

The Effectiveness of Balloon Atrial Septostomy in Neonates with Great Artery Transposition in Duhok, Iraq

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Abstract

D-loop transposition of the great arteries (d-TGA), the aorta arises anteriorly from the right ventricle and the pulmonary artery arises posteriorly from the left ventricle, is the second most common form of cyanotic congenital disease, d-loop transposition of the great arteries (d-TGA), has a high mortality rate (85-90 percent) if left untreated^{1,2}. The newborns' life expectancy is dependent on sufficient inter-circulatory mixing³. These patients' survival depends on creating defects that allow the two circulations to mix namely ASD, VSD, and PDA⁴. Conventionally, such a defect has been attained by formation of or enlarging pre-existing PFO/ASD³. In 1950, surgical septotomy ('Blalock–Hanlon septectomy') was first reported and ever since considered the gold standard of care for D-TGA patients⁵. Subsequently, Rashkind et al developed catheter-based fluoroscopy guided technique named Balloon Atrial Septostomy (BAS) or Rashkind septotomy in 1966-8.

Keywords: D-loop transposition of the great arteries (d-TGA), Balloon Atrial Septostomy(BAS), artery.

INTRODUCTION

D-loop transposition of the great arteries (d-TGA), the aorta arises anteriorly from the right ventricle and the pulmonary artery arises posteriorly from the left ventricle, is the second most common form of cyanotic congenital disease, d-loop transposition of the great arteries (d-TGA), has a high mortality rate (85-90 percent) if left untreated^{1,2}. The newborns' life expectancy is dependent on sufficient inter-circulatory mixing³. These patients' survival depends on creating defects that allow the two circulations to mix namely ASD, VSD, and PDA⁴. Conventionally, such a defect has been attained by formation of or enlarging pre-existing PFO/ASD³. In 1950, surgical septotomy ('Blalock–Hanlon septectomy') was first reported and ever since considered the gold standard of care for D-TGA patients⁵. Subsequently, Rashkind et al developed catheter-based fluoroscopy guided technique named Balloon Atrial Septostomy (BAS) or Rashkind septotomy in 1966-8.

BAS was developed to increase the atrial defect in total anomalous pulmonary venous return, tricuspid atresia, and pulmonary atresia with intact ventricular septum, as well as total anomalous pulmonary venous return, tricuspid atresia, and pulmonary atresia with intact ventricular septum and d-transposition of the great arteries⁸. BAS technique is the most significant element affecting survival in patient with d-TGA. A rapid stabilization of neonate patients is ensued before they undergo a conventional cardiac surgery⁹. Hence, BAS procedure is widely regarded as the favorable strategy of choice to stabilize critically ill neonate before surgery whenever there is adequate resources to safely perform the procedure¹⁰.

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How to cite this article: Kamal Ali Mohammed Maerozy, The Effectiveness of Balloon Atrial Septostomy in Neonates with Great Artery Transposition in Duhok, Iraq, J PHARM NEGATIVE RESULTS 2022;13:389-392.

Access this article online

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DOI:
10.47750/pnr.2022.13.03.060

Balloon septostomy can be performed at bedside with echocardiography guidance. However, most cardiologists, including our cardiac center, in current era opt for performing the procedure in the catheterization laboratory 11-12.

List of Abbreviations

Atrial Septal Defect	ASD
Ventricular Septal Defect	VSD
Patent Ductus Arteriosus	PDA
Patent Foramen <u>Ovale</u>	PFO
Balloon Atrial <u>Septotomy</u>	BAS
D-Loop Transposition of The Great Arteries	D-TGA

In July 2014, we started congenital heart disease intervention in our tertiary cardiac centre in Duhok city, Kurdistan Autonomous Region of Iraq . And we commenced catheter based fluoroscopy guided BAS, primarily for transposition of great arteries, in January 2016. In this case series, we review and reflect on our BAS practice.

Aims

To review and evaluate safety and effectiveness of BAS practice in D-TGA, PDA, PFO/restrictive small ASD patients.

Materials and methods

This is a retrospective study concerning our work at Azadi heart center/Duhok between January 2016 and December 2021. Fifty six patients over this period admitted to Heevi Paediatric Teaching Hospital/Duhok and Duhok Maternity Teaching Hospital with cyanosis and hypoxemia not responding to oxygen therapy during early neonatal period. They were diagnosed with Great Arteries transposition in its entirety (D-TGA, PDA, PFO/ small size ASD).

All patients underwent 2-D cardiac ultrasound with color flow mapping and specular Doppler. The machinery used in our centre is : Echocardiogram General Electric Vivid E9 and Vivid S5 supplied with 6 MHz and 10 MHz transducers, standard color flow mapping , and pulsed and continuous waves Doppler.

Management strategy for all patients were routinely initiated with supportive measures. No patients received prostaglandin E1 infusion before the procedure to maintain ductus arteriosus patency because most patient had delayed diagnosis and prostaglandin E1 was not available in our hospital. The clinical features which dictated performing

BAS procedure included the following : cyanosis, hypoxemia SPO2 less than 70%. A confirmatory echocardiography of restrictive ASD, characterized by small-size communication <3.0 mm or less than one fourth of interatrial septum in the subcostal acoustic window.

The entire procedures were undertaken in the catheterization laboratory under sedation, guidance of biplane fluoroscopy and echocardiography .Right or left femoral access were used in all patients. In term neonate of more than 2.5 kilograms of weight, a 13.5x13.5 mm NuMED Z-5™ Atrioseptostomy catheter which requires six French sheath were used for 43 patients (89.58%) . In preterm or small for gestational age neonate patients under 2.5 kilograms of weight , 9.5x9.5 mm NuMED Z-5™ Atrioseptostomy catheter which needs five French sheath used for 5 patients (10.42 %)

Statistical analyses

The characteristics of the patients were presented in number (percentage) and mean (Standard deviation), and the comparison of SPO2 and ASD size before and after BAS was examined in paired t-test. The statistical calculations were performed using JMP Pro 14.3.

Results:

This study included 56 simple D-TGA patients. 48 (85.71%) patients with PFO/restrictive ASD less than 3 mm, Spo2 less than 70% underwent BAS. The procedure was successful in 47 (97.92%) patients. One patient (2.08%) had abnormal inferior vena cava (IVC) and the procedure was abandoned as we were unable to pass through IVC to right atrium. Eight patients (14.29%) who had simple D-TGA did not undergo BAS because they has good shunt across inter-ASD (PFO/ASD > 3 mm) and their Oxygen Saturation was more than 70% .

As shown in table (1), we found patients mean age at diagnosis was 10.18 days ranging from (1-120 days). The average (mean age) at day of procedure was 12.38 days ranging from (2-121 days). The mean weight of patient at time of procedure was 3.04 kilograms. there was predominance of male sex 34 patients (60.71%).

Complications encountered in 2 (4.17%) patients. The first patient had recurrent apnea after procedure which was treated successfully. The second patient developed leg edema which was managed medically and resolved.

The ASD that was developed enlarged in size from 2.8±0.11 millimetre to 6.31±0.76 millimetre (p <0.0001). and SpO2 % raised from 52.95±12.54% to 84.54±5.07% (p <0.0001). as demonstrated in table (2).

Table 1: Patients general characteristics

Characteristics (n=56)	Frequency distribution	
Age at diagnosis (Range: 1-120 days)	Mean: 10.18 days	Sta. Deviation: 6.36
Age at rashkind (Range: 2-121 days)	Mean: 12.38 days	Sta. Deviation: 6.91
Weight (Range: 2.2-4.5 Kg)	Mean: 3.04 Kg	Sta. Deviation: 0.31
Gender no (56)		
Male	34	60.71%
Female	22	39.28%
Balloon atrial septostomy no (48)		
Done	48	85.71%
Not done	8	14.29%
Complications	2	4.17%

Table 2: Immediate effect of BAS (Comparison of SPO2 and ASD size) before and after balloon atrial septostomy

	SPO2 Mean (SD)		P-Value
	Before BAS	After BAS	
SPO2	52.95 (12.54)	84.54 (5.07)	P value <0.0001
ASD	2.80 (0.11)	6.31 (0.76)	P value <0.0001
Paired-test was performed for statistical analysis.			

Discussion

BAS is a salvage treatment modality . Patients with d-transposition of the great arteries greatly benefit from this treatment 6,13.

Our study revealed that the mean age was 12.38±6.91 days, The patients' average age was 16.5 (25.75) days ranging from 2 to 121 days. It is slightly higher than what was published by Marchi et al¹⁴ age range from 1 to 46 days, The average age of the patients was 8.3 days and the median age was four days. While Joutey et al¹⁵ found age range from 5 to 75 days and the mean age was 25 days. The reason for this wide age range is thought to be related to late presentation and diagnosis. The mean weight of patients at time of procedure was 3.04 kg which is approximate to results of Kumar, Shaikh et al and Marchi et al . They report mean (average) weight of 3.1±1 kg (2.3- 6.5 kilogram) and 2.93±0.3kg (2.40 - 3.60 kg) respectively^{11,14} . Mean weight was relatively higher in Joutey et al¹⁵ study with mean weight of 3.833 kg.

A male sex predominance was observed (60.71%) in our study . This is similar to what is reported by Joutey et al¹⁵ who found 60% male predominance.

Our series revealed an increase from 2.8±0.11 millimetre to 6.31±0.76 millimetre in the size of the created ASD and a

rise in oxygen saturation SpO2 % from 52.95±12.54% to 84.54±5.07%. Other studies showed comparable results both in terms of PFO/ASD size and SpO2 percent level.

Kumar and Shaikh ¹¹ found significantly increase of size of created ASD from 2.04±0.34 mm pre-procedure to 5.45±0.39 mm post-procedure (p value <0.001) and , oxygen saturation increase from 45.8±5.9% pre procedure to 80.93±2.96% post-procedure (p value <0.001) respectively¹¹.

Marchi et al¹⁴ the size of the newly constituted ASD has increase, according to his reports from 1.8±0.8 millimetre to 5.8±1.3 millimetre and SpO2% increased from 64.5±18.9% to 85.1±9.2%.

Joutey et al report the mean diameter of the ASD increase pre procedure from 2.2 millimetre to 8 millimetre post procedure, the average oxygen saturation level before and after the operation (55 percent and 85.8 percent, respectively)¹⁵.

Matter and Almarsafawy et al found that the communication between the atria diameter expand from 2.75 ± 0.97 millimetre to 7.07 ± 0.79 millimetre (p < 0.0001). Oxygen saturations elevate significantly from 65.38 ± 9.59% to 88.62 ± 3.13% (p < 0.0001)¹⁶.

Conclusion:

BAS is effective and low risk intervention in treating patients with d-TGA. Rate of complications were exceedingly low in our series.

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