

**Effects of balloon atrial septostomy on changes in left  
ventricular volume in patients with transposition of the  
great arteries**

**Thesis**

**Submitted for partial fulfillment of the master  
degree in cardiology**

**By**

**Mahmoud Farag Abd elmottileb**

**M.B.B.CH.**

**Under supervision of**

***Prof. Ali Ramzy Abd elmegeed***

**Professor of Cardiology Ain Shams University**

***Dr. Hebatalla Mohamed Attia***

**Lecturer of Cardiology Ain Shams University**

**Faculty of Medicine Ain Shams University**

**June 2007**

## Introduction

The natural history of untreated transposition of the great vessels in the neonate is poor. Complete correction has been possible since 1959 with the atrial switch procedure, first described by **Senning in 1959**. **Mustard in 1964** simplified this method, reducing mortality rates to a reasonable level. The best results with these procedures were achieved in children beyond six months of age. Therefore an early palliation by creation of an intraatrial communication was imperative (Blalock and Hanlon in 1950).

**In 1966 Rashkind and Miller** described a nonsurgical procedure to create an atrial septal defect, using a balloon catheter. Since then it has remained an integral part of cardiac catheterisation in neonates, even after the introduction of **the arterial** switch procedure by **Jatene and associates in 1976**.

Balloon atrial septostomy is an accepted method for palliation of certain types of congenital heart disease since its early introduction by **Rashkind in 1966**. It was the first intracardiac non surgical interventional procedure. It could be of potential benefit in patients with other severe congenital heart defects, such as tricuspid or mitral atresia, or total anomalous pulmonary venous drainage, with a restrictive foramen ovale. The use of two-dimensional transthoracic echocardiography to monitor the procedure (**Kipel et al, 1991**)

Since in patients with transposition of the great arteries the systemic venous blood & the pulmonary venous blood are parallel, the aim of balloon or blade atrial septostomy is to enlarge the foramen ovale to allow oxygenated blood to pass into the right atrium and mix with the

deoxygenated blood that is recirculating around the body. Static balloon atrial septostomy is a variation of balloon atrial septostomy. Which is usually used to enlarge the hole made in the inter-atrial wall during blade septostomy? This procedure aims to prolong survival until definitive surgery can be performed several months later.

Catheter is advanced from the inferior vena cava to the right atrium across the foramen ovale to the left atrium with the echo transducer in the subxiphoid position. The balloon is inflated and its position within the left atrium is confirmed by echo. The catheter is withdrawn according to the technique of Rashkind. Withdrawal is halted when the balloon traverses the atrial septum. Adequate septostomy is indicated on echo by a defect at least 5 mm in diameter and by flapping of the inferior rim of the atrial septum. There were no complications using this technique and a clinically adequate septostomy was achieved in each patient. Two-dimensional echocardiography-assisted balloon atrial septostomy minimizes risk of complications and decreases exposure to ionizing radiation.

### Aim of the work:

Study of the effects of Balloon atrial septostomy in patients with d-TGA on changes of left ventricular volumes, immediate & short term results & relate it to the degree of tissue oxygenation.

## **Patients & methods:**

All patients with d-TGA admitted to Ain Shams University Hospital Cardiology Department for balloon atrial septostomy will be included in this study.

### **Patients will be excluded from the study if:**

- 1- Patients with non restrictive interatrial communication.
- 2- Patients with non restrictive interventricular communication.

### **All patients will undergo**

#### **1-Full echocardiographic study:**

- Confirm the diagnosis of a d-TGA.
  - Asses possible other associated anomalies.
  - Measure LV volumes using Simpson's method, before the procedure, immediately after the procedure (within one hour) & after 2 weeks of the procedure.
- 2- Serum sample will be withdrawn before the procedure & immediately after the procedure (within one hour) to measure serum lactate as an assessment of tissue oxygenation.

Results will be plotted in tables & statistically studied.

## References

**Blalock A, Hanlon CR.:** The surgical treatment of complete transposition of the aorta and the pulmonary artery. Surg Gynecol Obstet 1950; 90: 1- 15.

**Jatene AD, Fontes VF, Paulista PP, Souza LCB, Neger F, Galantier M, Sousa JEMR.:** Anatomic correction of transposition of the great vessels. J Thorac Cardiovasc Surg 1976; 72: 364- 70.

**Kipel G, Arnon R, Ritter SB.:** Transesophageal echocardiographic guidance of balloon atrial septostomy. J Am Approach to Echocardiogr 1991; 4: 631-5.

**Mustard WT.:** Successful two-stage correction of transposition of the great vessels. Surgery 1964; 55: 469- 72.

**Rashkind WJ, Miller WW.:** Creation of an atrial septal defect without thoracotomy. A Palliative Complete Transposition of the Great Arteries. JAMA 1966; 196: 991-2.

**Senning A.:** Surgical correction of transposition of the great vessels. Surgery 1959; 45: 966- 80.

## ***ABSTRACT***

Simple transposition of the great arteries is one of the most common lethal causes of congenital cyanotic heart diseases.

Between September 2007 and February 2008, 15 patients with age ranged between 1 day and 60 days - were diagnosed to have d-transposition of great arteries, underwent balloon atrial septostomy under two-dimensional echocardiographic guidance.

Left ventricular volume was measured. Using Simpson's method before the procedure, immediately after the procedure and after 2 weeks of the procedure, and it demonstrated little or no change with this intervention. Serum sample was withdrawn before the procedure, and immediately after the procedure measuring serum lactate as an assessment of tissue oxygenation with decrease in the mean serum lactate and improvement of tissue oxygenation.

The balloon atrial septostomy was successful in 13 patients, and 2 patients did not improve inspite of adequately created atrial septal defects. There were no significant complications related to the balloon atrail septostomy and these results demonstrate that it is an effective palliation of transposition of the great arteries

## **KEYWORDS**

*Balloon atrial septostomy.*

*Two-dimensional Echocardiography.*

*Transposition of great arteries.*

*Congenital cyanotic heart disease.*

*Dedication*

**To My Mother And Father  
For Their Ceaseless Love  
And Support**



## ***ACKNOWLEDGEMENT***

First and foremost, thanks to *Allah*. The most merciful and for helping me to finish this work.

I wish to express my deepest gratitude to my supervisors and major advisor, Professor *Dr. Ali Ramzy Abd elmegeed*, for this patience and guidance throughout the whole work.

I also wish to express my appreciation to Professor *Dr. Hebatalla Mohamed Attia* for her initiation of this study, her patience, encouragement and her stimulating discussion during the course of the work, and her valuable comments and her effort during the conduction of the study, providing much facilities and references needed for the success of this work, also for her assistance in refining the presentation of the results.

Personal gratitude is expressed to my colleagues, doctors in the ICU, and members of the catheterization room for their assistance in conducting the practical part involved in this work.

Special thanks are extended to all my patients and their families who participated in this work.

Lastly, I greatly appreciate all the help, encouragement, moral support and patience of my mother and father.

***Mahmoud Farag Abd elmottileb***

## ***CONTENTS***

	Page
Introduction and aim of the work.....	1
Review of literature.....	3
Definition of d-TGA.....	3
Natural history.....	3
Epidemiology & Genetics.....	5
Embryology.....	11
Anatomy.....	15
Physiology.....	24
Clinical picture of d-TGA.....	33
Examination of neonates with d-TGA.....	33
Investigations of d-TGA.....	40
Management of d-TGA.....	61
Historical note.....	98
Serum lactate.....	102
Patients and methods.....	105
Results.....	111
Discussion.....	152
Summary and conclusion .....	157
References.....	160
Arabic summary.....	

### *Normal Values*

	Normal Values	In Neonates
BT	4-8 min.	
Ca	9-11 mg/dl	
CT	8-12 min.	
Glucose	50-90 mg/dl	
Hb	11-14 g/dl (in 2 months)	145-22 gm/dl
Ht	33-42%	44 – 72%
K (serum)	3.5 – 5 mmol/L	
Na (serum)	134 – 146 mmol/L	
Platelets	120 – 400 x 10 <sup>3</sup> /mm <sup>3</sup>	
PT	11 – 15 seconds	
PTT	25 – 35 seconds	
WBCs	4000 – 10000 ug/dl	
Serum lactate	0.7-2.1mmol\L	

## ***LIST OF TABLES***

	Page
Table 1: The incidence of different associated cardiac anomalies.....	9
Table 2: Indication for creation of an atrial septal defect.....	68
Table 3: The demographic data of the patients.....	118
Table 4: Clinical findings in d-TGA patients.....	120
Table 5: The ECG findings of the patients.....	121
Table 6: Roentgenographic finding of the patients with d-TGA.....	122
Table 7: The mean hemoglobin value.....	123
Table 8: The mean serum electrolyte values and blood glucose concentration prior to BAS.....	124
Table 9: The number and percentage of patients with normal, abnormal electrolyte and glucose level. ....	124
Table 10: Shows the bleeding and coagulation profile.....	125
Table 11: The percentage of patients with normal and prolonged PT, PTT, BT, CT.....	125
Table 12: The echocardiographic diagnosis of our patients as regards associated defects.....	126
Table 13: Measurement of LV volume using Simpson's method.....	127
Table 14: Oxygen saturation by arterial blood gases.....	130
Table 15: The change in serum lactate before the procedure and immediately after the BAS.....	131
Table 16: A comparison between the oxygen saturation prior and after balloon atrial septostomy.....	133
Table 17: The follow up the oxygen saturation.....	135
Table 18: The oxygen saturation of the patients and their mean values.....	136

Table 19: Comparison between the size of atrial setal defecr prior and immediately after BAS.....	138
Table 20: The follow up of the ASD size in mm.....	139
Table 21: The length of stay in the ICU, complications.....	141

## ***LIST OF FIGURES***

	Page
Figure 1: Heart with transposed vessels and related defects.....	4
Figure 2: Distribution of congenital heart defects.....	6
Figure 3: Development of the truncoconal ridg.....	13
Figure 4: Spiral shape of the aortico-pulmonary septum.....	13
Figure 5: Typical transposition of the great arteries.....	18
Figure 6: L-transposition of the great arteries (ITGA).....	19
Figure 7: Coronary artery anatomy.....	23
Figure 8: Fetal circulation.....	24
Figure 9: Fetal heart with TGA.....	26
Figure 10: Complete d-transposition of the great arteries.....	27
Figure 11: External view of the heart.....	28
Figure 12: Hemodynamic diagram of the circulation with TGA and intact ventricular septum.....	31
Figure 13: Hemodynamic diagram of a patient with TGA ventricular septal defect, and conopulmonary stenosis.....	32
Figure 14: (PA) chest film of 20-year-old male.....	43
Figure 15: (PA) chest film in a normal infant.....	43
Figure 16: X-ray silhouettes of 10 cases of complete TGA.....	44
Figure 17: Chest x-ray of an infant with d-TGA and VSD.....	45
Figure 18: ECG of patient with TGA.....	46
Figure 19: Axis view of the pulmonary artery originates from the LV..	48
Figure 20: Short-axis view of the aorta originates from the RV.....	49
Figure 21:	
A. Two-dimensional echocardiogram.	
B. Anterolateral projection of an angiogram in the smooth walled LV.....	50

Figure 22: Diagnosis of coronary artery anatomy by 2 dimensional echocardiography in pateint with TGA.....	54
Figure 23: Diagrammatic representation of the coronary patterns found in TGA.....	55
Figure 24: RV angiogram shows a patient with transposition of the great arteries (10° left anterior oblique).....	58
Figure 25: <b>RV</b> angiogram shows a patient with transposition of the great arteries (70° left anterior oblique).....	59
Figure 26: This LV angiogram shows a patient with TGA.....	59
Figure 27: LV angiogram shows a patient with TGA.....	60
Figure 29: Double lumen 6.5F catheters.....	69
Figure 30: BAS under echocardiographic guidance.....	72
Figure 31: Isolated, sequential frames of cineangiograms at 30 frames per second of a BAS.....	74
Figure 32: Frontal radiographic projection.....	75
Figure 33: Subcostal view showing the inflated balloon catheter in the left atrium.....	75
Figure 34: Rashkind procedure, balloon atrial septostomy.....	77
Figure 35: Subcostal view showing that the balloon is pulled back across the atrial septum.....	78
Figure 36: Subcostal view showing the adequate size of the created atrial hole after the procedure.....	78
Figure 37: Atrial septal defects produced by BAS.....	79
Figure 38: Echocardiography monitored BAS.....	80
Figure 39: BAS under fluoroscopic guidance.....	81
Figure 40: Records of inter-atrial pressure gradients.....	83
Figure 41: Chest X-ray before and 2 ½ years after a single BAS.....	88