



# **Intermediate and Long-Term Outcome of Percutaneous Trans-catheter Device Closure of Ventricular Septal Defects**

*Thesis*

*Submitted for Partial Fulfillment of Master  
Degree in Cardiology*

*By*

**Ahmed Amr El Alfy**

*(M.B.,B.Ch.)*

*Supervised by*

**Prof. Dr. Maiy Hamdy El Sayed**

*Professor and Head of the Cardiology Department*

*Faculty of Medicine - Ain Shams University*

**Dr. Hebatalla Mohamed Attia**

*Assistant Professor of Cardiology*

*Faculty of Medicine - Ain shams University*

**Dr. Tarek Khairy Mousa**

*Lecturer of Cardiology*

*Faculty of Medicine - Ain Shams University*

*Faculty of Medicine*

*Ain Shams University*

**2019**

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

قالوا

سببنا انك لا تعلم لنا  
إلا ما علمتنا إنك أنت  
العليم العظيم

صدق الله العظيم

سورة البقرة الآية: ٣٢

# Acknowledgment

*First and foremost, I feel always indebted to **ALLAH**, the Most Kind and Most Merciful.*

*I'd like to express my respectful thanks and profound gratitude to **Prof. Dr. Maiy Hamdy El Sayed**, Professor and Head of the Cardiology Department Faculty of Medicine - Ain Shams University for her keen guidance, kind supervision, valuable advice and continuous encouragement, which made possible the completion of this work.*

*I am also delighted to express my deepest gratitude and thanks to **Dr. Hebatalla Mohamed Attia**, Assistant Professor of Cardiology Faculty of Medicine - Ain shams University, for her kind care, continuous supervision, valuable instructions, constant help and great assistance throughout this work.*

*I am deeply thankful to **Dr. Tarek Khairy Mousa**, Lecturer of Cardiology Faculty of Medicine - Ain Shams University, for his great help, active participation and guidance.*



*I am truly thankful owing a great debt to **Dr. Dina Adel** who has never hesitated to offer me help, valuable advice, continuous encouragement and inspiration*

# *List of Contents*

Title	Page No.
List of Tables .....	i
List of Figures .....	ii
List of Abbreviations .....	vii
Introduction .....	1
Aim of the Study .....	3
Review of Literature	
▪ Overview on Ventricular Septal Defects .....	4
▪ Diagnostic Studies .....	11
▪ Management of Ventricular Septal Defects .....	15
▪ Recommendations and Follow-up Protocol .....	23
Patients and Methods .....	28
Results .....	47
Discussion .....	79
Conclusion .....	88
Summary .....	89
References .....	91
Arabic Summary .....	—

## *List of Tables*

Table No.	Title	Page No.
<b>Table (1):</b>	Indications for intervention in ventricular septal defect. ....	16
<b>Table (2):</b>	Shows the suggested normal values for LV CS in children on Philips machine by vendor .....	44
<b>Table (3):</b>	Showing descriptive table regarding demographic data. ....	48
<b>Table (4):</b>	Showing device types .....	52
<b>Table (5):</b>	Showing device types and sizes .....	53
<b>Table (6):</b>	Showing baseline and follow up demographic data. ....	55
<b>Table (7):</b>	Showing the comparison between baseline and last follow up ECG. ....	61
<b>Table (8):</b>	Post-procedure arrhythmia in relation with demographic and echocardiographic data.....	62
<b>Table (9):</b>	Showing sequential echocardiographic assessment .....	65
<b>Table (10):</b>	Showing comparison between Pre and Post-procedural circumferential and radial strain pattern .....	70
<b>Table (11):</b>	Showing incidence of complications in the current study. ....	72
<b>Table (12):</b>	Ventricular septal defect and device assessment .....	72
<b>Table (13):</b>	Residual VSD flow Relation with demographic and echocardiographic data. ....	75
<b>Table (14):</b>	Showing sequential echocardiographic analysis for valvular affection.....	77

## *List of Figures*

Fig. No.	Title	Page No.
<b>Figure (1):</b>	Showing morphological classification of VSDs.....	6
<b>Figure (2):</b>	<b>X-ray</b> showing cardiomegaly and increased Broncho vascular marking in patient suffering from VSD.....	11
<b>Figure (3):</b>	The electrocardiogram shows features of biventricular hypertrophy .....	12
<b>Figure (4):</b>	Showing apical muscular VSD by Color Doppler echocardiography of hemodynamically restrictive VSD.....	13
<b>Figure (5):</b>	Showing successful percutaneous device closure of VSD .....	18
<b>Figure (6):</b>	Showing modified HF Ross classification for children.....	24
<b>Figure (7):</b>	Different components of left ventricular myocardial deformation that can be measured by speckle-tracking echocardiography.....	26
<b>Figure (8):</b>	Normal myocardial motion and deformation, and typical profiles of strain rate and strain traces (A) Normal myocardial motion and deformation and its three major components: longitudinal, radial and circumferential motion and deformation (b) Typical profiles of strain rate and strain traces from a normal adult .....	27
<b>Figure (9):</b>	2D and color Doppler Echocardiography in modified apical 5 chamber view in patient number 12 showing measurement of the VSD from left and right ventricular sides.....	32

## *List of Figures Cont...*

Fig. No.	Title	Page No.
<b>Figure (10):</b>	The figure shows M-mode of the LV in the parasternal long axis view in patient number 3 at the level just distal to the MV with measurement of the end diastolic and end systolic diameters for measurement of the EF. ....	32
<b>Figure (11):</b>	LV end-diastolic and end-systolic volume by the modified Simpson in the apical 4-chamber and 2 chamber views in patient number 18.....	33
<b>Figure (12):</b>	Left ventriculography showing subaortic aneurysmatic ventricular septal defect in patient number 12.....	34
<b>Figure (13):</b>	Left ventriculography showing measurement of the base of aneurysm in patient number 9.....	35
<b>Figure (14):</b>	Aortography in patient number 13 during VSD PFM coil closure before coil release.....	37
<b>Figure (15):</b>	Apical 5 chamber view with color Doppler in patient number 12 showing well seated PFM coil and no residual flow and normal AV flow. ....	42
<b>Figure (16):</b>	Subcostal coronal LVOT view in patient number 9 showing residual VSD below the well seated PFM coil.....	42
<b>Figure (17):</b>	Apical 5 chamber view with color doppler in patient number 10 showing well seated coil, no residual VSD flow and mild aortic regurgitation. ....	43
<b>Figure (18):</b>	Left ventricular short axis views at apical (A) mitral valve (B) and basal (C) level with the region of interest at each level.....	45

## *List of Figures Cont...*

Fig. No.	Title	Page No.
<b>Figure (19):</b>	Pie chart showing the gender distribution among the study group. ....	47
<b>Figure (20):</b>	Pie chart showing the age distribution among the study group. ....	48
<b>Figure (21):</b>	Showing device types.....	52
<b>Figure (22):</b>	Bar chart comparing mean weight of patients before and after at least 12 months follow up. ....	56
<b>Figure (23):</b>	Bar chart comparing Z score weight of patients before and after at least 12 months follow up. ....	56
<b>Figure (24):</b>	Bar chart comparing mean height of patients before after at least 12 months follow-up .....	57
<b>Figure (25):</b>	Bar chart comparing Z score height of patients before after at least 12 months follow-up .....	57
<b>Figure (26):</b>	Bar chart comparing mean body surface area of patients before and after at least 12 months follow-up.....	58
<b>Figure (27):</b>	Bar chart comparing Z score body surface area of patients before after at least 12 months follow-up .....	58
<b>Figure (28):</b>	Bar chart comparing mean body mass index of patients before and after at least 12 months follow-up.....	59
<b>Figure (29):</b>	Bar chart comparing Z score body mass index of patients before and after at least 12 months follow-up.....	59



## *List of Figures Cont...*

Fig. No.	Title	Page No.
<b>Figure (30):</b>	Pie chart showing percentage of normal sinus rhythm, first degree and complete heart block with well-functioning pacemaker.....	61
<b>Figure (31):</b>	Post-procedure arrhythmia in relation with TV regurgitation .....	63
<b>Figure (32):</b>	Post-procedure arrhythmia in relation with the VSD size.....	63
<b>Figure (33):</b>	Bar chart showing sequential echocardiographic assessment of LVEDD .....	66
<b>Figure (34):</b>	Bar chart showing sequential echocardiographic assessment of LVEDV .....	66
<b>Figure (35):</b>	Bar chart showing sequential echocardiographic assessment of RVSP.....	67
<b>Figure (36):</b>	Bar chart showing sequential echocardiographic assessment of m PAP.....	67
<b>Figure (37):</b>	Bar chart showing sequential echocardiographic assessment of shunt fraction Qp/Qs .....	68
<b>Figure (38):</b>	Graph showing number of patients with increased Left ventricular end diastolic and end systolic diameters for body surface area. ....	70
<b>Figure (39):</b>	Comparison between pre and post procedural circumferential and pattern.....	71
<b>Figure (40):</b>	Comparison between pre and post procedural circumferential and radial strain patterns .....	71
<b>Figure (41):</b>	Incidence of complications in the current study.....	73

## *List of Figures Cont...*

Fig. No.	Title	Page No.
<b>Figure (42):</b>	Pie chart showing number of residual shunts.....	74
<b>Figure (43):</b>	Bar chart showing relationship between residual VSD shunt and Aneurysmal tissue.....	75

## *List of Abbreviations*

Abb.	Full term
1st DHB .....	First degree heart block
ADO .....	Amplatzer duct occlude
ASO .....	Amplatzer Septal Occluder
AV prolapse .....	Aortic valve prolapse
AV .....	Aortic valve
AVP .....	Amplatzer vascular plug
BMI .....	Body mass index
BSA .....	Body surface area
CHB .....	Complete heart block
CHD .....	Congenital heart disease
CHD .....	Congenital heart disease
Cm .....	Centimeter
Complete AVB ....	Complete atrioventricular heart block
Dist-Av-VSD .....	Distance between aortic valve and VSD
ECG .....	Electrocardiogram
EF .....	Ejection fraction
ESC .....	European society of cardiology
Fup .....	Follow up
Kg .....	Kilogram
LA .....	Left atrium dimension
LV .....	Left ventricle
LVEDD .....	Left ventricular end diastolic dimension
LVEDV .....	Left ventricular end diastolic volume
LVESD .....	Left ventricular end systolic dimension
LVESV .....	Left ventricular end systolic volume
LVOT .....	Left ventricular outflow tract
LVESDD/BSA .....	left ventricular end diastolic diameter per body surface area

## *List of Abbreviations Cont...*

Abb.	Full term
LVESD/BSA .....	left ventricular end systolic diameter per body surface area
mPAP .....	Mean pulmonary artery pressure
MSCT .....	Multi-slice computed tomography
MV .....	Mitral valve
PFM coil .....	Nit-Occlud® Lê-VSD-Coil (Produkte für die Medizin AG, Cologne, Germany)
PV .....	Pulmonary valve
Qp:Qs .....	: Ratio of pulmonary blood flow to systemic blood flow
RAO .....	Right anterior oblique
RV .....	Right ventricle
RVSP .....	Right ventricular systolic pressure
SC .....	Spontaneous closure
TEE .....	Transesophageal echocardiography
TTE .....	Transthoracic echocardiography
TV .....	Tricuspid valve
VSD size LV .....	Size of ventricular septal defect from the left ventricular side
VSD size RV .....	Size of ventricular septal defect from the right ventricular side
VSD .....	Ventricular septal defect
Yr .....	Year

## INTRODUCTION

**V**entricular septal defect (VSD) is the most common congenital heart defect in children and adults. As an isolated finding, VSD accounts for approximately 20% to 30% of all types of congenital cardiac malformations.<sup>[1]</sup>

It has an overall prevalence of 3.94 per 1000 patients with a recent notable marked increase in incidence rates recently observed that is attributed to the advancement in imaging and screening programs.<sup>[2]</sup>

Clinical presentation of ventricular septal defects is variable according to its pathophysiology, which depends on several factors as size, location, direction, pressure gradient across defect and other associated defects in cardiac skeleton<sup>[3]</sup>.

Untreated ventricular septal defect (VSD) with clinically significant left-to-right shunting is one of the most common causes of congestive heart failure and growth retardation in early infancy. These babies typically fail to thrive and are frequently hospitalized for lower respiratory tract infections<sup>[4]</sup>.

Children with volume-overloaded left atrium and ventricle due to a symptomatic hemodynamically significant VSD, require intervention thus preventing long-term complications, including pulmonary hypertension, ventricular dilatation, arrhythmias, aortic insufficiency, double-chambered right ventricle, and endocarditis.<sup>[5]</sup>

Until recently, open-heart surgical closure has traditionally been considered the mainstay of intervention for the majority of VSDs which is a major procedure that necessitates thoracotomy, cardiopulmonary bypass (CPB), blood transfusion during or after surgery, permanent scarring and potential risk of complete heart block, residual shunting (10%), need for reoperation (2–5%), early and late arrhythmias, post-pericardiotomy syndrome and even mortality (0–3%) which is more significant in multiple, muscular, and apical VSD <sup>[6]</sup>.

The development of a trans-catheter occlusion technique with the advancement of the newer percutaneous occluding VSD closure devices that can safely and effectively close these defects was welcomed by cardiologists, patients, and their families making trans-catheter device closure of ventricular septal defects (VSDs) an attractive and feasible alternative to surgical closure. <sup>[7]</sup>.

Percutaneous ventricular septal defect closure is relatively a new effective treatment modality for ventricular septal defect patients. It seems appealing to study more the effect of percutaneous closure on left ventricle and to evaluate procedural complications <sup>[8]</sup>.

## **AIM OF THE STUDY**

**T**o evaluate the intermediate and long-term follow-up outcome of patients who underwent percutaneous transcatheter closure of isolated ventricular septal defects