ORIGINAL ARTICLE

# Immediate and long-term outcomes of native aortic coarctation and postsurgical aortic recoarctation treated with stent implantation: a single-center experience

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**KEY WORDS**

aortic coarctation, bare metal stent, covered stent, postsurgical aortic recoarctation

**ABSTRACT**

**INTRODUCTION** Stent implantation has become the treatment of choice for native aortic coarctation (CoA) and postsurgical aortic recoarctation (reCoA) in adults and adolescents.

**OBJECTIVES** This study aimed to compare the immediate and long-term outcomes of patients with native CoA and postsurgical reCoA who underwent stent implantation in our center.

**PATIENTS AND METHODS** The data of 136 patients with native CoA and reCoA who underwent stent implantation between May 1999 and December 2016 were retrospectively analyzed. The study population was divided into 2 groups: 108 patients with native CoA and 28 patients with reCoA. Clinical and procedural characteristics and immediate and long-term outcomes after the intervention were compared between the groups. The use of antihypertensive drugs was analyzed in all patients.

**RESULTS** There were no significant differences in the clinical characteristics of the study groups. The gradient before the intervention was significantly higher in the native CoA than in the reCoA group ($P = 0.011$), and the diameter of stenosis before the intervention was smaller in the native CoA group compared with the ReCoA group ($P = 0.003$). Procedural treatment was successful in 77.8% of the patients with native CoA and 78.5% of those with reCoA. There were no differences in the immediate and long-term outcomes between the groups. The antihypertensive treatment was tapered or discontinued in about 34% of the study population.

**CONCLUSIONS** Stenting is an effective and safe procedure in patients with native CoA and reCoA, with good late outcomes.

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**INTRODUCTION** Aortic coarctation (CoA) accounts for about 5% to 8% of all congenital cardiac malformations and represents the fourth common lesion requiring treatment during infancy.[1] Most patients are diagnosed as neonates or infants and undergo corrective surgery as an accepted standard of practice. The indication for intervention in CoA is a decrease in the lumen diameter by more than 50% at the narrowed site or a pressure gradient of more than 20 mm Hg at rest.[2,3] However, many cases are unrecognized until late childhood and adulthood. Intravascular stent therapy is considered as a primary therapeutic option for most adults and adolescents with CoA, as well as for patients with aortic recoarctation (reCoA).[4-10] To our knowledge, there have been no studies comparing the immediate and long-term results of patients with native CoA and reCoA treated with bare metal stent (BMS) and covered stent (CS) implantation. Therefore, the aim of this retrospective study was to compare the immediate and long-term outcomes of

patients with native CoA and postsurgical reCoA who underwent stent implantation in our center.

## PATIENTS AND METHODS

### Study population

From May 1999 to November 2016, data of 136 patients with native CoA (108 patients) and reCoA (28 patients) treated with stent implantation were retrospectively analyzed. The diagnosis of CoA was based on clinical signs, echocardiography, computed tomography (CT), and invasive gradient measurements. More specifically, CoA was defined as the presence of systemic hypertension with a difference in systolic blood pressure between the upper and lower limbs of 20 mm Hg or higher, which was confirmed by echocardiography, CT, or aortography. In 25 patients, additional cardiac lesions were reported, including bicuspid aortic valve (n = 25), aortic insufficiency (n = 16), aortic arch hypoplasia (n = 4), ventricular septal defect (n = 3), right pulmonary artery hypoplasia (n = 1), and previous aortic valve replacement (n = 5). One patient with native CoA presented with middle aortic syndrome. Two patients suffered from Turner syndrome (1 patient in the native CoA group and the other in the reCoA group) and 1 patient from the native CoA group had Down syndrome. There was 1 patient with pulmonary hypertension, and 3 patients were in New York Heart Association class IV. One patient suffered 3 cardiac arrests before urgent stent implantation. Informed written consent was obtained before the procedure from all patients, or in the case of children, from their legal guardians.

### Procedural technique

All procedures were performed under deep sedation with general anesthesia or intravenous sedation and antibiotic prophylaxis throughout the procedure. Percutaneous access was obtained into the right femoral artery. Aortography was performed in the anteroposterior and left lateral 90° positions. The measurements of the CoA site, proximal and distal to the obstruction, were made to select the appropriate size of the balloon and stent. The pressure gradient across the CoA was assessed during catheterization by measuring the pressure above and below the lesion. The decision on stent implantation was made on the basis of angiographic evidence of significant coarctation. Depending on the coarctation anatomy, height and weight of the patient, the operator's preference, and availability of the bare metal balloon expandable stent, the following stent types were used: Palmaz (Johnson and Johnson, New Brunswick, New Jersey, United States), Cheatham Platinum (CP) (NuMED, New York, New York, United States), Valeo (Bard, Tempe, Arizona, United States), AndraStents (Andramed, Reutlingen, Germany), and covered balloon-expandable CP stents (NuMED). Moreover, in 3 patients, self-expandable stent as Sinus Aorta (Optimed, Ettlingen, Germany) and Smart (Cordis, Hialeah, United States) were used. To expand the stents, we used Power Flex (Cordis), Maxi LD (Cordis), Tyshak (NuMED), or BIB (NuMED) balloons. The indications for CS placement included hypoplasia of aortic stenosis, aneurysms, or severe arch obstruction (≤4 mm). The final balloon size was based on the ratio of the balloon diameter to the narrowest coarctation segment (the ratio should not exceed the value of 3.5).[11] In 1 patient, a progressive balloon angioplasty before stent implantation was performed.

After stent deployment, a hemodynamic study and angiography were repeated to confirm the success of the procedure and to detect possible complications. Procedural success was established when the invasive gradient was less than 20 mm Hg, in the absence of immediate complications. Manual hemostasis was performed. All patients underwent transthoracic echocardiography before and 24 hours after the procedure to evaluate stent position and the presence of any residual gradients. On discharge, aspirin (100 mg/d) was prescribed for all patients, for up to 6 months.

### Follow-up

Clinical follow-up was planned at 3, 6, and 12 months after discharge, and annually thereafter. Follow-up outcomes were assessed by CT angiography/magnetic resonance imaging (MRI) or catheterization. A satisfactory late result was defined as the absence of restenosis (>10% of the stent lumen obstruction due to intimal proliferation), with a residual pressure gradient of less than 20 mm Hg. Aortic aneurysm was defined as an increase in the descending aortic diameter by more than 20% measured at the level of the diaphragm (ie, not considered to be poststenotic dilation of the aorta) or an abnormal enlargement of the aortic segment.[8] Hypertension was defined for patients aged 18 years or older as a systolic blood pressure of 140 mm Hg or higher or a diastolic blood pressure of 90 mm Hg or higher. In patients younger than 18 years of age, we used sex- and age-specific reference ranges for blood pressure (≥95th percentile). The use of antihypertensive drugs was carefully analyzed in all patients. β-blockers, angiotensin-converting enzyme inhibitors, or angiotensin receptor blockers were used.

### Statistical analysis

The distribution of continuous variables was assessed by visual inspection of the frequency histograms and with the use of the Shapiro–Wilk test. Continuous variables were expressed as mean (SD) or median with interquartile range (IQR), if they followed a normal or nonnormal distribution, respectively. Continuous variables were compared using the unpaired *t* test or Mann–Whitney test, whereas categorical variables were compared using the $\chi^2$ test or Fisher exact test, as appropriate. A repeated measures analysis of variance was used to compare pressure gradients and diameter values before and after the intervention in each group. A *P* value of less than 0.05 was considered significant. The statistical analysis was performed using SPSS 17 (SPSS Inc., Chicago, Illinois, United States).

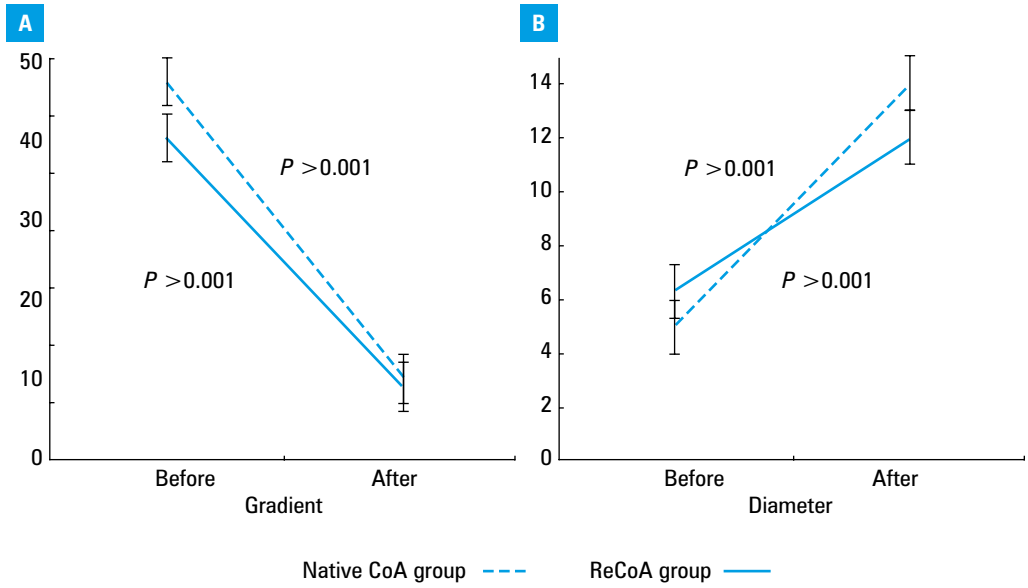


**FIGURE 1** **A** – gradient before and after the intervention in the native coarctation (CoA) and recoarctation (reCoA) groups. In each group, the pressure gradient significantly decreased after stent implantation ($P$ <0.001 for both). **B** – diameter before and after the intervention in the native CoA and reCoA groups. In each group, the diameter significantly increased after stent implantation ($P$ <0.001 for both).

**TABLE 1** Clinical and procedural characteristics of the patient groups

| Parameter | Native CoA group (n = 108) | ReCoA group (n = 28) | *P* value |
|---|---|---|---|
| Male sex, n (%) | 68 (63) | 16 (57) | 0.85 |
| Age at procedure, y, mean (SD) | 27.69 (15.0) | 25.46 (15.7) | 0.48 |
| Weight, kg, median (IQR) | 62 (51.2–77.7) | 66 (50.5–83.7) | 0.75 |
| Gradient before intervention, mm Hg, median (IQR) | 47 (36–57.7) | 40 (27–44) | 0.011 |
| Gradient after intervention, mm Hg, median (IQR) | 10 (3–19) | 9 (12–20) | 0.96 |
| Percentage gradient reduction, %, median (IQR) | 77 (58.5–91) | 68 (51–95) | 0.60 |
| Diameter before intervention, mm, median, (IQR) | 5 (3.2–7) | 6.3 (5.5–9.4) | 0.003 |
| Diameter after intervention, mm, median (IQR) | 14 (11–15.7) | 12 (11–15) | 0.58 |
| Ratio of post- to preprocedural diameter, median (IQR) | 2.45 (1.9–3.5) | 1.7 (1.4–2.2) | <0.001 |
| Number of covered stents, n (%) | 20 (18.5) | 3 (10.7) | 0.32 |
| Fluoroscopic time, min, median (IQR) | 6.3 (4.8–8.4) | 6.3 (4.9–12.4) | 0.57 |
| Predilation, n (%) | 15 (13.8) | 3 (10.7) | 0.52 |
| Redilation, n (%) | 50 (46.2) | 11 (39.2) | 0.44 |

Abbreviations: CoA, aortic coarctation; IQR, interquartile range; reCoA, recoarctation

**RESULTS** **Clinical and procedural characteristics** The clinical and procedural characteristics of the study groups are presented in TABLE 1. The study population included 136 patients with a clinical diagnosis of CoA, who underwent stent implantation at our institution for the treatment of native CoA (108 patients; 68 men; mean [SD] age at the time of stent implantation, 27.69 [15.0] years; median [IQR] weight, 62 kg [51.2–77.7]) or reCoA after surgical repair (28 patients; 16 men; mean [SD] age at the time of stent implantation 25.46 [15.7] years; median [IQR] weight, 66 kg [50.5–83.7]). There were no differences in age, sex, and weight between the study groups.

The median gradient before the intervention was higher in the native CoA than in the reCoA group (47 mm Hg [IQR, 36–57.7] vs 40 mm Hg [IQR, 27–44], $P$ = 0.011). However, the gradient after intervention was the same in both groups. The median diameter before the intervention was smaller in the native CoA than in the reCoA group (5 mm [IQR, 3.2–7] vs 6.3 mm [IQR, 5.5–9.4], $P$ = 0.003), whereas there was no difference in the diameter after the intervention. Fluoroscopy time, the number of the CSs used, and the rates of predilation and redilation were similar between the study groups.

Within the single groups, the gradient and diameter before the intervention were significantly different in comparison with those after the intervention (FIGURE 1A and 1B). In particular, the pressure gradient decreased by about 77% in the native CoA group and by 68% in the reCoA group ($P$ <0.001 for both). On the other hand, the diameter of the stenotic lesion increased by about 180% in the native CoA group and 90% in the reCoA group ($P$ <0.001 for both).

**Immediate follow-up** Immediate complications are summarized in TABLE 2. There were no

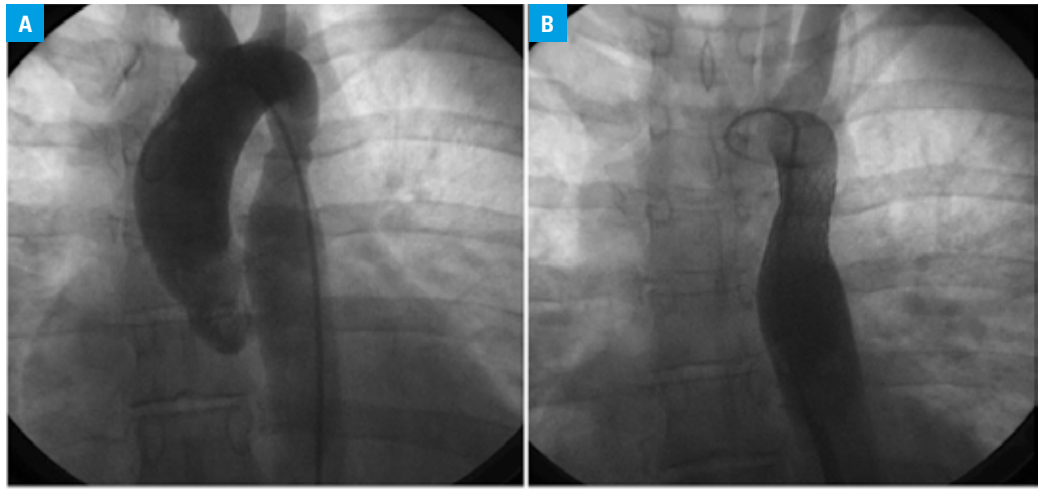


**FIGURE 2** Selective angiograms of a 30-year-old female patient with native coarctation before (**A**) and after (**B**) implantation of Andra XXL 30 mm stent. The gradient and diameter of stenosis before the procedure were 20 mm Hg and 9 mm, respectively, while they were 0 mm Hg and 17 mm, respectively, after the procedure.

**TABLE 2** Immediate complications

| Complication | Native CoA group (n = 108) | ReCoA group (n = 28) | *P* value |
|---|---|---|---|
| Aortic dissection | 0 (0) | 1 (3.5) | 0.05 |
| Stent migration | 4 (3.7) | 0 (0) | 0.30 |
| Hematoma | 1 (0.9) | 0 (0) | 0.46 |
| Artery thrombosis | 1 (0.9) | 0 (0) | 0.60 |
| Stroke | 1 (0.9) | 0 (0) | 0.60 |

Data are presented as number (percentage) of patients.

Abbreviations: see TABLE 1

differences in the percentage of successful interventions ($P = 0.87$) and of immediate complications between the study groups ($P = 0.39$). No procedure-related deaths were observed in either of the groups. In patients with native CoA, the rate of successful procedures was 77.8%. FIGURE 2 shows the selective angiograms of a patient with native CoA before (FIGURE 1A) and after an effective percutaneous procedure (FIGURE 1B). Four patients experienced stent migration during the procedure, and BMSs were used in 4 cases, with a good result of extension. Stent migration occurred proximally to the stent placement in 2 patients and distally in another 2 patients. Of note, in one of these patients, the Sinus Aorta stent was implanted. A mild permanent stroke occurred in 1 patient with CoA and native aortic aneurysm during CS implantation. However, the patient showed full recovery after 6 months of rehabilitation. Two patients revealed a large femoral hematoma that resolved spontaneously. Artery thrombosis occurred in 1 patient and required surgical thrombectomy.

In patients with reCoA, the mean (SD) time between primary surgery and endovascular stent implantation was 19.35 (11.65) years. The rate of successful procedures was 78.5%. A CS was used as primary treatment in 1 patient because of acute aortic dissection that occurred during balloon angioplasty. In particular, the CS was immediately used to close the initial tear of the dissection, with successful dilation of the coarctation. In another case, a CS was implanted in a 23-year-old man with a fracture of a previous BMS (CP) and important restenosis causing a peak systolic gradient across the lesion of about 31 mm Hg.

The association between CoA and hypoplastic isthmus was observed in 4 patients (3 with native CoA and 1 with reCoA), 2 of whom required CS implantation.

There were no differences in immediate complications between patients who were implanted with the CS or BMS (7.4% vs 7.1%, respectively, $P = 0.78$).

**Long-term follow-up** The results of the long-term follow-up are presented in TABLE 3. The average follow-up duration was different between the native CoA and reCoa groups ($P < 0.001$). In particular, in the native CoA group, 77 patients (72%) were followed for a mean (SD) of 49.2 (39.9) months, whereas the follow-up of the reCoA group was completed in 26 patients (93%), with a mean (SD) duration of 96.7 (53.8) months. In the native CoA group, 3 patients underwent MRI and 47 patients were followed by CT to assess stent position, diameter at the dilated site, possible intimal hyperplasia, and the presence of late aneurysm and dissection. Four patients underwent catheterization to assess the gradient across the stent. In the reCoA group, 8 patients underwent angiographic study, 3 patients underwent MRI, and 11 patients were followed by CT.

There were no differences in the late adverse events between the study groups ($P = 0.078$) (TABLE 3) and between patients treated with CS vs BMS ($P = 0.63$). In particular, we observed 8 adverse events in patients with native CoA and 1 in those with reCoA. In the native CoA group, 3 patients underwent a planned Bentall procedure, and 1 patient underwent additional AndraStent XL 26 implantation because of restenosis of the primary CP stent. There were 5 cases of aneurysms in patients with BMS implantation: 4 in the native CoA group and 1 in the reCoA group (TABLES 3 and 4). All these cases were successfully treated with CS. FIGURE 3 shows selective angiograms of an aneurysm in a patient with reCoA

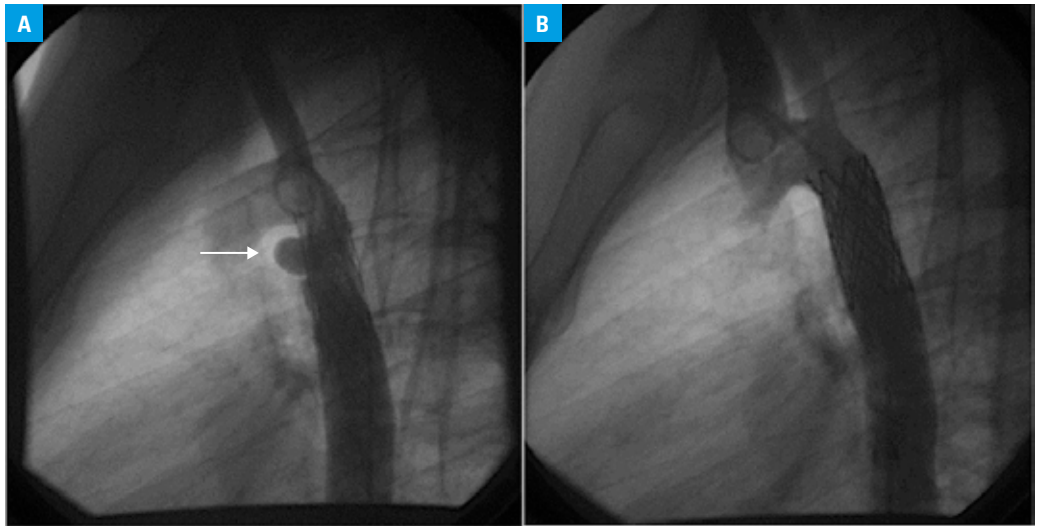


**FIGURE 3** Selective angiograms of a 17-year-old female patient with recoarctation, with an aortic aneurysm (**A**, white arrow) detected 5 years after the primary bare metal stent implantation (Palmaz stent 4014, 40 mm), and successfully treated with a covered stent (CVCP, 34 mm) (**B**).

**TABLE 3** Long-term complications

| Complication | Native CoA group (n = 77) | ReCoA group (n = 26) | *P* value |
|---|---|---|---|
| Aneurysm | 4 (5.2) | 1 (3.8) | 0.46 |
| Restenosis | 1 (1.3) | – (0) | 0.60 |
| Bentall procedure | 3 (3.9) | – (0) | 0.37 |

Data are presented as number (percentage) of patients.

Abbreviations: see TABLE 1

(FIGURE 1A) 5 years after the primary BMS implantation, successfully treated with a CS (FIGURE 1B).

In the native CoA group, balloon redilation of the stent was performed in 50 patients (46.2%). In 4 cases, the aneurysms were observed after BMS implantation and were treated with CS. In the reCoA group, redilation of the stent was performed in 11 patients (39.2%). Reintervention with additional CS implantation due to aneurysm formation was required in 1 patient after initial BMS placement. A balloon rupture occurred during redilation in 1 patient. A surgery was required to remove the balloon from the groin.

At follow-up, the mean (SD) systolic and diastolic blood pressures were 129 (11.9) and 76 (9.3) mm Hg, respectively, in patients with native CoA, and 128.6 (17.7) and 71.8 (12.6) mmHg, respectively, in those with reCoA, without any statistical difference between the study groups. About 85% of the patients with native CoA and 90% of those with reCoA required antihypertensive treatment. All those patients underwent primary BMS implantation. The last clinical assessment revealed no significant difference in antihypertensive management between the study groups. In particular, it was possible to either discontinue antihypertensive drugs in 14.5% of the patients with native CoA and in 10% of those with reCoA ($P = 0.74$), and to reduce the doses in 19% of the patients with native CoA and 25% of those with reCoA ($P = 0.89$). The medication was unchanged in 50.5% of the patients with native CoA and in 50% of those with reCoA, whereas a new medication was added after stent implantation in 16% of the patients with native CoA and 15% of those with reCoA.

**DISCUSSION** Our findings show that: 1) stent implantation is a safe, feasible, and effective procedure in the treatment of both native CoA and reCoA; 2) patients with native CoA reveal a higher pressure gradient and a smaller diameter compared with those with reCoA, but their immediate and late outcomes are the same; and 3) on final clinical assessment, reduction or discontinuation of the antihypertensive treatment was possible in about 34% of the population.

Treatment of CoA should be performed shortly after establishing the diagnosis to avoid potential late complications such as congestive heart failure, death, and hypertension-related events. Several techniques for surgical treatment of CoA are available, including resection with end-to-end anastomosis, subclavian flap aortoplasty in infants with long-segment coarctation, and a bypass graft across the area of coarctation.[4] Balloon angioplasty alone may result in recoil, residual or recurrent restenosis, possible dissection, and higher risk of aneurysm development due to intimal tear.[12-14] Over the past 20 years, endovascular stenting has proved to be an acceptable treatment option for native and postsurgical reCoA in children and adults.[4,5,15] Its advantage over balloon angioplasty lies in the fact that stent implantation supports the wall and maintains the increase in aortic diameter.[8]

The most common indications for stent implantation in patients with CoA include unfavorable anatomy for balloon angioplasty (such as hypoplasia of the aortic isthmus), unsuccessful opening by balloon angioplasty, restenosis or dissection after angioplasty, previous surgical repair, high surgical risk, and lack of consent to surgical intervention.[16] Potential stent-related complications include incomplete stent expansion, fracture, and migration, as well as thromboembolic episodes. Another complication is the aneurysm formation, which has been observed in 0.7% to

**TABLE 4** Clinical and procedural characteristics of patients who developed aortic aneurysm after primary stent implantation

| Type of coarctation | Age of patient at BMS implantation, y | Type of BMS | Length of BMS, mm | Time of aneurysm diagnosis after BMS implantation, mo | Type of CS implanted |
|---|---|---|---|---|---|
| Native CoA | 13 | CP | 34 | 18 | CVCP |
| | 35 | CP | 34 | 41 | CVCP |
| | 34 | ASXXL | 48 | 15 | CVCP |
| | 23 | ASXL | 39 | 15 | CVCP |
| ReCoA | 12 | 4014 | 40 | 60 | CVCP |

Abbreviations: 4014, Palmaz stent 4014; AS, andrastent; BMS, bare metal stent; CP, Cheatham Platinum; CS, covered stent; CVCP, covered CP stent; others, see **TABLE 1**

9% of patients in previous studies.[17] Moreover, stent placement is not generally recommended in patients weighing less than 25 kg owing to the small aortic size and the potential injury to the femoral artery from the larger sheath required for stent delivery.[9,18] The use of CS is preferred in the case of aneurysm, subatretic or blind coarctation and coarctation with patent ductus arteriosus, or in restenosis.[19] To our knowledge, there are no data on the differences in the pressure gradient and stenosis diameter before and after stent implantation in patients with native CoA and reCoA.

In this paper, we reported that patients with native CoA presented a higher gradient and a smaller diameter before the procedure compared with patients with reCoA. This finding might be related to the different physiopathology of stenosis, particularly to the specific tissue underlying native CoA and reCoA. In this context, significantly fewer complications of stent implantation have been reported in patients with reCoA compared with those with native CoA.[14] However, in our study, the rates of successful intervention, as well as immediate complications, were not significantly different between the groups.

One of the major challenges during stent implantation is stent migration, which may occur during the attempt to achieve a proper apposition of the implanted stent to the aortic wall.[20] In our study, stent migration during the procedure was reported in 4 patients from the native CoA group. Another known complication of stent implantation is the fracture of endovascular stents. In most cases, it has been reported with the use of CP stents.[21] It can occur by aortic pulsatility and cyclical bending of the stent after its full endothelization. In our cohort, a fracture of a CP stent was observed in 1 patient, who was successfully treated with CS implantation. Of note, in our recent study, no stent fractures were reported in a population of patients treated with AndraStent.[22]

Stent fracture, severe intimal stenosis, and adjacent somatic growth are the potential factors requiring second stent placement or reintervention with angioplasty.[11] Recommendations from the American College of Cardiology / American Heart Association suggest reintervention in patients who have a peak-to-peak recoarctation gradient of 20 mm Hg or higher or in those with a gradient of less than 20 mm Hg if there is evidence of significant coarctation with significant collateral flow.[23] Staged stent dilation has been recommended for high-risk patients (eg, those with critical lesions) to prevent the development of such aortic wall abnormalities.[24] In our study, we performed redilation of the stent as part of the staged approach due to the abnormal enlargement.

Our study showed that the late outcomes were low in number and similar between the study groups. Of note, complications of the stent implantation procedure, including aortic rupture or stent fracture, embolization, or displacement, can occur immediately or many years after the intervention. Moreover, patients may develop restenosis, aneurysm, and pseudoaneurysm at the site of prior repair. The vascular causes of aneurysm include damage to the vessel wall by the balloon with overstretching, technical difficulties, and aortic cystic medial necrosis with a decreased elastin density in the arterial wall and increased collagen content as underlying anomalies. Indeed, special precautions need be taken to avoid manipulating the tip of the catheter or guidewire over the recently dilated aortic segment. In previous studies,[8,25] no predictive factors could be established for aneurysm formation, including age, initial systolic blood pressure, coarctation dimension, prestenting or poststenting gradient, native CoA or reCoA, or the type of stent. Moreover, the incidence of aortic wall injury depended on the volume of patients admitted to our center.[26] However, a balloon-to-coarctation ratio of more than 3.5 at primary procedure and prestent angioplasty has been associated with more extensive aortic wall injury,[8] and should therefore be avoided. Importantly, the majority of these aneurysms are small and can be managed conservatively.

The rate of aneurysm formation in our study was 4.8%, with a mean (SD) time of diagnosis after primary stent implantation of 29.8 (20) months. This incidence is lower than that reported in previous research.[8] A systematic follow-up with imaging techniques is necessary to detect aneurysm formation. The mean (SD) age of patients developing an aneurysm was 23.4 (11) years, while no events were observed in patients older than 36 years. However, this finding is in

contrast to the previous literature and has to be confirmed in future larger studies.[27]

Patients with repaired CoA are at high risk for hypertension, even after adequate anatomic surgical or endovascular treatment. Hypertension has been shown to be more common in patients who were treated after the age of 20 years compared with those who underwent surgical repair in early childhood.[28-31] In our study, discontinuation or reduction of antihypertensive treatment after stent implantation was possible in about 34% of the patients.

Our study showed no differences in the immediate and long-term outcomes between patients treated with CS and those treated with BMS. As primary treatment modality, CS implantation may reduce the risk of significant complications related to stent implantation and prevent dissection or aneurysm in the aortic wall during the follow-up.[19] The main concern with the use of CS in the aorta is the possibility of the occlusion of side branches, especially the spinal artery, which may result in paraplegia or paraparesis. Of note, this complication is uncommon when the covered segment is short and limited to the thoracic aorta.[24] The immediate results of trials on CS implantation as the primary treatment modality in adolescents and adults with native CoA and reCoA have been promising.[19,32] However, restenosis of CS has been reported. Butera et al[33] evaluated the possibility to redilate covered CP stents during follow-up in 7 growing children with CoA, thus suggesting that CS can be reexpanded with favorable outcomes. Seven patients in our cohort experienced redilation of CS with good outcomes. In a randomized clinical trial on BMS and CS implantation for the treatment of 120 patients with postductal, short-segment, severe native CoA, the procedural success rate was 100%. During the 31 months of follow-up, there was no difference in the rate of reCoA and pseudoaneurysm formation between patients who underwent implantation with BMS vs CS.[34]

There is still no evidence indicating which stent is better in the treatment of CoA. In our opinion, CS could be the preferred treatment in adequately selected patients (eg, with severe arch obstruction, tortuosity of the aorta, aneurysms, or hypoplasia of aortic stenosis).[35]

**Study limitations** The main limitations of our study include the single-center experience, small sample size, and retrospective design. Moreover, we had a limited amount of the available follow--up data, which might have influenced the assessment of the late outcomes. Future larger randomized trials are required to assess the immediate and long-term outcomes in patients with native CoA and reCoA who underwent stent implantation and to evaluate the differences between patients treated with BMS and those treated with CS.

**Conclusions** Our results indicate that stent implantation is an effective and safe treatment in patients with CoA, with good late outcome. CS implantation could be the preferred option in adequately selected patients.

**Contribution statement** JB conceived the idea for the study. RF and MS contributed to the design of the research. SS was involved in the first draft and data collection. GS and OGM analyzed the data and drafted the second version. All authors edited and approved the final version of the manuscript.

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