally visualize the lesion. Rapid ventricular pacing was not used during stent implantation in the study cohort. Following control angiography to assess stent position, expansion and potential vascular complications, the procedure was concluded once proper stent placement and adequate reduction of the pressure gradient were confirmed.

The procedure was deemed successful when the residual peak systolic pressure gradient across the coarctation was ≤20 mm Hg, and no complications such as stent migration or aortic dissection were observed.

Laboratory, Echocardiographic, and Aortic Computed Tomography Angiography Assessments

Laboratory evaluation included complete blood count, liver and kidney function tests, serum electrolytes, lipid profile, plasma glucose, and thyroid function parameters. Blood counts were determined using an automated hematology analyzer (MINDRAY BC-6800, China), and biochemical assays were carried out with the ARCHITECT PLUS CI-4100 platform (Abbott, USA).

All participants underwent transthoracic echocardiography (TTE) performed by an experienced cardiologist. Examinations were performed both before the procedure and at follow-up evaluations. This assessment also enabled the detection of concomitant intracardiac abnormalities. Follow-up echocardiographic evaluations, performed after the intervention and during subsequent clinical visits, were

HIGHLIGHTS

- Percutaneousinterventions for adult coarctation of the aorta demonstrated high proceduralsuccess and low in-hospital complication rates.
- Endovascular stent implantation was thepredominant treatment strategy and effectively reduced post-procedural pressuregradients.
- Lifelong surveillance remains essentialbecause of the risk of late recoarctation and vascular events

utilized to verify stent position and to evaluate for residual gradients. The echocardiographic protocol included measurements of left ventricular ejection fraction (LVEF), left ventricular end-diastolic diameter (LVEDD) and left ventricular end-systolic diameter (LVESD), interventricular septal thickness, and posterior wall thickness. In addition, valvular and intracardiac abnormalities were systematically assessed and documented.

Patients were followed according to guideline recommendations.[11] However, standardized early follow-up at 1 and 6 months was not available for all individuals. Due to the retrospective study design, no predefined time window existed for the surveillance of adverse events. Instead, events were identified based on the available medical records during a comprehensive backward review of the entire follow-up period. Consequently, follow-up data in the cohort reflected real-world clinical practice rather than fixed protocol-driven time points. Transthoracic echocardiographic reassessment was available at a median of 6.0 months (IQR 4.7-10.7 months) after the procedure. Echocardiographic evaluation included measurements of left ventricular dimensions (LVEDD, LVESD), LVEF, and Doppler-derived systolic pressure gradients across the stented segment. In cases where follow-up echocardiography suggested increased peak gradients indicative of possible re-coarctation, confirmation was performed using invasive peak-to-peak gradient measurement during cardiac catheterization. Re-coarctation was defined as an invasive systolic pressure gradient >20 mm Hg, and reintervention was undertaken when indicated.

Statistical Analysis

Continuous variables are presented as mean ± standard deviation or median [Q1-Q3] (interquartile range), as appropriate. Categorical variables are expressed as counts and percentages. Normality of continuous variables was assessed using the Shapiro–Wilk test. For comparisons between 2 groups, the independent-samples *t*-test was used for normally distributed variables and the Mann–Whitney *U*-test for non-normally distributed variables. For comparisons across more than 2 groups, 1-way ANOVA or the Kruskal–Wallis test was applied, as appropriate. Categorical variables were compared using the chi-square test or Fisher's exact test, with Fisher's exact test used when expected cell counts were less than 5.

Additional exploratory analyses were performed according to sex and predefined age groups (<29, 29-45, and >45 years). Continuous variables in subgroup analyses were compared using distribution-appropriate tests, and categorical variables were compared using Fisher's exact test. For the comparison of recoarctation rates between covered and uncovered stents, a 2-sided Fisher's exact test was used, and effect size was reported as risk difference (RD) along with 95% CIs.

Follow-up TTE for assessment of recoarctation was available in 27/29 patients; aside from these 2 missing follow-up echocardiograms, there were no other missing follow-up data relevant to the analyses. All analyses were performed using R (R Foundation for Statistical Computing, Vienna, Austria). A 2-sided *P* value <.05 was considered statistically significant.

RESULTS

Between July 2017 and July 2023, 29 patients with CoA were treated at the center. The median age was 40 [29-45] years, with more than half of the patients between 29 and 45 years, and 31% were female. In the present study, endovascular stent placement was the predominant interventional approach for CoA, performed in 89.7% of cases, whereas balloon angioplasty alone was utilized in a minority of patients, 10.3%.

Table 1 presents the baseline, procedural and clinical characteristics of the patients. Hypertension was the most prevalent comorbidity 15 (51.7%), whereas coronary artery disease 2 (6.9%) and prior cardiac interventions such as aortic valve replacement 4 (13.8%) or coarctation repair 1 (3.4%) were less frequent. Echocardiographic evaluation showed normal systolic function (median EF 60%) with mild left ventricular hypertrophy present in 11 (40.7%) of patients. Hemodynamic assessment revealed a high pre-procedural peak gradient 57.5 [50.0-68.8] mmHg and mean gradient 40.0 [30.0-45.0] mmHg, with aortic diameters measuring 18.0 [15.6-23.5] mm proximally, 7.2 [3.9-9.6] mm at the coarctation site and 23.0 mm [19.5-32.0] distally. In the study, the majority of patients undergoing interventional treatment for CoA received endovascular stent placement 26 (89.7%), while only 3 patients (10.3%) underwent balloon angioplasty alone. Covered stents were used in 20 (74%) of cases, with 7.2 [3.9-9.6] mm at the coarctation site. The median balloon nominal diameter was 22 [20-22.5] mm. Predilatation was performed in only 3 (10.3%) of patients. Technical success was achieved in all cases 29 (100%), with a post-procedural peak gradient of 9.0 [1.2-11.8] mmHg. Clinical success was achieved in 93% of patients. Recoarctation occurred in 2/6 (33.3%) patients in the uncovered stent group and in 2/20 (10.0%) patients in the covered stent group; the RD (uncovered minus covered) was +23.3% with an exact 95% CI of −7.7% to 60.7%, and Fisher's exact test *P* = .30. Two patients had missing echocardiographic follow-up data and therefore could not be evaluated for recoarctation based on imaging. For these patients, follow-up outcomes were assessed using clinical records and the national health system database. According to these sources, no mortality was observed during the follow-up period; however, recoarctation could not be assessed due to the lack of echocardiographic data.

In sex-based comparisons, male patients had a higher pre-procedural peak gradient than female patients (64.2 ± 16.9 vs. 49.9 ± 10.8 mmHg, *P* = .025). Male patients also had larger proximal aortic diameter (21.4 ± 8.8 vs. 16.0 ± 3.3 mm, *P* = .042) and distal aortic diameter (29.0 ± 12.2 vs. 19.4 ± 5.5 mm, *P* = .044). No significant sex-related differences were observed in other baseline characteristics, procedural features, or outcomes (Table 2).

In exploratory analyses according to predefined age groups (<29, 29-45, and >45 years), coronary artery disease and distal aortic diameter differed significantly across groups.

Table 1. Baseline, Procedural, and Outcome Characteristics

Variables	Mean ± SD/n (%)	Median [Q1-Q3]
Baseline characteristics		
Age, years	38.5 ± 10.9	40 [29-45]
Age >45, n (%)	6 (20.7)	
Age 29-45, n (%)	15 (51.7)	
Age <29, n (%)	8 (27.6)	
Female sex, n (%)	9 (31.0)	
Hypertension, n (%)	15 (51.7)	
Diabetes mellitus, n (%)	0 (0.0)	
Coronary artery disease, n (%)	2 (6.9)	
Prior AVR, n (%)	4 (13.8)	
Prior coarctation repair, n (%)	1 (3.4)	
Haemoglobin, g/dL	13.4 ± 1.9	13.6 [12.4-15.0]
Creatinine, mg/dL	0.8 ± 0.2	0.77 [0.66-0.86]
LDL cholesterol, mg/dL	102.7 ± 29.4	105.5 [80.8-124.5]
LVEF, %	57.5 ± 10.8	60 [60-60]
LVEDD, mm	47.5 ± 7.6	45.5 [42.0-52.5]
LVESD, mm	31.7 ± 7.9	30.0 [27.0-34.0]
IVS thickness, mm	11.7 ± 3.6	10.0 [9.5-13.5]
Posterior wall thickness, mm	11.0 ± 3.0	10.0 [9.0-13.5]
Left ventricular hypertrophy, n (%)	11 (40.7)	
Pre-procedural hemodynamic and anatomy		
Peak gradient, mm Hg	58.3 ± 16.1	57.5 [50.0-68.8]
Mean gradient, mm Hg	38.7 ± 12.5	40.0 [30.0-45.0]
Proximal aortic diameter, mm	20.0 ± 8.0	18.0 [15.6-23.5]
Coarctation site diameter, mm	7.6 ± 4.4	7.2 [3.9-9.6]
Distal aortic diameter, mm	26.1 ± 11.4	23.0 [19.5-32.0]
Procedural characteristics		
Endovascular stent, n (%)	26 (89.7)	
Balloon angioplasty only, n (%)	3 (10.3)	
Covered stent use, n (%)	20 (74.0)	
Stent length, mm	40.2 ± 6.8	39.0 [38.5-45.0]
Balloon nominal diameter, mm	21.0 ± 2.8	22 [20-22.5]
Predilatation, n (%)	3 (10.3)	
Procedural success, n (%)	29 (100)	
Outcomes		
Post-procedural peak gradient, mm Hg	8.2 ± 6.6	9.0 [1.2-11.8]
Any complication, n (%)	2 (6.9)	
Aortic rupture, n (%)	1 (3.4)	
Access site bleeding, n (%)	1 (3.4)	
Recoarctation, n (%)	4 (14.0)	
Time to recoarctation, months	41.0 ± 53.1	18 [11.0-48.0]
In-hospital mortality, n (%)	0 (0.0)	
Out-of-hospital mortality, n (%)	2 (6.9)	

%, percent; AVR, aortic valve replacement; EF, ejection fraction; IVS, interventricular septum; LDL, low-density lipoprotein; LVEDD, left ventricular end diastolic diameter; LVEF, left ventricular ejection fraction; LVESD, left ventricular end-systolic diameter; LVH, left ventricular hypertrophy. n: sample size; PWT, posterior wall thickness. Continuous variables are presented as mean ± standard deviation and median [Q1-Q3]. Categorical variables are presented as n (%).

Coronary artery disease was present only in patients aged >45 years (33.3%, *P* = .037), and distal aortic diameter increased with age (18.6 ± 7.2 mm vs. 23.6 ± 6.6 mm vs. 38.8 ± 16.0 mm, *P* = .007). No other significant differences were observed (Table 3).

Procedure-related complications occurred in 6.9% of patients, including 1 major complication consisting of aortic rupture (3.4%) and 1 minor complication consisting of bleeding at the closure device access site (3.4%). At a median follow-up of 6 months (IQR 4.7-10.7) echocardiography was available for all 17 patients. The median LVEDD was 45.5 [42.0-52.5] mm, LVESD 30.0 [27.0-34.0] mm, and LVEF 60% [60-60]. Doppler-derived peak gradient across the treated segment was 9.0 [1.2-11.8] mmHg. Re-coarctation occurred in 4 patients (14%), with a median time to diagnosis of 17.5 months (IQR 11.0-47.3), and was confirmed in 2 of 20 patients in the covered stent group and in 2 patients in the uncovered group; this difference was not statistically significant (Fisher's exact test, *P* = .30). No in-hospital mortality was recorded; out-of-hospital mortality occurred in 2 (6.9%) patients. One patient died within the first month due to a posterior mediastinal hematoma following aortic rupture. The second death occurred at approximately 3 months after the procedure; however, the underlying cause could not be determined.

DISCUSSION

This single-center retrospective observational study evaluated the procedural outcomes, complication rates, and long-term follow-up results of percutaneous interventions for adult patients with CoA. Advances in technology and treatment options have led to increased life expectancy in patients with congenital heart disease. Individuals living with aortic coarctation are increasingly being diagnosed at older ages. In the study, the mean age of patients was higher compared to that reported in previous studies.[7,9] Balloon angioplasty alone was performed in a small number of patients treated early in the study period (2017), whereas stent implantation was subsequently adopted as the standard approach in accordance with evolving guideline recommendations. Hemodynamic assessment demonstrated a marked reduction in the peak systolic gradient following the procedure, from 58.3 ± 16.1 mmHg to 8.2 ± 6.6 mmHg. Similarly, Shabestari et al[12] revealed that placement of a self-expandable stent produced a profound reduction in the trans-coarctation pressure gradient, decreasing from 67.48 ± 14.79 mmHg to 5.04 ± 3.01 mmHg. Yazıcı et al[13] also reported that the systolic gradient measured across the narrowed segment decreased from 37.2 ± 11.3 mmHg to 3.5 ± 2.9 mmHg following stent implantation. The findings demonstrated that endovascular stent implantation achieved high procedural success with a low rate of acute complications, aligning with previously published data supporting the safety and efficacy of this approach in adult populations.[8,9,14]

These favorable outcomes can be attributed in part to the widespread adoption of endovascular stenting as the primary treatment strategy, while balloon angioplasty was reserved for selected cases. Covered stents were employed

Table 2. Comparison of Baseline, Procedural, and Outcome Characteristics According to Sex

Variables	Female (n = 9) Mean ± SD/n (%)	Female Median [Q1-Q3]	Male (n = 20) Mean ± SD/n (%)	Male Median [Q1-Q3]	*P*
Baseline characteristics					
Age, years	33.2 ± 8.5	34.0 [25.0-41.0]	40.9 ± 11.2	42.5 [33.0-46.0]	.062
Hypertension, n (%)	3 (33.3)		12 (60.0)		.245
Coronary artery disease, n (%)	0 (0.0)		2 (10.0)		1.000
Prior AVR, n (%)	0 (0.0)		4 (20.0)		.280
Prior coarctation repair, n (%)	0 (0.0)		1 (5.0)		1.000
Pre-procedural LVEF, %	60.0 ± 0.0	60.0 [60.0-60.0]	55.5 ± 11.5	60.0 [57.5-60.0]	.137
Left ventricular hypertrophy, n (%)	1 (12.5)		10 (52.6)		.090
Pre-procedural hemodynamic and anatomy					
Pre-procedural peak gradient, mm Hg	49.9 ± 10.8	50.0 [43.0-54.0]	64.2 ± 16.9	61.0 [56.0-71.0]	.025
Pre-procedural mean gradient, mm Hg	33.2 ± 9.0	35.0 [26.0-40.5]	41.1 ± 13.6	40.0 [30.0-46.0]	.250
Proximal aortic diameter, mm	16.0 ± 3.3	16.5 [12.4-18.6]	21.4 ± 8.8	19.4 [17.0-26.0]	.042
Coarctation site diameter, mm	6.5 ± 3.0	7.5 [3.5-9.0]	8.1 ± 4.8	7.0 [4.0-10.0]	.343
Distal aortic diameter, mm	19.4 ± 5.5	20.0 [15.0-24.0]	29.0 ± 12.2	27.4 [20.0-33.0]	.044
Procedural and outcome variables					
Stent-based treatment, n (%)	7 (77.8)		19 (95.0)		.220
Covered stent use, n (%)	5 (55.6)		16 (80.0)		.209
Post-procedural peak gradient, mm Hg	9.5 ± 5.1	10.5 [6.5-13.5]	7.2 ± 7.7	6.0 [0.0-11.0]	.460
Recoarctation, n (%)	1 (11.1)		3 (15.0)		1.000
Procedure-related complication, n (%)	0 (0.0)		3 (15.0)		.532

%, percent; AVR, aortic valve replacement; EF, ejection fraction; LVEF, left ventricular ejection fraction; n, sample size.
Continuous variables are presented as mean ± standard deviation and median [Q1-Q3]. Categorical variables are presented as n (%) and were compared using Fisher's exact test.

Table 3. Comparison of Baseline, Procedural, and Outcome Characteristics According to Age Groups

Variables	Female (n = 9) Mean ± SD/n (%)	Female Median [Q1-Q3]	Male (n = 20) Mean ± SD/n (%)	Male Median [Q1-Q3]	*P*
Baseline characteristics					
Age, years	33.2 ± 8.5	34.0 [25.0-41.0]	40.9 ± 11.2	42.5 [33.0-46.0]	.062
Hypertension, n (%)	3 (33.3)		12 (60.0)		.245
Coronary artery disease, n (%)	0 (0.0)		2 (10.0)		1.000
Prior AVR, n (%)	0 (0.0)		4 (20.0)		.280
Prior coarctation repair, n (%)	0 (0.0)		1 (5.0)		1.000
Pre-procedural LVEF, %	60.0 ± 0.0	60.0 [60.0-60.0]	55.5 ± 11.5	60.0 [57.5-60.0]	.137
Left ventricular hypertrophy, n (%)	1 (12.5)		10 (52.6)		.090
Pre-procedural hemodynamic and anatomy					
Pre-procedural peak gradient, mmHg	49.9 ± 10.8	50.0 [43.0-54.0]	64.2 ± 16.9	61.0 [56.0-71.0]	.025
Pre-procedural mean gradient, mmHg	33.2 ± 9.0	35.0 [26.0-40.5]	41.1 ± 13.6	40.0 [30.0-46.0]	.250
Proximal aortic diameter, mm	16.0 ± 3.3	16.5 [12.4-18.6]	21.4 ± 8.8	19.4 [17.0-26.0]	.042
Coarctation site diameter, mm	6.5 ± 3.0	7.5 [3.5-9.0]	8.1 ± 4.8	7.0 [4.0-10.0]	.343
Distal aortic diameter, mm	19.4 ± 5.5	20.0 [15.0-24.0]	29.0 ± 12.2	27.4 [20.0-33.0]	.044
Procedural and outcome variables					
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n, sample size; %: percent; AVR, aortic valve replacement; EF, ejection fraction.
Continuous variables are presented as mean ± standard deviation and median [Q1-Q3]. Categorical variables are presented as n (%) and were compared using Fisher's exact test.

in the majority of patients, reflecting contemporary guideline recommendations that favor their use in adults due to their potential to reduce recoarctation and vascular injury. Balloon angioplasty as a standalone procedure often results in residual or recurrent obstruction.[15] Aortic stenosis involves complex structural alterations with the medial layer showing fragmented elastic fibers, increased connective tissue, and a loss of smooth muscle cells.[16] Operators may need to apply excessive dilation to overcome these issues, which increases the risk of aortic wall injury.[17,18] During balloon angioplasty, damage to this abnormal tissue can result in serious complications such as aneurysm formation, aortic dissection, or rupture.[19] Consequently, stent implantation has gradually become the preferred treatment option in anatomically complex cases, including those with recurrent coarctation or coarctation accompanied by aneurysm formation. Several studies have shown that the covered Cheatham-Platinum (CP) stent exhibits enhanced radial strength, maintaining its structural integrity even at larger diameters[7,9,14] while also while also demonstrating efficacy in managing aortic wall injury and reducing the risk of its development in patients with CoA.[20]

Sadeghipour et al[21] demonstrated a higher incidence of residual hypertension in patients treated with balloon-expandable stents compared to self-expanding stents, although no significant difference was observed in the number of antihypertensive medications at 3-year follow-up. This difference has been attributed to the greater flexibility and conformability of self-expanding stents, which may cause less arterial wall injury. Similar findings have been reported in other studies, highlighting that residual hypertension remains a common issue despite technically successful endovascular or surgical interventions.[22,23] The persistence of hypertension may result from irreversible vascular remodeling and increased arterial stiffness due to long-standing pre-procedural hypertension.

Early and late complications remain an important clinical concern. Two procedure-related complications were observed—1 aortic rupture and 1 access site bleeding. The patient who experienced aortic rupture subsequently developed a posterior mediastinal hematoma and died within the first month after the intervention. This rupture did not occur during the procedure or index hospitalization but developed approximately 1 month after discharge in a patient treated with a covered stent, in whom no predilatation or intraprocedural complications were observed. This delayed presentation suggests that the underlying mechanism was unlikely to be related to acute procedural factors such as balloon-to-aorta diameter mismatch or excessive overdilatation. Instead, delayed aortic rupture may reflect intrinsic aortic wall fragility, chronic degenerative changes at the coarctation site, or progressive mechanical stress at the stent edges following restoration of normal aortic pressures. Abrupt normalization of afterload and altered wall shear stress after relief of severe coarctation may also contribute to delayed weakening of the aortic wall. Although covered stents are designed to reduce the risk of acute rupture, they may not fully prevent late vascular complications in patients with advanced aortic wall pathology. A second death occurred about 3 months after the intervention, though the available data did not clarify the cause. In the study by Moltzer et al,[24] acute complications included 1 death from aortic rupture and 2 groin hematomas, while late complications involved stent migration to the ascending aorta, pseudoaneurysm formation at the initial stent site, and external iliac artery occlusion. In the study, recoarctation occurred in approximately 14% of patients during follow-up, with a median time to diagnosis of 18 months. This incidence aligns with prior studies; however, when considering studies that focused exclusively on adult patients, such as that by Sadeghipour et al,[21] recoarctation occurred in fewer than 10% of patients. Recoarctation may arise from stent underexpansion, neointimal proliferation, or vascular remodeling, particularly in cases with complex anatomy. According to Zussman et al,[25] improvements in endovascular devices and procedural techniques have markedly decreased the risk of aortic wall injury and access site complications during percutaneous treatment of CoA. In line with previous reports, the study also demonstrated an absence of in-hospital mortality and a low rate of procedure-related complications, further supporting the safety profile of percutaneous treatment in experienced centers. Nevertheless, the occurrence of aortic injury or fatal aortic rupture in 1 patient during follow-up highlights the potential severity of delayed vascular events and emphasizes the need for careful patient selection and long-term post-procedural surveillance. In addition, subgroup analyses suggested that male patients presented with higher baseline gradients and larger aortic dimensions, while older patients demonstrated a higher burden of coronary artery disease and increased distal aortic diameter. These findings may reflect the impact of long-standing hemodynamic stress and age-related vascular remodeling, potentially contributing to differences in disease severity and clinical outcomes.

Study Limitations

This study is limited by its retrospective, single-center design, which may introduce selection and information biases and limit generalizability. The relatively small sample size further restricts statistical power and the applicability of findings to broader populations. In addition, follow-up duration was variable and limited, potentially underestimating late complications or re-coarctation events. Follow-up was primarily based on TTE and office blood pressure measurements, without routine use of advanced imaging or ambulatory blood pressure monitoring, which may have limited the detection of late vascular complications and persistent hypertension. In the future, larger prospective multicenter studies with long-term follow-up could provide more robust insights into the durability and outcomes of aortic coarctation interventions.

CONCLUSION

In the present study, percutaneous interventions for adult CoA were associated with a high rate of procedural success and low in-hospital mortality. Endovascular stent implantation was the predominant therapeutic strategy and was associated with a reduction in post-procedural pressure gradients. Although complications were uncommon, serious adverse events such as aortic rupture underscore the necessity of meticulous procedural planning and execution. Furthermore, while rare, the occurrence of recoarctation highlights the importance of lifelong cardiologic surveillance to ensure timely detection and management of recurrent aortic obstruction. Overall, these findings support percutaneous endovascular therapy as a viable treatment modality for adult patients with coarctation of the aorta, emphasizing the critical role of technical precision and continuous follow-up in optimizing long-term outcomes.

Declarations on AI Use: No artificial intelligence (AI) or AI-assisted technologies were used in the preparation of this study.

Ethics Committee Approval: This article does not contain any studies with human participants or animals performed by any of the authors. The study was approved by the Hamidiye Scientific Research Ethics Committee, University of Health Sciences (document registration number: 23/431, date: 11.09.2023).

Informed Consent: As this was a retrospective study, no informed consent was obtained from the patients.

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