

Immediate results of balloon angioplasty for native coarctation of the aorta

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Summary:

Background: Percutaneous balloon angioplasty is a less invasive alternative to surgical repair for patients with discrete coarctation of the aorta and although the use of balloon angioplasty in patients with recurrent postoperative coarctation gained a wide consensus, the use of this technique for native coarctation is still controversial. This study was carried out to evaluate our experience in Ibn Al-Bitar cardiac center with balloon angioplasty of native coarctation of aorta.

Patients and Methods : From August 2001 to May 2004, the catheterization data of 97 patients who underwent balloon angioplasty for unoperated coarctation of thoracic aorta in Ibn Al-Bitar cardiac center had been reviewed.

Results : the procedure acutely reduced the systolic gradient to less than 20 mm in 79 patients (81.3%), in 18 patients (18.7%) there was suboptimal results with residual gradient of more than 20 mmHg was reported and the systolic pressure in the ascending aorta decreased significantly ($p < 0.000$). Complications occurred in 17 patients (17.3%) but there were no death.

Conclusions : This study showed that a balloon angioplasty is safe and effective treatment option alternative to surgery in the majority of patients with native coarctation and is applicable to infants, older children and adults. We recommend the use of low profile balloon to reduce arterial complications and intimal tear.

Keywords : Coarctation, Angioplasty

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Introduction:

Definition: Coarctation of the aorta is a congenital malformation, consists of constriction of the aorta. Coarctation of aorta is a common defect that occurs in approximately 6-8% of patients with congenital heart diseases and it is the fourth most common lesion requiring cardiac catheterization or surgery during the first year of life and it occurs more commonly in males than in females^(1, 2, 3).

Pathology: The vascular malformation responsible for coarctation is a defect in the vessel media giving rise to a prominent posterior infolding which may extend around the entire circumference of the aorta. The lesion is most often discrete, but may be long-segment or tortuous in nature⁽⁴⁾. Important intracardiac lesions occur commonly in association with coarctation of the aorta. Patients who present during infancy are much more likely with another intracardiac lesion^(5, 6). Uncorrected coarctation of the aorta is associated with substantially shortened life expectancy in which most patients die before the age of 40 years from heart failure, ruptured aorta or cerebral vessel, or infective endocarditis^(7, 8).

Corrective surgery for coarctation was introduced in 1944⁽⁹⁾, and for many decades is considered conventional treatment for this condition, it carries a low risk and a high expectation of success, this repair may be associated with significant morbidity such as restenosis and aneurismal formation⁽⁷⁾. In contrast, reoperation for recurrent postoperative coarctation is more difficult and is associated with increase morbidity and mortality than initial surgery for native disease⁽¹⁰⁾.

Percutaneous balloon angioplasty of native coarctation of aorta was first described by Singer et al⁽¹¹⁾ as a less invasive alternative to surgical repair for patients with discrete coarctation of the aorta. Although the use of balloon angioplasty in patients with recurrent postoperative coarctation gained a wide consensus, there is controversy regarding the angioplasty for native coarctation and this is related to residual or recurrent stenosis and aneurismal formation at the dilatation site⁽¹²⁾.

The cost of balloon coarctation angioplasty is significantly (58%) less than the cost of surgical repair of unoperated coarctation of the aorta. The majority of this cost differential is a result of the longer hospital stay for surgical patients and this is clearly one advantage of balloon angioplasty over surgical repair of unoperated coarctation⁽¹³⁾.

In this study, we evaluated the clinical experience with balloon angioplasty of native

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coarctation of aorta and the possibility of using this procedure as alternative to surgical repair. The immediate outcome and complications had been reviewed and the risk factors for a poor result were assessed.

PATIENTS AND METHODS

From August 2001 to May 2004, cardiac catheterization data of all patients who underwent balloon angioplasty for native coarctation of thoracic aorta in Ibn Al-Bitar cardiac center in Baghdad had been reviewed.

The procedure had been done for those patients with discrete thoracic coarctation with a resting systolic gradient of more than 20 mmHg. Patients with pressure gradient less than 20 mmHg, long segment coarctation or severe isthmic hypoplasia were not candidate for angioplasty.

Angioplasty procedure: Percutaneous balloon angioplasty is performed in the cardiac catheterization laboratory with patient under general anesthesia (for those below 14 years) or with slight sedation for those older than 14 years. A pigtail catheter is inserted percutaneously into each femoral artery. A 5-7 F catheter is advanced into the ascending aorta and 4 F catheter is positioned in the descending aorta to monitor distal pressure.

After recording pressures across the coarctation, ascending aortography was performed. If after angiography, the coarctation is judged to be suitable for angioplasty, 100 U/Kg heparin was administered and a balloon catheter is advanced over appropriate size balloon. 0.018 to 0.035 inch J-tipped exchange wire is positioned in the ascending aorta. The balloon catheter is chosen whose inflated balloon diameter is equal to the diameter of the isthmus just distal to the left subclavian artery or the size of descending aorta at the level of diaphragm. The deflated balloon is placed across the coarctation and is inflated until the waist disappears and this is repeated three to five times each for 10 to 15 seconds. The balloon catheter was replaced (over the guide-wire) with multipurpose catheter. Pressures were again recorded in the ascending and descending aort then ascending aortogram is done.

To determine the independent factors predictive of acute results, a suboptimal outcome was defined as the residual peak to peak systolic pressure gradient ≥ 20 mmHg.

Results are expressed as median and range or as mean \pm standard deviation. Data were evaluated by paired t-test for individual paired comparisons. To achieve statistical significance, probability was set at 0.05.

RESULTS

Among the 97 patients, 72 were male (74.2%) and 25 were female (25.8%) and the male to female ratio was 2.88 to 1. The age of the patients ranged from 1 month to 45 years (median age at time of procedure was 11.3), and the weight of patients ranged from 4 Kg to 75 Kg (median weight at intervention was 33.06 kg).

Among these patients, there were 21 patients (21.6%) below

Age in years	Number of the patients	Percent	Cumulative percent
< 1	21	21.6	21.6
1-4	16	16.5	38.1
5-9	15	15.5	53.6
10-14	11	11.3	64.9
> 14	34	35.1	100
Total	97	100	100

1 year of age, 42 patients (43.3%) between the age of 1- 14 years and 34 patients (35.1%) above 14 years of age (table 1).

Table (1): Age groups of the patients

Associated anomalies: About one third of patients had another associated cardiac anomalies, Table (2). Aortic stenosis (AS) was the most common associated lesions anomaly while patent ductus arteriosus (PDA) was the most frequent shunt lesion and VSD was the next most common.

Table 2: Associated anomalies

Associated anomaly	No.	%
AS	13	13.4
PDA	9	9.2
VSD	7	7.2
MR	3	3

LV function: LV dysfunction (LVEDP more than 12) was recorded in 15 patients (15.4%), 8 patients of them had coarctation and other associated lesions while 7 patients had isolated coarctation. Most patients had myopathic LV.

Pressure gradient: The procedure acutely reduced the systolic coarctation gradient to less than 20mm in 79 patients (81.3 %). And although there was some reduction in the systolic gradient in all patients, there were 18 patients (18.7 %) had suboptimal results with residual pressure of more than 20 mmHg. The mean systolic pressure gradient before the dilatation was 57.47 \pm 25.52, which decreased significantly after angioplasty to 9.38 \pm 12.3, which is statistically highly significant ($p=0.0001$) and the mean systolic pressure gradient decreased by 81.23%. The systolic pressure in the ascending aorta decreased from 152.06 \pm 30 to 127.52 \pm 23.67 mmHg ($p<0.0001$). And the systolic

pressure in descending aorta increased from 95.05+24.53 to 118.82+24.39 (p. 0.0001).

Complications: Complications were reported in 17 procedures (17.3%). Intimal tear had been recorded in 7 patients (7.2%) and 5 patients (5.01%) had reduced pulses in the catheterized leg and in all these patients there was reappearance of the pulse within 24 hours. All patients were discharged home within 24 hours of the procedure.

In all procedures, these complications led to no major sequelae. There were no deaths associated with procedure.

DISCUSSION

This paper reports experience in Ibn Al-Bitar cardiac center in the last two years with balloon angioplasty for native coarctation of the aorta in 97 patients. The study showed the immediate result of this procedure and limited by the lack of follow up of these patients because of the local circumstances in our country.

The male predominance of our patients compatible with other studies^(14, 15) who reported that the male to female ratio ranges from 1.4:1 to 3.1:1.

The wide range of the age (the patients at time of procedure compatible with the concept reported that the coarctation of aorta tends to produce significant symptoms in early infancy and after the age of 20 years^(15, 16)).

The fact that aortic stenosis is the most associated anomalies is due to high incidence of bicuspid aortic valve.

The incidence and type of associated anomalies in our patient is compatible by the result reported elsewhere^(17, 18).

The significant number of patients with LV dysfunction is compatible with other study⁽¹⁹⁾ and caused by associated obstructive or shunt lesion valvular incompetence, hypertension, or other unexplained causes.

Pressure gradient: Balloon angioplasty has become the preferred treatment for patients with recurrent coarctation of the aorta. The application of this technique for treatment of native coarctation is controversial due to perceived risks of vessel integrity, its influence on long-term vessel stability initial success of the procedure, the high incidence of restenosed and the risk of aneurismal formation^(12, 20, 21).

The data obtained from our results showed significant reduction in the pressure gradient across the constricted site and significant decrease in the systolic pressure in the ascending aorta and this indicates that balloon angioplasty is an effective treatment, alternative to surgery, in the management of native coarctation of aorta.

Also the effectiveness of the procedure in relieving the obstruction in all age groups mean that

this procedure is equally applicable in young infant, older children and adult patients.

This is compatible with Hijazi et al⁽²²⁾ and Tyna et al⁽²³⁾ study, Brian et al⁽¹⁷⁾ who reported that the acute results of balloon angioplasty of native coarctation were equivalent or slightly superior to those for recurrent aortic obstruction. Our study also agree with Shaddy et al study⁽¹³⁾ who reported that immediate gradient reduction is similar after balloon coarctation angioplasty and surgical treatment of operated coarctation of the aorta.

Although there was some reduction in the pressure gradient in all patients even those patient with an early suboptimal outcome which represent 18.6% of our patient and this agree with Michael et al study⁽²³⁾. Brian et al⁽¹⁷⁾ showed that residual gradient of ≥ 20 mm.Hg were recorded in 19% of patients underwent angioplasty for native coarctation and in 25% of those with postoperative recurrent lesions.

Our result is less favorable in comparison with Hijazi et al study⁽²²⁾ who was successful in removing the gradient across the coarctation to less than 20 mm.Hg in all treated group "100%" and this may reflect the difference in the institutional experience, length and intensity of experience due to late adoption of this procedure in our center.

There was no statistical difference between the group of the patients with suboptimal early outcome and those with successful results in age, weight, gender. Systolic pressure gradient across coarctated site and degree of systolic pressure in ascending aorta so our data demonstrate that although balloon angioplasty is effective in aortic coarctation these data, also demonstrate that the outcome is unpredictable, and this finding compatible with other studies^(23, 24, 25) but it differs from Hellebrand et al⁽²⁶⁾ who found that increasing patient age predicted poor results and he suggest earlier rather than later intervention by balloon angioplasty techniques and he explained that on the basis of increased fibrotic change in the aorta. By long standing obstruction, however, this finding may reflect follow up results, and some series have shown an increased risk of recurrence in younger patients⁽²⁷⁾ and our data showed that there is good early results even in neonate infant and older children which agree with other studies⁽²⁸⁾.

Although our study support that angioplasty is safe and there was no deaths, the significant arterial complications which reported in this and other studies^(16, 17, 24). So the miniaturization of balloon catheter systems may reduce those arterial complications and to minimize the arterial damage and intimal tear low profile balloon should be used and should not manipulated on the raw area unless its on exchange guide-wire.

CONCLUSIONS AND RECOMMENDATION

So we conclude that our study support the previous studies showing that balloon angioplasty is a safe and effective treatment option, alternative to surgery in majority of patients with native coarctation.

Our results, also suggest that balloon angioplasty is applicable to infants, older children and adult patients. Our data also demonstrate that the outcome is unpredictable and we recommend the use of low profile balloon to reduce the arterial complications and the intimal tears.

Finally, more longitudinal data are necessary to evaluate the risk of restenosis and aneurysm formation in our patient group.

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