Immediate results of balloon angioplasty with stenting in patients with coarctation of descending aorta

Resultados inmediatos de la angioplastia con balón con stent en pacientes con coartación de aorta descendente

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Abstract

Background: Coarctation of the aorta, identified by Morgagni in 1760, is a narrowing of the aorta between the left subclavian artery's origin and the aorta-ductus arteriosus junction, with its cause still not fully understood. The aim of the study is to evaluate the immediate results &the complications of balloon angioplasty with covered CP- stent for coarctation of descending aorta. **Method:** A prospective study at Ibn-AL-Bitar center treated 27 patients with coarctation of the descending aorta using 33 CP stents. Patients, diagnosed via multiple methods, were divided into native coarctation and recoarctation post-balloon angioplasty groups. Success was defined by gradient reduction and diameter increase, with complications categorized as major or minor. **Result:** The study at Ibn-AL-Bitar center used 33 covered CP stents to treat 27 aortic coarctation patients, divided into native coarctation (20) and post-angioplasty recoarctation (7). Stenting significantly reduced pressure gradients and increased aortic diameter in both groups. Group 2 experienced a higher complication rate, but there were no procedure-related deaths. **Conclusion:** Stent implantation effectively manages both native and recoarctation of the descending aorta, but complications, especially stent migration, can arise. Such issues are common with recoarctation post-balloon angioplasty and Z-MED balloon catheter use. Continued follow-up is crucial for assessing outcomes.

Keywords: Immediate, balloon, angioplasty, stenting, Coarctation, descending aorta.

Resumen

Antecedentes: La coartación de aorta, identificada por Morgagni en 1760, es un estrechamiento de la aorta entre el origen de la arteria subclavia izquierda y la unión aorta-ductus arterioso, cuya causa aún no se comprende completamente. El objetivo del estudio es evaluar los resultados inmediatos y las complicaciones de la angioplastia con balón con stent CP cubierto para coartación de aorta descendente. **Método:** Un estudio prospectivo en el centro Ibn-AL-Bitar trató a 27 pacientes con coartación de la aorta descendente utilizando 33 stents CP. Los pacientes, diagnosticados mediante múltiples métodos, se dividieron en grupos de coartación nativa y recoartación posterior a la angioplastia con balón. El éxito se definió por la reducción del gradiente y el aumento del diámetro, clasificándose las complicaciones como mayores o menores**. Resultado:** El estudio en el centro Ibn-AL-Bitar utilizó 33 stents CP cubiertos para tratar a 27 pacientes con coartación aórtica, divididos en coartación nativa (20) y recoartación post-angioplastia (7). La colocación de stent redujo significativamente los gradientes de presión y aumentó el diámetro aórtico en ambos grupos. El grupo 2 experimentó una mayor tasa de complicaciones, pero no hubo muertes relacionadas con el procedimiento. **Conclusión:** La implantación de un stent gestiona eficazmente tanto la recoartación como la nativa de la aorta descendente, pero pueden surgir complicaciones, especialmente la migración del stent. Estos problemas son comunes con la recoartación posterior a la angioplastia con balón y el uso del catéter con balón Z-MED. El seguimiento continuo es crucial para evaluar los resultados.

Palabras clave: Inmediata, angioplastia con balón, stent, coartación, aorta descendente.

Introduction

Coarctation of the aorta, first described by Morgagni in 1760, remains a focal point in cardiology due to its still elusive pathogenesis[1]. The term "coarctation" is Latin for "drawing together to make tight." In relation to the aorta, it defines a distinct constriction located in the aortic isthmus between the left subclavian artery's origin and the aorta-ductus arteriosus junction[2]. Although the anatomical anomaly seems straightforward, the coarctation of the aorta is complex and varied in its presentation. It can manifest as a brief or long-segment constriction, be associated with hypoplasia of the transverse aortic arch, or occur in the abdominal aorta. Its pathophysiology is shaped by the constriction's severity and the presence of accompanying lesions like the patent ductus arteriosus, ventricular septal defect, and aortic or mitral stenosis. Clinical presentations can range from heart failure in infants to undetected hypertension or a murmur in older children[3]. Treatment strategies have evolved over the years. Initially, surgical interventions, such as resection or subclavian flap angioplasty, were common. In 1982, balloon dilation emerged as a non-surgical remedy[4]. Balloon angioplasty became a widely accepted solution for both initial and recurrent coarctations in patients aged over six months. However, the technique isn't without issues. There's potential for vessel recoil and lesion persistence, with over-extension risking aortic wall damage[5-7]. To address these challenges, stents started to gain popularity, especially for older children and young adults. O' Laughlin et al introduced the endovascular stent's application for aortic coarctation in 1991[8]. Initially reserved for cases resistant to surgery and balloon angioplasty, stents have, with time, been recognized as the preferred treatment in certain complex anatomies, coarctation with patent ductus arteriosus, and CoA associated with aneurysms[9]. Among the various stents available, the covered Cheatham-Platinum (CP) stent stands out. It is frequently employed in aortic coarctation treatment. This stent, primarily made from platinum (90%) and iridium (10%), has gained preference in pediatric cardiology. Its design, mainly available in 6 and 8 rows and often utilized in an 8-zig configuration, can be expanded up to 28 mm. Apart from its robust radial strength, even at vast diameters, its high visibility on fluoroscopy is also commendable[12]. The aim of the study is to evaluate the immediate results &the complications of balloon angioplasty with covered CP- stent for coarctation of descending aorta.

Methods

Treatment of Coarctation of the Aorta Using CP Stents: A Prospective Analysis at Ibn-AL-Bitar Center from October 2011 to February 2013, a prospective study was conducted at Ibn-AL-Bitar center for cardiac surgery to treat 27 patients with coarctation of the descending aorta using 33 covered CP stents (NuMED CP stent, Heart Medical Europe BV, Best, the Netherlands). Diagnosis was based on a combination of clinical signs, echocardiography, CT scans, and pressure gradient measurements. Patients were categorized into two groups: those with native coarctation (20 patients) and those with recoarctation after primary balloon angioplasty (7 patients). Each procedure began by obtaining informed written consent from patients or their guardians. General anesthesia was administered to 5 patients, while 22 received local anesthesia with conscious sedation. The process involved diagnostic catheterization, angiography, measurement of the aortic dimensions, and subsequent determination of the suitable stent and delivery balloon. The stent was carefully placed in the coarctation site using specific techniques and equipment. A successful procedure meant a gradient reduction to <20 mmHg and/or an angiographic diameter increase of >50%. Adverse events were classified as major complications, which include death, life-threatening events, necessity for surgical intervention, and permanent lesions. Minor complications consisted of transient events like temporary arterial thrombosis. Statistical analysis was done using the SPSS program for Windows, version 20. Data were compared before and after stenting, and between the two patient groups, using various statistical tests. A p-value <0.05 was deemed statistically significant.

Results

The study treated 27 patients with coarctation of the descending aorta using 33 covered CP stents. Patients were divided into two groups: Group 1 had 20 patients with native coarctation, and Group 2 consisted of 7 patients with recoarctation after a prior balloon angioplasty.

Patient Features:

- Age ranged from 11-56 years, with Group 1 averaging 28.4 years and Group 2 averaging 16.14 years, a significant difference between groups.
- Male-to-female ratios varied slightly between groups,

but differences weren't significant.

- 48.14% of patients showed no associated lesions. The most common lesion was a bicuspid aortic valve (29.62%), primarily found in Group 1, while PDA (11.11%) was most common in Group 2.

Procedural Features:

- 33 CP stents were used, with no significant difference in the number of stents between groups.
- Average stent length was about 32.4mm, with no significant difference between groups.
- The balloon size used varied significantly between the groups, being larger in Group 1.
- Procedure and fluoroscopy times were comparable between groups.

Effects of Stenting:

- Significant reductions in systolic pressure gradient were observed post-stenting in both groups.
- Post-stenting, the aortic diameter significantly increased for all patients.
- Echocardiographic gradients showed a significant reduction after stenting for both groups.
- The overall success rate was 96.3%, with 100% in Group 1 and 85.7% in Group 2.

Complications:

- No deaths related to the procedure were reported.
- Four minor complications (14.8%) were noted, predominantly in Group 2. Two involved stent migration, and two involved femoral pulse loss, which resolved with heparin treatment. Group 2 had a significantly higher complication rate.

Table 1. Patient's features

variables	*All patients N=27*	*Group1 N=20*	*Group2 N=7*	*P*
Age (Years)	25.22±12 (11-56)	28.4±12.3 (13-56)	16.14±3.4 (11-21)	**0.001**
Sex M/F (%)	15/12 (55.6%)	10/10 (50%)	5/2 (71.42%)	0.3

Table 2. Associated lesions

Lesions	All patients N= 27	Group1 N=20	Group2 N=7
NON	**13** (48.14%)	**9** (33.33%)	**4** (14.8%)
BAV	**8** (29.62%)	**8** (26.62%)	---
VSD	**1** (3.7%)	**1** (3.7%)	---
PDA	**3** (11.11%)	----	**3** (11.11%)
MVA	**2** (7.4%)	**2** (7.4%)	----

BAV (bicuspid aortic valve), VSD (ventricular septal defect), PDA (patent ductus arteriosus, MVA (mitral valve abnormalities).

Table 3. Procedural features

Variables	All patients N=27	Group 1 N=20	Group2 N=7	P
Stents length mm	32.4±7.8 (22-52)	32.3±7.5 (22-52)	33±9 (22-45)	0.8
Balloon size mm	16.56±2.9 (12-22)	17.55±2.6 (12-22)	13.7±1.7 (12-16)	0.002
Fluoroscopy time min	23.9±7.7 (12-40)	22.8±7.5 (12-40)	27.1±7 (18-38)	0.2
Procedure time min	91.8±29.9 (40-145)	93.5±30.3 (45-145)	87.2±30.8 (40-115)	0.6
Number of stents	33	24	9	0.7

P: comparison of group1&group2 values

Table 4. Effects of stenting on lesion

Variables		**All patients** N=27	**P1**	**Group1** N=20	**Group2** N=7	**P2**
Invasive gradient mm/Hg	Pre-stent	62.2±21.5 (20-100)	0.001	64±21.1 (30-100)	57.1±23.6 (20-90)	0.4
	Post-stent	9.6±14.4 (0-60)		8.2±11 (0-40)	13.5±22.1 (0-60)	0.4
Aortic diameter mm	Pre-stent	6.5±1.6 (4-10)	0.001	6.9±1.5 (4-10)	5.4±1.1 (4-7)	0.03
	Post-stent	13.7±3.6 (6-20)		15±3.1 (9-20)	10.1±2 (6-13)	0.001
Echocardiographic gradient mm/Hg	Pre-stent	60.8±19.3 (25-100)	0.001	60.8±19.1 (25-90)	60.8±21.6 (35-100)	0.9
	Post-stent	29.5±11.6 (18-70)		28±9 (18-52)	33.86±17.2 (20-70)	0.2
Success rate (%)		96.3%	---	100%	85.7%	0.08

P1: comparison of post-stent versus pre-stent values for all patients.

P2: comparison of group1&group2 values.

Discussion

In the present research, we compared various metrics concerning patients with coarctation of the descending aorta treated with CP stents to a handful of international studies. The average age of our patients was 25.2±12 years, close to the Italian study's average of 21.8±6.2 years but older than the American and Turkish studies which averaged 16±8 and 12.2±5.9 years respectively. This difference may stem from delayed diagnosis and treatment in our region. The male/female ratio from our study slightly deviated from the Italian, American, and Turkish studies[11-13]. The mean stent length used in our research was 32.4±7.8mm, akin to the Turkish study. The mean balloon size used in our study differed slightly from the Turkish research, with

ours being 16.5±2.9 mm against their 15±2 mm. This variance might be attributable to differing patient ages influencing aortic diameters[13]. Our study's average procedure time (91.8±29.9 minutes) was comparable to the Turkish study's 97±37 minutes[13]. Fluoroscopy time was also analogous between our study and the Turkish one[13]. A significant drop was observed in the invasive pressure gradient post-procedure, similar to Italian, American, and Turkish research findings. The aortic diameter also saw a significant increase post-stenting in our study, aligning with findings from Italian and Turkish studies[11-13]. Echocardiographic gradient significantly reduced post-stenting in our study, matching the results of the Turkish research[13]. The success rate in our study was 96.3%. While this was on par with Italian and American studies, it was slightly lower than the 100% rate of the Turkish study. Variance in the success rate might be due to diverse medical teams working on our study[13-16]. Our study recorded a 14.8% minor complications rate. Two instances of stent migration were observed with the use of Z-MED balloon catheters, and two other cases noted a loss of femoral pulse. Our findings closely resemble the minor complication rate from the Turkish study but differ from both the Italian and American studies. Differences in complication rates across these studies might be attributed to the technological advancements over the years[11-13].

Conclusions

Stent implantation is effective for native and recoarctation descending aortas. Our findings of effective gradient alleviation and rising lesion sizes in native and recurrent coarctation confirm this. However, some people have major consequences. Stent migration may doom stenting. These problems are prevalent in group2 (recoarctation after primary balloon angioplasty) and Z-MED balloon catheter dilatation. Following stent insertion, short, intermediate, and long-term outcomes should be monitored.

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