

## Late complications of aortic coarctation treatment: a mexican cohort study with more than 10-year follow-up

*Complicaciones tardías de tratamiento de coartación aórtica: estudio mexicano de cohorte con más de 10 años de seguimiento*

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### Key words:

Aortic coarctation, congenital heart disease, interventional cardiology, stent aortoplasty, complications.

### Palabras clave:

Coartación aórtica, enfermedades cardíacas congénitas, cirugía, intervención vascular percutánea, complicaciones.

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### ABSTRACT

Aortic coarctation's (CoA) prevalence is 0.2 in every 1000 live births. Therapeutic options include surgery and, for the last 20 years, interventional cardiology. **Objective:** To determine the complications of CoA and examine their association with the type of treatment received. **Methods:** Patients that underwent CoA treatment and had follow-up in our center were included. They were included according to treatment in 3 groups: balloon aortoplasty (group 1), stent aortoplasty (group 2) and open surgery (group 3). Patients who suffered from interrupted aortic arch and those who received treatment in other hospitals or presented complications detected in other hospitals were excluded. Data analysis: Descriptive statistics with central mean tendency and dispersion according to distribution, inferential statistics, X-square, ANOVA/Kruskal-Wallis and Kaplan Meier analysis of survival. **Results:** n =166, age = 18 (range 13-25), 118 male (71%), 48 in group 1, 57 in group 2 and 61 in group 3. The mean follow-up was 15 years. From the analyzed complications, those with statistical significance were: persistent systemic arterial hypertension (group 1, 15%; group 2, 34%; group 3, 41%,  $p < 0.001$ ) and re-intervention (group 1, 58%; group 2, 11%; group 3, 36%),  $p = 0.03$ . **Conclusions:** The balloon aortoplasty presents greater percentage of reoperation; and aortoplasty stent has fewer complications, but these are manifested in less time.

### RESUMEN

La prevalencia de Coartación Aórtica (CoA) es de 0.2 por cada 1000 nacidos vivos. Las opciones terapéuticas incluyen cirugía y en los últimos 20 años cardiología intervencionista. **Objetivo:** determinar las complicaciones de CoA y determinar la asociación con el tipo de tratamiento recibido. **Material y métodos:** Se incluyeron todos los pacientes con CoA atendidos en nuestra unidad y con seguimiento. Se incluyeron 3 grupos de acuerdo al tratamiento: Grupo 1, aortoplastia con balón, Grupo 2, aortoplastia con Stent y Grupo 3, cirugía. Se excluyeron pacientes con interrupción de arco aórtico o los que habían sido atendidos en otros hospital pero que las complicaciones se registraron en nuestra unidad. Análisis estadístico, se usó estadística descriptiva con medidas de tendencia central y dispersión de acuerdo a la distribución, estadística inferencial con X-cuadrada, ANOVA y Kruskal-Wallis, Kaplan Meier para supervivencia. **Resultados:** n =166, edad = 18 (rango 13-25), 118 hombres (71%), 48 en grupo 1, 57 en grupo 2, 61 en grupo 3. Seguimiento por 15 años. Al analizar las complicaciones las que tienen significancia estadística fueron: hipertensión arterial persistente (grupo 1, 15%; grupo 2, 34%; grupo 3, 41%,  $p < 0.001$ ) y reintervención (grupo 1, 58%; grupo 2, 11%; grupo 3, 36%),  $p = 0.03$ . **Conclusiones:** La aortoplastia con balón tiene mayor porcentaje de reintervención y la aortoplastia con stent tiene menor porcentaje de complicaciones, pero estas se manifiestan en un lapso menor de tiempo.

## INTRODUCTION

Aortic coarctation (CoA) represents up to 5-7% of all congenital cardiopathies, with a prevalence of 0.2 per 1000 live births and a male-female ratio of 2-1.<sup>1</sup>

CoA is an abnormal thickening in the medial layer and intimal hyperplasia of the aorta. It usually affects the posterior wall, adjacent to the beginning of the subclavian artery, mainly the distal aortic arch and the emergence of the descending aorta.<sup>2</sup> It is accompanied by other cardiac anomalies like bicuspid aortic valve, patent ductus arteriosus or ventricular septal defects and is one of the heart defects usually found in genetic syndromes such as Turner syndrome.<sup>3</sup>

Untreated CoA decreases quality of life and life expectancy, and in spite of treatment, secondary complications may arise, so the need for continuous monitoring for diseases such as arterial hypertension, premature coronary artery disease or stroke is warranted.<sup>4</sup>

Corrective treatment must be invasive, and there are two possible approaches: catheterization (balloon or stent aortoplasty); and open surgery (coarctation resection with end-to-end anastomosis, arch dilatation and placing of extra-anatomic bypass).<sup>5</sup>

Which intervention is used depends on the age of the patient, CoA's anatomy and the presence of coexisting alterations. Cardiologist and pediatric cardiologist are obliged to provide appropriate follow-up in patients in order to timely detect complications.

## OBJECTIVE

To compare the frequency of complications in patients CoA treated balloon aortoplasty, stent aortoplasty and open surgery.

## METHODS

After obtaining approval from the local ethics committee, we performed a prospective, ambispective study, from CoA patients who had been treated with balloon aortoplasty, stent aortoplasty and open surgery in the congenital heart disease clinic of the Centro

Médico Nacional Siglo XXI general hospital in Mexico City.

Patients of both sexes over four years old, that underwent balloon aortoplasty, stent aortoplasty and open surgery and attended all programmed follow-up visits in our hospital were enrolled. We excluded subjects who had complications that were detected in other hospitals, or underwent surgical procedures in other hospitals, as well as patients who had other complex heart diseases, like interruption or hypoplasia of the aortic arch, or that were treated in other services and subjects with unsuccessful surgical interventions.

The inclusion of patients was obtained from databases of our department. According the

Table I. General characteristics.

Variable	Frequency (%)
Gender	
Male	87 (76%)
Female	27 (24%)
Age (years)*	17 (12-25)
Procedure type	
Surgery	44 (39%)
Stent	44 (39%)
Aortoplasty	26 (22%)
Cerebrovascular disease	0 (0%)
Rupture	0 (0%)
Endocarditis	0 (0%)
Coronary disease	0 (0%)
Aortic aneurysm	2 (1.8%)
Aortic dissection	1 (0.9%)
Double aortic lesion	6 (5.3%)
Aortic stenosis	3 (2.6%)
Aortic regurgitation	3 (2.6%)
Migration	1 (0.9%)
Reoperation	44 (38%)
Percutaneous reintervention	31 (27%)
Surgery reintervention	11 (9.6%)
Hypertension	37 (32%)
Vascular compromise	1 (0.9%)
Bleeding	1 (0.9%)
Death	0 (0%)

\* Median (interquartile range).

type of interventionist treatment. Three groups were formed: group 1, balloon aortoplasty; group 2, stent aortoplasty; and group 3, open surgery.

In those patients that require re-interventionism (surgical or catheterization) through follow-up, were grouped as a dichotomous outcome variable named: catheterization re-intervention or surgical re-intervention. The outcome variables were defined as follows:

- Re-coarctation: after successful procedure, evidence of maximum gradient in the re-stenosis site over 20 mmHg.<sup>6</sup>
- Systemic arterial hypertension: blood pressure values over 140/90 mmHg in more than three isolated times in patients with

history of normotensive values or patients that need reset antihypertensive drugs after withdrawal.

- Stroke: ischemic or hemorrhagic lesions by skull CT scan and neurology clinical examination.
- «Associated injury» was considered by the high prevalence of bicuspid aorta in this type of heart disease and aortic injury it was divided into:
  - Aortic valve insufficiency: moderate and severe degree were included. by two methods, echocardiography (contract vein, diameter of the regurgitant orifice area, M-mode deceleration time and pressure half-time) or catheterization (Seller's classification).
  - Aortic valve stenosis: were considered as present any degree of manifestation in the absence of diagnosis of aortic regurgitation in the immediate post operative. For the diagnosis was performed echocardiography and catheterization.
  - Double aortic lesion: was considered as present to any patient who in the same valve was demonstrated the two lesions described above, in the absence of previous injuries.
  - Aortic dissection: diagnosticated by contrast CT scan trough aorta from the root to the descendant segment.
  - Endocarditis: were used international guidelines for infectious endocarditis of the infectious Diseases Society of America (IDSA).<sup>7</sup>

Table II. Differences presenting complications by type of procedure.

	Surgery	Stent	Plasty	p value
Gender	30 (68%)	34 (77%)	23 (88%)	<b>0.05</b>
Male	14 (32%)	10 (23%)	3 (12%)	-
Female				
Cerebrovascular disease	0 (0%)	0 (0%)	0 (0%)	-
Rupture	0 (0%)	0 (0%)	0 (0%)	-
Aortic dissection	0 (0%)	0 (0%)	0 (0%)	-
Endocarditis	0 (0%)	0 (0%)	0 (0%)	-
Double aortic lesion	3 (6.8%)	2 (4.5%)	1 (3.8%)	0.5
Aortic stenosis	2 (4.5%)	1 (2.3%)	0 (0%)	0.2
Aortic regurgitation	0 (0%)	3 (6.8%)	0 (0%)	0.7
Migration	0 (0%)	2 (2.3%)	0 (0%)	0.8
Reoperation	16 (36%)	5 (11%)	15 (58%)	<b>&lt; 0.0001</b>
Hypertension	18 (41%)	15 (34%)	4 (15%)	<b>0.03</b>
Aneurysm	0 (0%)	0 (0%)	1 (3.8%)	0.1
Bleeding	1 (2.3%)	0 (0%)	0 (0%)	0.2
> 2 complications	9 (20.5%)	2 (4.5%)	4 (15.4%)	0.3
Death	0 (0%)	0 (0%)	0 (0%)	-

χ<sup>2</sup> Test.

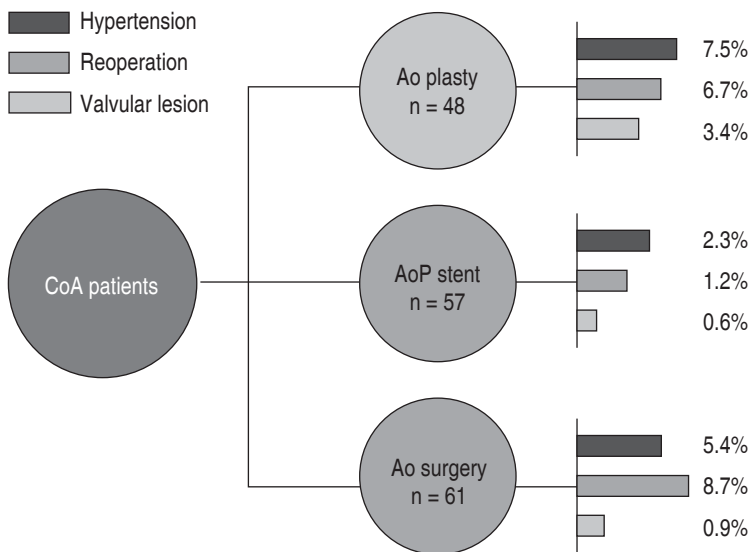
Table III. Time between the filing of complications by type of procedure.

	Surgery	Stent	Plasty	p value
Reoperation*	6.5 (1-12)	1.4 (1-5)	5 (1-7)	0.1
Hypertension**	3.8 ± 1	0.3 ± 0.1	7.2 ± 1.2	<b>0.05</b>

\* Kruskal-Wallis. \*\* ANOVA test.

Another outcomes considered were the death and the presence of two or more coexisting complications. The minimal follow-up in the patients was 5 years and maximum of 20. Patients who received treatment in other hospitals or presented complications in other hospitals were considered losses.

Data analysis: Descriptive statistics, measures of central tendency and dispersion according to distribution was evaluated. Incidence density for each of the outcomes was calculated. Inferential statistics, X-squared, ANOVA was calculated and was performed Kaplan Meier bivariate survival analysis in the outcomes with statistical significance.



Cases/100,000 patients year.

Figure 1. Density of incidence calcule.

Table IV. Special features of patients with more than two complications.

Patient	Procedure	Complication
1	Surgery	Double aortic lesion + reoperation
2	Surgery	Hypertension + reoperation
3	Surgery	Aneurysm + reoperation
4	Surgery	Aneurysm + reoperation
5	Surgery	Aortic stenosis+ reoperation
6	Surgery	Hypertension+ reoperation
7	Surgery	Bleeding + reoperation
8	Surgery	Hypertension + reoperation
9	Surgery	Aneurysm + reoperation + hypertension
10	Surgery	Hypertension + reoperation
11	Stent	Migrate + reoperation
12	Plasty	Bleeding + reoperation
13	Plasty	Hypertension + reoperation
14	Plasty	Hypertension + reoperation
15	Plasty	Hypertension + reoperation

RESULTS

166 subjects were included, with a mean age of 18 years (13-25), of which 118 were male (71%, male to female ratio 2.45:1). 48 patients had undergone balloon aortoplasty (27%), 57 stent aortoplasty (34%) and 61 open surgery (37%). The last group included different surgical techniques, in order of frequency: coarctectomy

and termino-terminal anastomosis (85%), Dacron patch (11%) and extracardiac tube (3%). The incidence density is presented in image 1, the rest of the descriptive variables is presented in table I.

The statistically different complications according to the type of procedure were re-intervention and systemic arterial hypertension, as seen in table II. In stent aortoplasty, the time free of systemic arterial hypertension was the longest (Table III), this procedure was also the one with the lowest risk of re-intervention compared with the rest of procedures (Figure 1). Open repair was the one with the highest rate of re-interventions, which are described in table IV.

DISCUSSION

Our patients show similarities to previous reports, male predominance and hypertension, as the main complication.

While the election treatment is given by the individualized intervention criteria and the experience in each center; the universal recommendation is that percutaneous approaches like aortoplasty are performed in children without other injuries, while stent aortoplasty is preferable in those adults with isolated CoA and poststenotic aneurysmal dilatation.<sup>8</sup>

We observed complications such as endocarditis and aortic valve lesion without achieving statistical significance, we consider that this facts are not procedure dependent but on the previous anatomy of the valve prior to the procedure, or the coexistence with bicuspid aortic valve.

The balloon aortoplasty was the procedure less associated with hypertension, and showed longer time presentation. We relate these findings that this procedure is performed in children, where the growth has not yet completed and the age is not a risk factor to the hypertension development. The group of patients treated with stent showed aortoplasty have lower complication rate compared with the treated group balloon aortoplasty, but complications such as hypertension and reoperation occurred in less time; This is explained in which the subjects selected had probably arch hypoplasia or unfavorable anatomy and added that in adulthood essential hypertension manifests.

In adulthood, Any type of intervention is prone to hypertension development due to the sum of previous factors such as endothelial modifications and angiogenic effects stimulated by the surgical procedure. Taelman L et al, described an exacerbated response in those endotheliums mostly handled as in the case of repeated aortoplasty and surgery.<sup>9</sup>

Cannife et al<sup>10</sup> in a systematic review found 32.5% prevalence of hypertension in CoA patients, and showed that the main factors to its development are: late-age correction, invasive procedures and repetitive interventions raise the likelihood to manifest.

### CONCLUSIONS

In our study, high blood pressure and reoperation were the most frequent complications.

The balloon aortoplasty presents greater percentage of reoperation; and aortoplasty stent has fewer complications, but these are manifested in less time.

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