Sudan University of Science and Technology

College of Graduate Studies

A statistical Study Of Cardiac Catheterization For Children

دراسة احصائية لقسطرة القلب للاطفال

A thesis Submitted for Partial Fulfillment of Requirements of M.sc.Degree in Diagnostic Radiological Technology

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2016

بسم الله الرحمن الرحيم

(وَيَسْأَلُونَكَ عَنِ الرُّوحِ قُلِ الرُّوحُ مِنْ أَمْرِ رَبِّي وَمَا أُوتِيتُمْ مِنَ الْعِلْمِ إِلا قَلِيلا)

صدق الله العظيم

سورة الاسراء الاية (85)

Dedication

To my family

To my dear uncle for motivation me and helping

To all whom aid me to complete this work

Acknowledgment

I would like to express my grateful to my main supervisor Dr .Caroline Edward Eyad for her close supervision guidance and accomplishment through practical medical advices, and my gratitude and thanks to extended to all colleagues in General Administration of Medical Services-Sudan Heart Center.

Abstract

This study was conducted at Sudan Heart Center during the period from January 2014 to December 2015 and targeted 171 patients 81 males and 90 females.

The statistical study aimed to find out the pediatric frequency examined by cardiac catheterization, gender, the type of cardiac catheterization used and to determine relationship type of cath lab with the diagnostic findings.

Data from pediatrics were collected and were presented in data collection sheets includes file number, gender, age, primary diagnosis, the type of catheter ,right ventricle ,angiogram , left ventricle ,aortogram findings as well usage of shunt or balloon and the presence of complications . And then the data were analyzed using SPSS.

It was observed from this study that the distribution of female frequency was more common than males with the distribution of 81 males (47.4 %) and 90 females (52.6%).

The primary diagnosis frequency showed that the Arterial Septal Defect in 12patients (7% of the patients diagnosed by cath lab),Teterology Of Fallot in32 patients (18.7% of patients),patent duct's arterious in 33 patients(19.3% of patients),Ventricle Septal Defect in 40 patients(23.4% of patients),trans position of great arteries

in 13 patients(7.6% of patients),Trancus Arterous Post Repair in 1 patients (0.6% of patients),Pulmonary stenosis in 19 patients (11.1% of patients),right ventricle Fistula in 2 patients(1.2% of patients),Pulmonary Problems in 15 patients (8.8 % of patients) and Heart problems in 4 patients(2.3% 0f patients).The study concluded The shunt and pulmonary stenosis presence is independent from the type of cardiac catheterization**.** The collateral presence and balloon using is dependent from the type of cath lab .The right ventricle angiogram and left ventricle angiogram views are not positive to determine presence of shunt and stenosis.

ملخص الدراسة

هذه الدراسة اجريت في مركز السودان للقلب في الفترة من يناير 2014 الي ديسمبر 2015 واستهدفت 171 مريض 81 ذكر و90 انثي .

وتهدف الدراسة الإحصائية لمعرفة عدد وجنس وتشخيص ونوع القسطرة وتحديد العلاقة بين قسطرة البطين الايمن والايسر والتضيق الرئوي والناور وتصوير الابهر والضمانات وتحديد العلاقة بين نوع القسطرة والتشخيص الموجود.

اخذت البيانات من الاطفال وجمعت وتم تمثيلها علي ورقة البيانات وتحتوي علي رقم الملف والجنس والعمر والتشخيص المبدئي ونوع القسطرة واستخدام البالون ووجود الناور وما تظهر صورة البطين الايمن والايس والابهر . ثم حللت البيانات بواسطة خوارزميات برنامج التحليل الاحصائى .

ولوحظ من هذه الدراسة تردد توزيع الاناث اكثر شيوعا من الذكور مع توزيع 81 للذكور (47.4 ٪) و 90 من الإناث (52.6%).

أظهر تردد التشخيص الأولي ان عيب الحاجز الاذيني في 12مريض(بنسبة7% من المرضي الذين شخصو بالقسطرة) ورباعية فالو في 32 مريض (بنسبة18.7%)والقناة الشريانية السالكة في 33مريض (بنسبة 19.3)وعيب الحاجز البطيني في 40مريض (بنسبة 23.4%) وانعكاس الشرايين الكبيرة في 13 (بنسبة 7.6%)وجذع إصلاح آخر الشريانية في مريض واحد بنسبة (0.6%) التضيق الرئوي في 19مريض بنسبة (11.1%) الناسور البطين الأيمن في مريضين بنسبة 1.2% والمشاكل الرئوية في 15 مريض بنسبة **8.8**%) ومشاكل القلب في 4مرضي بنسبة 2.3% من المرضي الذين شخصو بالقسطرة).

وخلاصة الدراسة إلى أن وجود الناور والتضيق الرئوي مستقل عن نوع قسطرة القلب.وجودالضمانات واستخدام البالون يعتمد علي نوع قسطرة القلب المستخدمة.صورالبطين الايمن والايسر ليست ايجابية لتحديد الناور والتضيق الرئوي.

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List of Abbreviations

RV	**Right Ventricle Angiogram**
LV	**Left Ventricle Angiogram**
PDA	**Patent Duct's Arterious**
PVR	**Pulmonary Valve Resistance**
TGA	**Transpostion Of Great Arteries**
RVOT	**Right Ventricle Out Flow Tract**
PAB	**Pulmonary Artery Banding**
PS	**Pulmonary Stenosis**
ASD	**Arterial Septal Defect**
VSD	**Ventricle Septal Defect**
TOF	**Teterology Of Fallot**
TAPR	**Trancusarterous Post Repair**

1-1 Introduction

Our concepts of heart disease are based on the enormous reservoir of physiologic and anatomic knowledge derived from the past 80 years of experience in the cardiac catheterization laboratory. As Andre Cournand remarked in his Nobel lecture of December, 1956, "the cardiac catheter was ... the key in the lock. By turning this key, Cournand and his colleagues led us into a new era in the understanding of normal and disordered cardiac function in humans. According to Cournand/ cardiac catheterization was first performed (and so named) by Claude Bernard in 1844. The subject was a horse, and both the right and left ventricles were entered by a retrograde approach from the jugular vein and carotid artery.

Werner Forssmann is credited with performing the first cardiac catheterization of a living person-himself .At age 25, while receiving clinical instruction in surgery in Germany, guiding it by fluoroscopy until it entered his right atrium. He then walked to the radiology department (which was on a different level, requiring that he climb stairs), where the catheter position was documented by a chest roentgenogram (**Mauro Moscucci, et-al 2014)**

Transseptal catheterization was first developed by Ross and Cope in 1959 and quickly became accepted as a standard technique. Selective coronary arteriography was reported by Sones and others in 1959 and was perfected to a remarkable excellence over the ensuing years. Coronary angiography was modified for a percutaneous approach by Ricketts and Abrams in 1962 and judkins in 1967. In 1970 Swan and Ganz introduced a practical balloon-tipped, flow-guided catheter technique enabling the application of catheterization outside the laboratory, and in 1977, Andreas Gruntzig introduced the technique of balloon angioplasty, generally known as percutaneous transluminal coronary angioplasty (PTCA), thus expanding

the use of cardiac catheterization to therapeutic interventions and spearheading its future exponential growth.(**Mauro Moscucci,, et-al 2014)**

1-2 Statement of the proplem

Cardiac catheterization is categorized as an invasive procedure that possible get complications may lead to death and these complication increased in the recent period. Study the number and type of cases that are made for children at the center.

1-3 Research Objectives

1-3-1 General objective

To study and known frequencies of pediatric cardiac catheterization in Sudan Heart Center.

1-3-2 Specific objectives

- To study the number and gender of cases examined at Sudan Heart Center
- To study the diagnosis of cases that comes to the center.
- Determine the number and type of cardiac catheterizations.
- Determine of relation between type of cathlab, right ventricle, left ventricle, stenosis , shunt ,aortogram and collaterals.

1-4 Overview of the study

Chapter one (Introduction and objectives),**Chapter two(** literature review , anatomy and physiology of the heart , pathology),**Chapter three (**Materials and methods) ,**Chapter four(** Results presentation) and **Chapter five(**Discussion , Conclusion and Recommendations as well as References used in this research) .

Literature Review and Previous Studies

2-1 Anatomy of the heart

The heart weighs between 7 and 15 ounces (200 to 425 grams) and is a little larger than the size of your fist. By the end of a long life, a person's heart may have beats (expanded and contracted) more than 3.5 billion times. In fact, each day, the average heart beats 100,000 times, pumping about 2,000 gallons (7,571 liters) of blood.

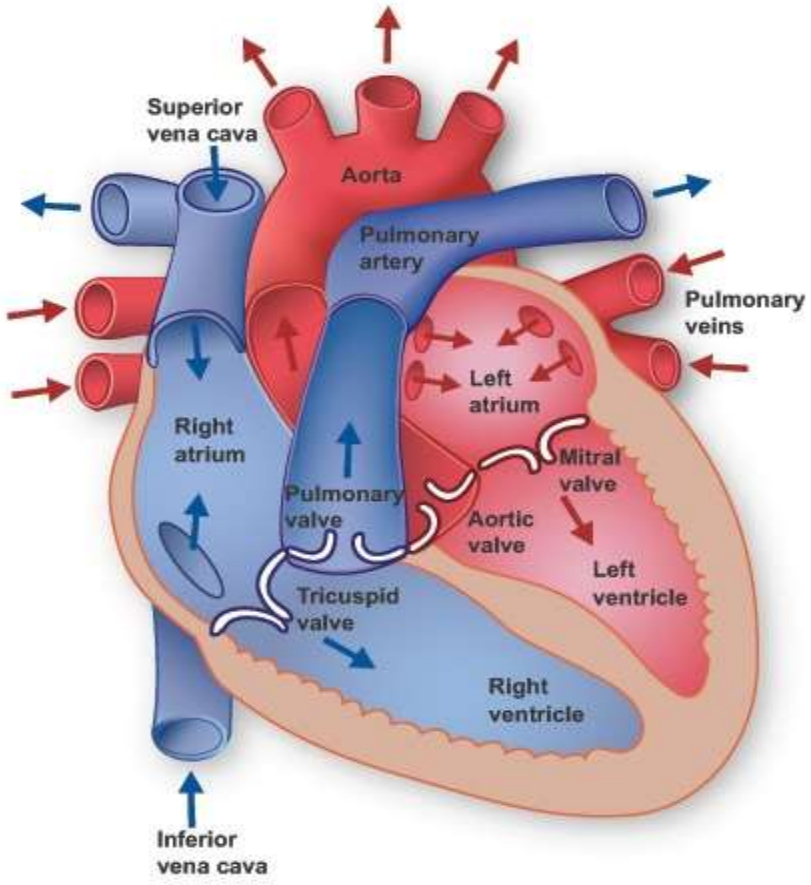


Figure (2-1) coronal section of the heart showing heart chamber, valves and greater vessels**.** (**Peterlibby, et-al 1997**)

The heart is located between the lungs in the middle of chest, behind and slightly to the left of the breastbone (sternum). A double-layered membrane called the pericardium surrounds the heart like a sac. The outer layer of the pericardium surrounds the roots of the heart's major blood vessels and is attached by ligaments to the spinal column, diaphragm, and other parts of the body. The inner layer of the pericardium is attached to the heart muscle. A coating of fluid separates the two Layers of membrane, letting the heart move as it beats.

The heart has 4 chambers. The upper chambers are called the left and right atria, and the lower chambers are called the left and right ventricles. A wall of muscle called the septum separates the left and right atria and the left and right ventricles. The left ventricle is the largest and strongest chamber in the heart. The left ventricle's chamber walls are only about a half-inch thick, but they have enough force to push blood through the aortic valve and into the human body. **(Michael Ronaldo,et-al 1976)**

2-1-1The Heart Valves

Four valves regulate blood flow through your heart, the tricuspid valve regulates blood flow between the right atrium and right ventricle, the pulmonary valve controls blood flow from the right ventricle into the pulmonary arteries, which carry blood to your lungs to pick up oxygen, the mitral valve lets oxygen-rich blood from your lungs pass from the left atrium into the left ventricle , the aortic valve opens the way for oxygen-rich blood to pass from the left ventricle into the aorta, the body's largest artery. **(Michael Ronaldo, et-al 1976)**

2-1-2 Blood supply to the heart:

Coronary circulation is the circulation of blood in the blood vessels of the heart muscle (myocardium). The vessels that deliver oxygen-rich blood to the myocardium are known as coronary arteries. The vessels that remove the deoxygenated blood from the heart muscle are known as cardiac veins. These include the great cardiac vein, the middle cardiac vein, the small cardiac vein and the anterior cardiac veins.

As the left and right coronary arteries run on the surface of the heart, they can be called pericardial coronary arteries. These arteries, when healthy, are capable of auto regulation to maintain coronary blood flow at levels appropriate to the needs of the heart muscle. These relatively narrow vessels are commonly affected by atherosclerosis and can become blocked; causing angina or a heart attack .The coronary arteries that run deep within the myocardium are referred to as sub endocardial.

The coronary arteries are classified as "end circulation", since they represent the only source of blood supply to the myocardium; there is very little redundant blood supply, which is why blockage of these vessels can be so critical **(Michael Ronaldo ,et-al 1976)**.

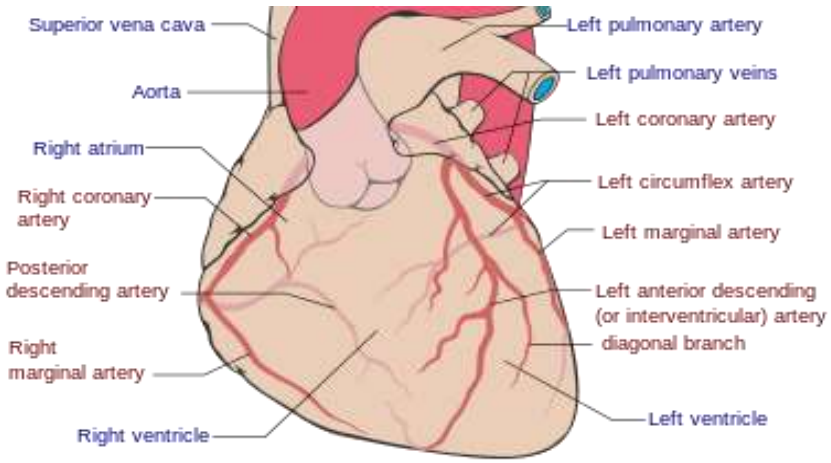


Figure (2-2) shows blood vessels that supply heart. (Michael Ronaldo, et-al 1976)

2-2 Physiology of the heart

The normal heart is a strong muscle that beats about 100,000 times a day to pump blood through the body. The blood carries oxygen and nutrients to tissues and organs and waste products to the kidneys and liver. The blood travels through a large network of blood vessels known as the circulatory system. This system includes the arteries, veins, and lungs. The heart responds to the body's needs and adjusts its rate of pumping to meet the body's requirements. The heart consists of four chambers that work together. Right and left atria – these are the small upper chambers. Right and left ventricles – these are the larger, lower chambers. The right ventricle pumps blood out of the heart to the lungs, and the left ventricle pumps blood to the rest of the body. The left ventricle is the heart's main pumping chamber. Blood Flow During each heartbeat, the right side of the heart receives blood from your body and then sends it to the lungs to pick up oxygen. The left side of the heart receives the blood from the lungs and then sends the blood to the rest of the body to deliver oxygen. How the Heart's Electrical System Works The heart has an electrical system that causes it to beat and pump blood in a smooth

and regular way. Special cells in the heart start electrical signals; these signals then travel along pathways through the heart and cause it to beat. During a normal heartbeat, an electrical signal is first made in a group of cells called the sinus node (SA node). The signal then spreads like a wave through both of the upper chambers of the heart (the atria) and travels to another group of cells called the atrioventricular node (AV node). The AV node serves as an electrical filter between the upper and lower chambers (ventricles) of the heart. After a pause, the electrical signal spreads through the ventricles. In a healthy heart, the heart beats once and pumps blood for each electrical signal that starts in the SA node. A normal heart rate is generally between 60 and 100 beats per minute, but will vary based on age and how active a person is .**(Michael Ronaldo, et-al1976)**.

A single cardiac cycle of cardiac activity can be divided into two basic phases diastole and systole : diastole represents the period of time when the ventricles are relaxed (not contracting).Throughout most of this period, blood is passively flowing from the left atrium (LA) and right atrium (RA) into the left ventricle (LV) and right ventricle (RV), respectively. The blood flows through atrioventricular valves (mitral and tricuspid) that separate the atria from the ventricles. The RA receives venous blood from the body through the superior vena cava (SVC) and inferior vena cava (IVC). The LA receives oxygenated blood from lungs through four pulmonary veins that enter the LA. At the end of diastole, both atria contract, which propels an additional amount of blood into the ventricles. **(Michael Ronaldo, et-al 1976)**

Systole represents the time during which the left and right ventricles contract and eject blood into the aorta and pulmonary artery, respectively. During systole, the aortic and pulmonic valves open to permit ejection into the aorta and pulmonary artery. The atrioventricular valves are closed during systole, therefore no blood is

entering the ventricles; however, blood continues to enter the atria though the vena cava and pulmonary veins. uncontrolled high blood pressure (HTN) can damage your heart in a number of ways, such as hinder the movement of blood through the chambers of the heart ,Coronary artery disease ,Enlarged left heart and Heart failure .**(Michael Ronaldo, et-al1976)**

The cardiovascular system is made up of: heart; lungs; arteries and veins, and it are under the control of the autonomic nervous system (sympathetic and parasympathetic). In a healthy individual with a healthy heart, heart rate is dictated by the body's needs. If an individual is resting then organs, muscles and tissues require a reduced amount of blood and oxygen. (**Michael Ronaldo , et-al 1976)**

When the individual becomes active then the organs, muscles and tissues require an increasing amount of blood and oxygen, resulting in raised blood pressure and an increase in heart rate and respirations. These responses are all involuntary, under the direct control of the autonomic nervous system. If the individual remains reasonably healthy with no cardiac complications then the cardiovascular system will continue to work just like this for life. **(Michael Ronaldo, et-al 1976)**

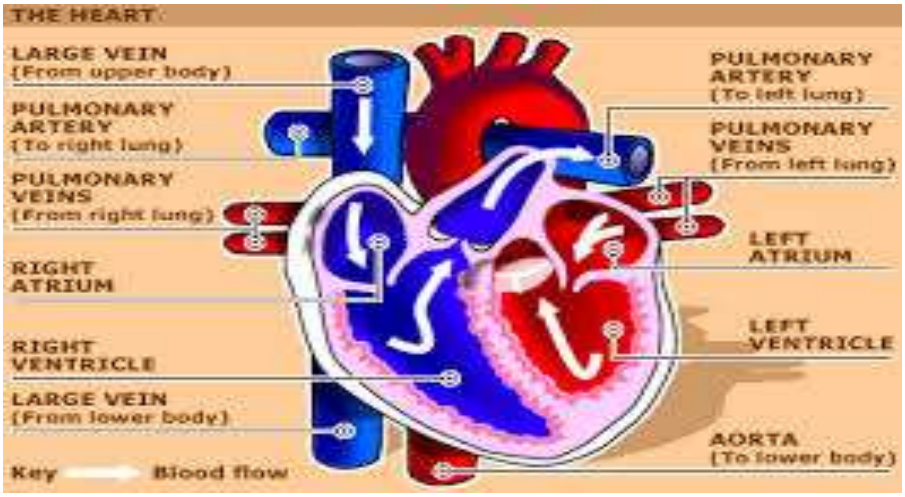


Figure (2-3) shows circulation of blood in heart. **(Michael Ronaldo, et-al 1976)**

2-3 Pathology of heart

2-3-1 Defects that increase pulmonary blood flow

2-3-1The ductus arteriosus is a communication between the pulmonary artery and the aortic arch distal to the left subclavian artery. Patent ductus arteriosus (PDA) is the failure of the fetal ductus arteriosus to close after birth**. (Michael J. Gerber, 2008)**.

2-3-1-2Atrial septal defect (ASD) is a communication or opening between the atria that results in shunting of blood between the two chambers. There are 4 anatomic types: Ostium primum - low in atrial septum, may involve a cleft mitral valve. Ostium secundum - center of the atrial septum. Most common type of ASD. Sinus venosus - high in the atrial septum. Associated with P-TAPVR. Coronary sinus - large opening between the coronary sinus and left atrium **(Michael J. Gerber,2008)**

2-3-1-3A ventricular septal defect (VSD) is a communication (or multiple communications) between the right and left ventricles. VSD's are classified by their location in the ventricular septum. There are 4 anatomic types: Perimembranous - upper portion of septum (most common). Subpulmonary - below pulmonary valve. Muscular - muscle portion of ventricular septum. Usually low in the ventricular septum. Multiple muscular defects may be referred to as 'swiss cheese' defects. Atrioventricular canal - located beneath the tricuspid valve. Also called an inlet VSD. **(Michael J. Gerber,2008)**

2-3-2Defects with decrease blood flow and mixed defects:

2-3-2-1Tetrology of Fallot (TOF)

It is a congenital heart defect characterized by the association of four cardiac abnormalities; malaligned VSD, sub pulmonary stenosis, overriding aorta and right

ventricular hypertrophy. There is a wide spectrum of right ventricular outflow tract obstruction (RVOTO) in TOF. It may be subvalvar, valvular and/or supravalvular. Typically, there is hypoplasia of the right ventricular outflow tract, stenosis of the pulmonary valve and hypoplasia of the pulmonary annulus and trunk. The right and left pulmonary arteries are usually normal in size. Some infants with TOF may be referred to as a 'pink' TET, if no cyanosis is present. **(Michael J, 2008)**

2-3-2-2Truncus arteriosus

It is a rare congenital heart defect in which a single great vessel arises from the heart, giving rise to the coronary, systemic and pulmonary arteries. This single vessel contains only one valve (truncal valve). The truncus arteriosus overlies a VSD that is almost always seen in conjunction with this defect. There are 4 major types: Type I: The most common; a single great vessel arises from the ventricles, and divides into an aorta and a main pulmonary artery (PA). Type II: There is no main PA segment. The right and left PA's originate from the back of the truncus at the same level. Type III: The right and left PA arise separately from the lateral aspect of the truncus. There is no main PA segment. Type IV: No main PA. Pulmonary artery circulation is supplied from the systemic arterial circulation through collateral vessels of the bronchial arteries. This type is currently considered a form of Tetralogy of Fallot with pulmonary atresia. **(Michael J. Gerber, 2008)**

2-3-2-3Pulmonary stenosis (PS)

It is a narrowing that obstructs blood flow from the right ventricle. It may be subvalvular, valvular, supravalvular or in the pulmonary arteries. When this presents in neonates, it is referred to as 'critical pulmonary stenosis**'**. **(Michael J. Gerber, 2008)**

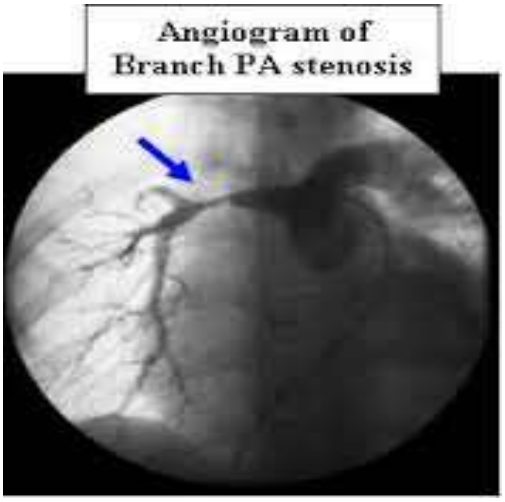


Figure (2-4) shows angiogram of pulmonary stenosis. (**www.American Heart Association, 2014)**

2-3-2-4 Transposition of Great Vessels

In Transposition of the Great Arteries (TGA) the aorta arises from the anatomic right ventricle and the pulmonary artery arises from the anatomic left ventricle. The most common form of transposition occurs when the ventricles are normally positioned and the aorta is malposed anteriorly and rightward above the right ventricle. A VSD is present in 40% of patients with TGA. Abnormal coronary artery patterns present in 33% of cases **(Michael J. Gerber, 2008)**

Defects obstructing Systemic blood flow

Coarctation of the aorta is a narrowing in the aortic arch. The coarctation may occur as a single lesion, as a result of improper development of the involved area of the aorta, or as a result of constriction of that portion of the aorta when the ductus arteriosus constricts. The coarctation is most often located near the ductus arteriosus; if narrowing is proximal to the ductus it is 'pre-ductal', if it is distal to the ductus it is 'postductal'**(Michael J. Gerber,2008)**

Aortic Stenosis (AS) is a narrowing that obstructs blood flow from the left ventricle, leading to left ventricular hypertrophy and/or aortic insufficiency. AS may be mild, moderate, or severe. When this condition presents in neonates, it is referred to as 'critical aortic stenosis'. There are three types of AS, classified according to the location of the stenotic area: Valvar Failure of the cusps to separate, creating fusion of the valve, or presence of a bicuspid valve instead of tricuspid. Accounts for 80% of AS. Sub aortic: Caused by the formation of a fibrous ring with a narrowed central orifice below the aortic valve. It may be discrete or diffuse and in infants is seen as a component of a more complex lesion. Supravalvar: Caused by a fibro membranous narrowing of the aorta above the aortic valve and coronary arteries. Associated with Williams Syndrome **(Michael J. Gerber, 2008)**

The Bi-directional Glenn is the initial step in preparation for the Fontan operation for patients with single ventricle physiology. The eventual goal is to separate the systemic and pulmonary circulations. This operation is done at 6 months of age, although may be done earlier if cardiac function is poor or infant is desaturated. **((Michael J. Gerber, 2008)**

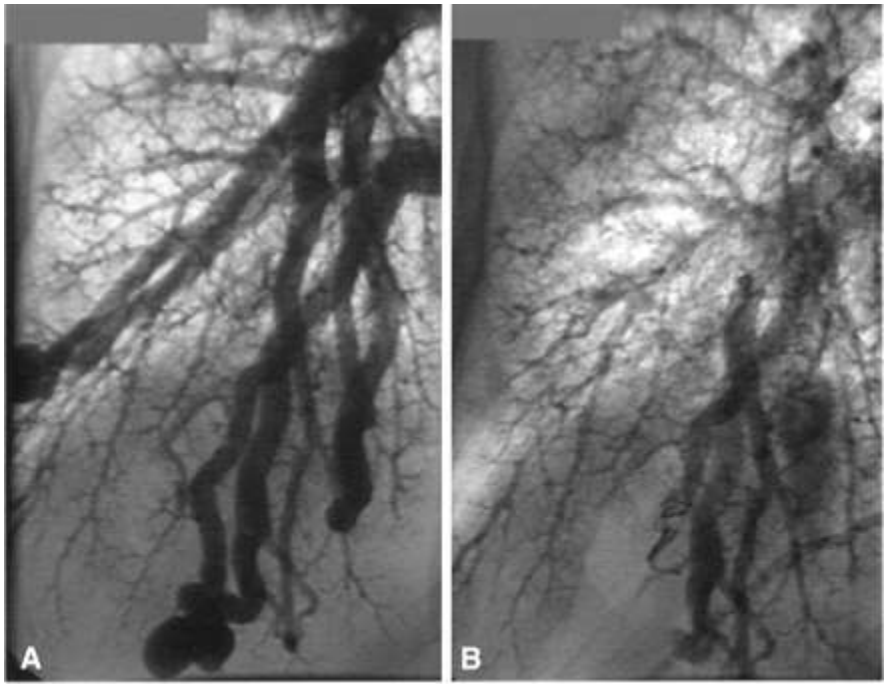


Figure2-5 . Selective pulmonary angiography of the right lower lobe in a patient with tricuspid atresia and unidirectional Glenn shunt. A, Multiple pulmonary arteriovenous malformations. B, One residual pulmonary arteriovenous malformation after trans catheter coil occlusi (**www.American Heart Association, 2014)**

Rash kind Balloon Septostomy: This procedure is performed either during cardiac catheterization or at the bedside under ECHO guidance. The goal is to create an opening in the atrial septum that provides improved mixing of venous and oxygenated blood. A standard venous catheterization is performed, and a balloon-tipped catheter is inserted. The catheter is passed from the right to the left atrium; the balloon is inflated, and pulled quickly back into the right atrium. This tears a hole in the atrial septum, and allows greater mixing of systemic and pulmonary venous blood. This is a desirable outcome in many first stage defect palliations, as it improves oxygen saturations. This is a temporary procedure and the defect created may close at any time **(Michael J. Gerber, 2008)**

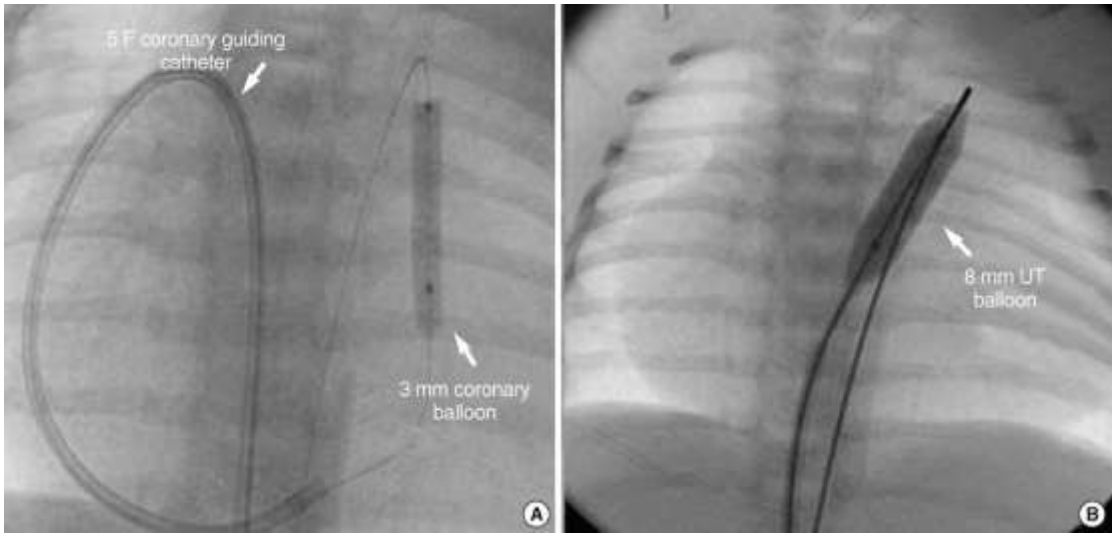


Fig2-6 shows Successful balloon valvuloplasty for pulmonary valvar stenosis. (**A**) Successful ballooning of a 3-mm diameter coronary balloon catheter with the assistance of a 5F right coronary artery guiding catheter formed a loop within the right atrium. (**B**) Sequential dilatation of pulmonary valve with an 8-mm diameter Ultra-thin (UT) balloon catheter (**www.American Heart Association, 2014**)

Collateralization is the growth of a blood vessel or several blood vessels that serve the same end organ or vascular bed as another blood vessel that cannot adequately supply that end organ or vascular bed sufficiently.

Coronary collateralization is considered a normal response to hypoxia and may be induced, under some circumstances, by exercise. It is considered to be protective.

Collateral or anastomotic blood vessels also exist even when blood supply is adequate to an area, and these blood vessels are often taken advantage of in surgery. Some notable areas where this occurs include the abdomen, rectum, knee, shoulder, and head. **. (MariannPavone-Gyöngyösi, 2002)**

Coronary collateralization exists latently in the normal heart. Microscopic collateral vessels of the heart undergo a process called *transformation* that widens the vessel lumen at the expense of its cell wall in response to myocardial stresses—specifically, myocardial spasm and hypoxia secondary to myocardial infarction or acutely stressful exercise. The status of the coronary collaterals has also been shown to be influenced by the presence of diabetes mellitus**. (Mariann Pavone-Gyöngyösi,2002)**

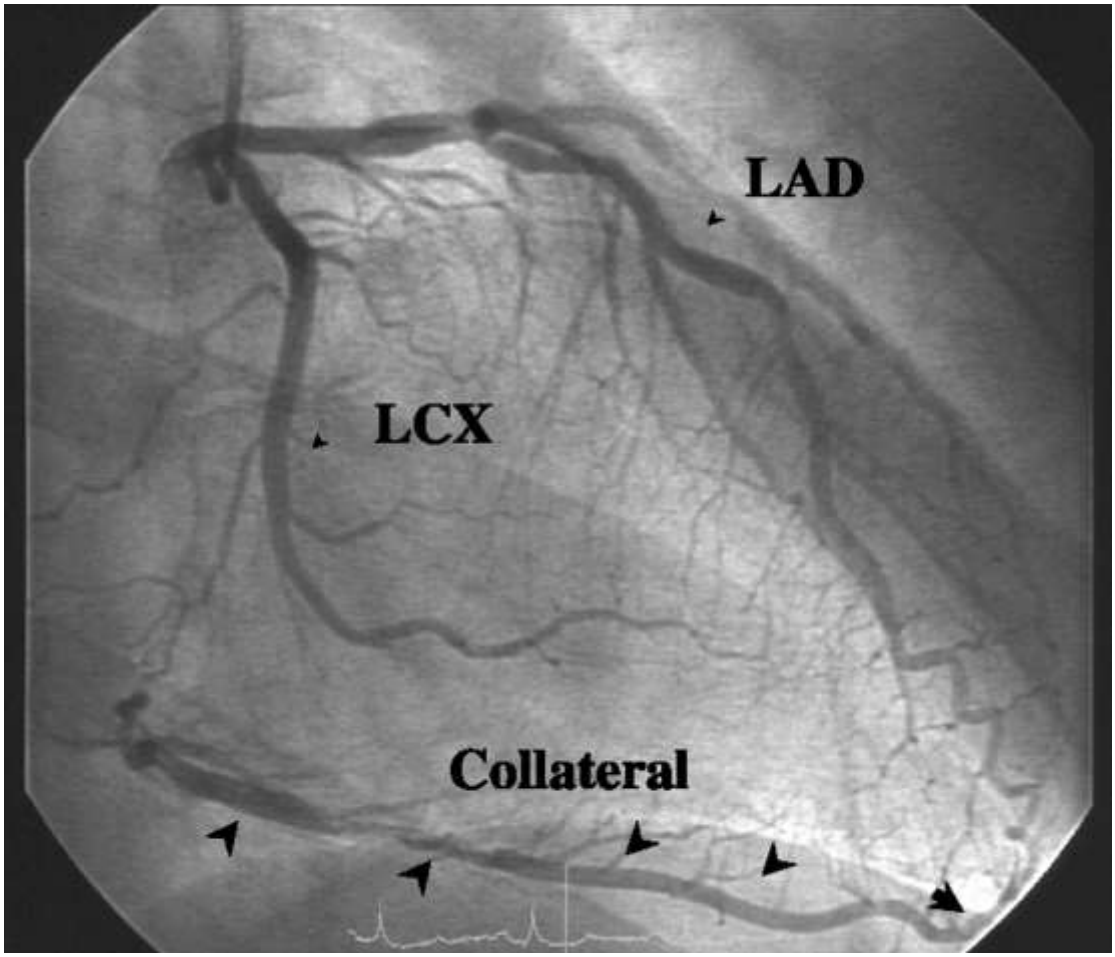


Fig2-7 shows Representative coronary angiography for collaterals. The patient is a 42-yr-old man. His right coronary artery is totally occluded, but Rentrop grade III collateral (arrowheads) can be seen from the left coronary artery. His left

ventricular ejection fraction is 60%. LAD, left anterior descending coronary artery; LCX, left circumflex coronary artery (**www**.**American Heart Association, 2014**)

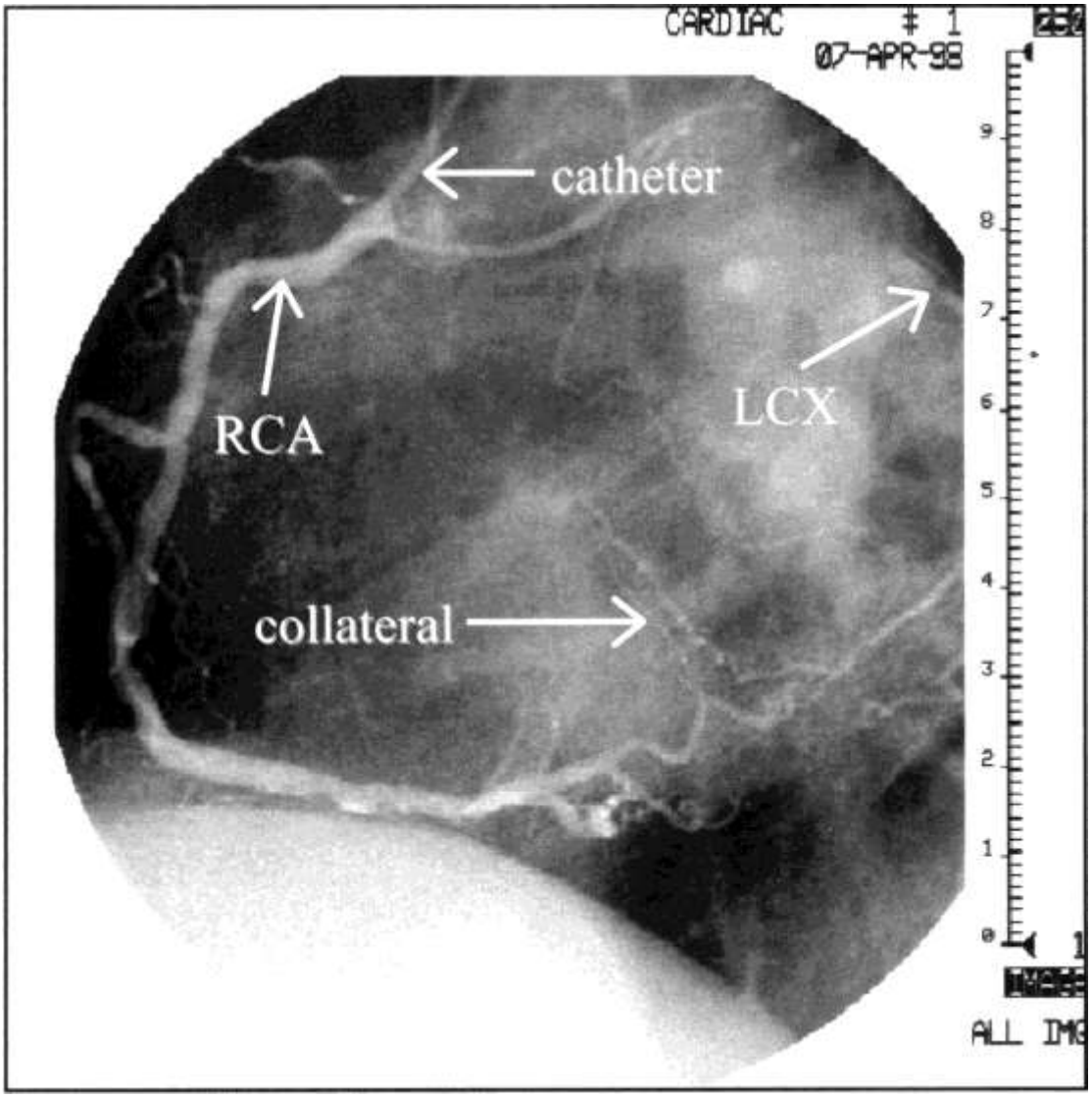


Figure 2-8shows Left anterior oblique view of the right coronary arteriogram**. (www.American Heart Association, 2014)**

2-3-6 Interventional cardiac catheterization for children

The purpose of an interventional catheterization is to fix a defect in the heart. The cardiologist will first perform most of the diagnostic techniques listed above, and then continue with corrective procedures that could include:

Balloon Valvuloplasty: using a catheter (a long, skinny hollow tube) with a balloon at the tip that is inflated to open a narrowed heart valve (Pulmonic valveand Aortic valve) **(Colorado, 2016)**

Balloon Angioplasty: using a catheter with a balloon at the tip that is inflated to open narrowed blood vessels (coarctation of the aorta and pulmonary vasculature) **(Colorado, 2016)**

Stent Placement: inserting a stent (a small wire mesh tube) on a catheter with a balloon at the tip; the stent expands with the inflation of the balloon and is then able to support narrow blood vessels after the balloon is removed **(Colorado, 2016)**

Coil mobilization: include (PDA and Aorto-pulmonary collaterals)

Septal Closures: using devices that collapse to pass through a catheter (and are then reformed when pushed out of the catheter) to close holes within the heart wall (ASD closure, VSD closure and PDA device closure) **(Colorado, 2016)**

Heart Valve Placement: placing an artificial valve in the heart by collapsing it and passing it through a catheter; the valve is then reformed out of the catheter within the heart **(Colorado, 2016)**

2-3-7 previous studies

2-3-7-1(Sulafa KM,2007) have done study in Sudan Heart Centre.

All children and adults with congenital heart disease seen at Sudan Heart Centre by one paediatric cardiologist from July 2004 to June 2005.

Five hundred and twenty two patients were evaluated, 435 had abnormal hearts. The median age was 48 months (one day to sixty five years). Congenital heart disease constituted 87% and acquired heart disease and rhythm disorders 13%.. Cardiac catheterization was done for 81 patients, for diagnosis in 61 (75%) and for intervention in 20 (25%) patients. Balloon dilatation, atrial septostomy septal defect and patent ductus arteriosus closure with the help of a visiting team, the success rate for interventions was 95%. Common inductions for diagnostic catheterization were TOF to delineate the pulmonary artery anatomy in 16(23%) patients and VSD in 12(15%) patients.(**Sulafa KM,2007).**

2-3-7-2 (**Mary K. M. Shann,1969**) have done study in The cardiac catheterization laboratory of the National Taiwan University Hospital has performed right and left heart catheterizations, selective angiocardiography, and dye-dilution studies since October 1962. In the 5 years from October 1962 to September 1967, a total of 232 cardiac catheterizations have been done. The sex distribution did not show a significant difference, there being 103(44.4%) females and 129(55.6%) males.

The relative frequency of the various types of congenital heart disease in the 232 cases diagnosed Interventricular septal defect was the most frequently encountered defect, comprising 19.4% of the total. In descending order, tetralogy of Fallot was found in 18.1%, patent ductus arteriosus in 16.0%, atrial septal defect in 8.6%, pulmonic stenosis with intact ventricular septum in 6.0%, and transposition of the great vessels in 3.9%. Only three cases of coarctation of aorta with or without patent ductus (1.3%) were encountered. There were no cases of congenital aortic stenosis. **(Mary K. M. Shann, 1969**)

2-3-7-3(**Advisor –EndaleTefera, 2013)** has done study in**, Addis Ababa Ethiopia** intervention including cardiac catheterization and surgical intervention. 136(86.6%) and 23(14.6%) had one or more complication and co morbid conditions respectively at diagnosis. 77(49%) of the study subjects were on one or more forms of treatment for the associated complication. A total of 157 patients (78 male,79 female) was included in the study. Mean age at time of diagnosis CHD was 33 months (range 1 month-18 years) and mean at diagnosis of PAH was 40 months(range 1 month-12 years). Types of congenital heart diseases seen were VSD (26.8%), PDA (22.3%), ASD (6.4%), combined simple left to right shunt lesion (75.2%), tetralogy of Fallot (15.3%), D-TGA(5.7%), other complex congenital heart 3.8 per cent. (**Advisor –EndaleTefera, 2013)**

2-3-7-4 Table (2-1) Percentage Incidence of Major Defect Reported by Authors from Various Countries during the period from1956 to 1967:

Author	Nadas2	Wood, P3	Keith4	Kjellberg5	Hansen & Warburg6	Storstein et al.7
Country	U.S.A.	England	Canada	Sweden	Denmark	Norway
No. of cases	3786	900	6647	668	1678	1000
Interventricular septal defect	19.97	11	25	17.5	6.5	15.1
Tetralogy	14.55	11	10.2	9.4	14.3	8
Patent ductus arteriosu	12.3	15	12.1	26.5	21	12.9
Pulmonary stenosis	11.97	12	8.5	10.5	10.4	9.9
Interatrial septal defect	10.4	19.5	10.6	11.5	18	19.1
Aortic stenosis	5.73	3	5.5	3.4	3.6	3.8
Coarctation of aorta	4.99	9	5.6	10.2	7.2	4.7
Transposition of great vessel	3.96	1	5.5	3	3.94	1.8

Material and methods

The study was conducted in Sudan **Heart Centre** in Khartoum during the period from January 2014 to December 2015.

3-1- Material &tools

3-1-1 Sampling

171 pediatric patients (81 male 90 female).

3-1-2 Tools &equipments

Using TOSHIBA machine.

Fig (3-1**)**: TOSHIBA machine in Sudan Heart Centre

3-2- Methods

3-2-1Data Collection

Data Collection The records of pediatric Statistics Department of the Sudan heart center, from January 2014 to December 2015.The collection of data on datasheets includes file number , gender, age ,primary diagnosis, the type of catheter , balloon using ,right ventricle angiogram showing, left ventricle angiogram showing, aortogram showing, and shunt found .

3-2-2 Data processing and analysis

Data compiled from the archives of Statistics Department of the Sudan heart center. All data were entered and analyzed using Microsoft excel and statistical package for social science (SPSS) version 16 statistical analysis included description statistics of frequency tables , graphs cross tabulation .variables will be tested for significance using t-test for single sample. Ordinal and categorical variables were tested using the Chi Square goodness-off it-test and multiple logistic regressions.

Results

Table (4:1): Show Frequency and Percent of gender

Gender		
	Frequency	Percent
Female	90	52.6
Male	81	47.4
Total	171	100.0

Figure (4:1): Show Frequency and Percent of gender

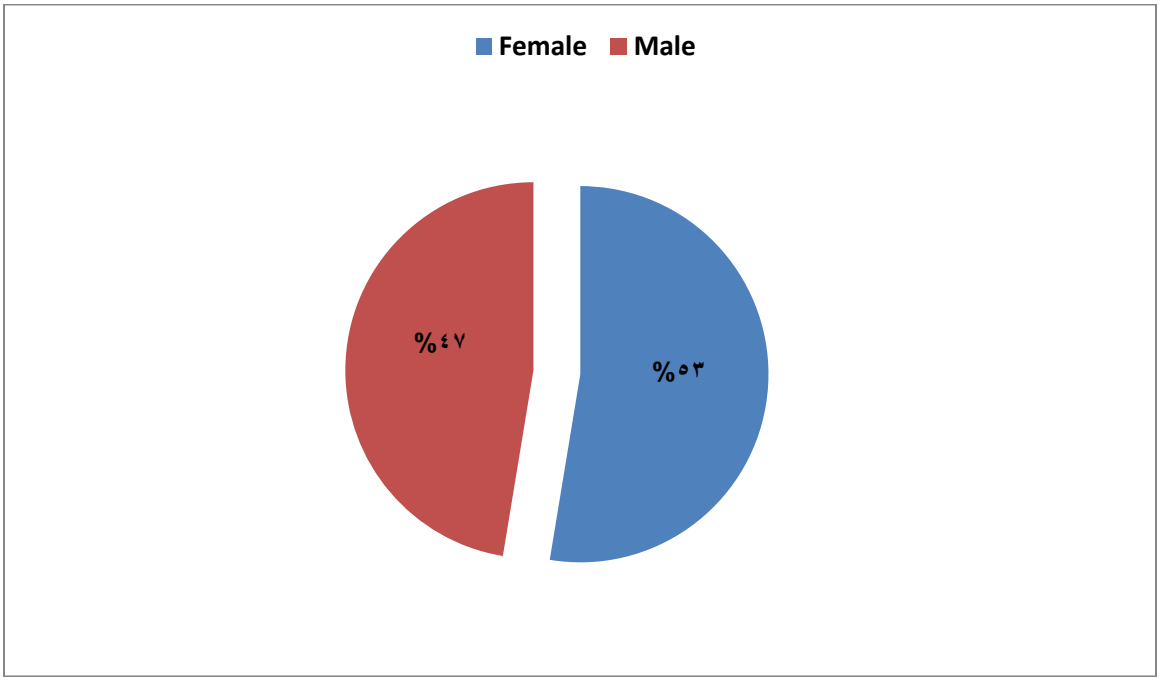


Table (4:2): Show Frequency and Percent of Primary Diagnosis

Primary Diagnosis		
	Frequency	Percent
ASD	12	7.0
TOF	32	18.7
PDA	33	19.3
VSD	40	23.4
TGA	13	7.6
TAPR	1	.6
PS	19	11.1
RV Fistula	2	1.2
Pulmonary Problems	15	8.8
Heart Problems	4	2.3
Total	171	100.0

Figure (4:2): Show Percent of Primary Diagnosis

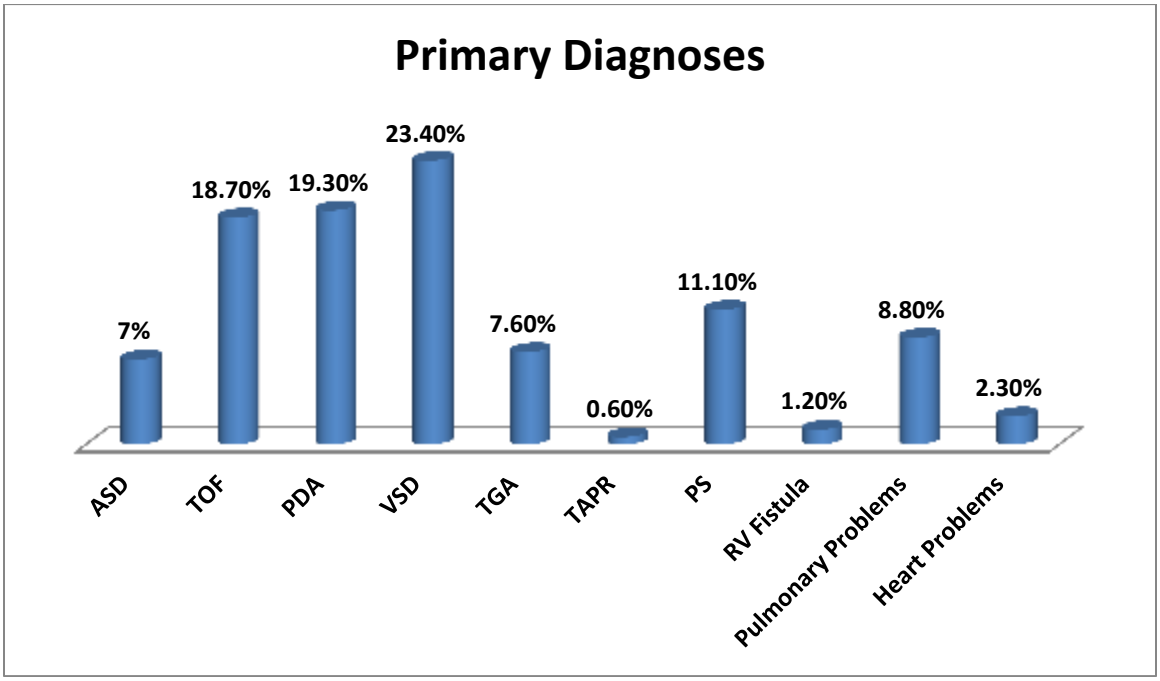


Table (4:3): Show Frequency and Percent of Type of cath

Type Of Cath		
	Frequency	Percent
Therapeutic	66	38.6
Diagnostic	105	61.4
Total	171	100.0

Figure (4:3): Show Percent of Type of cath

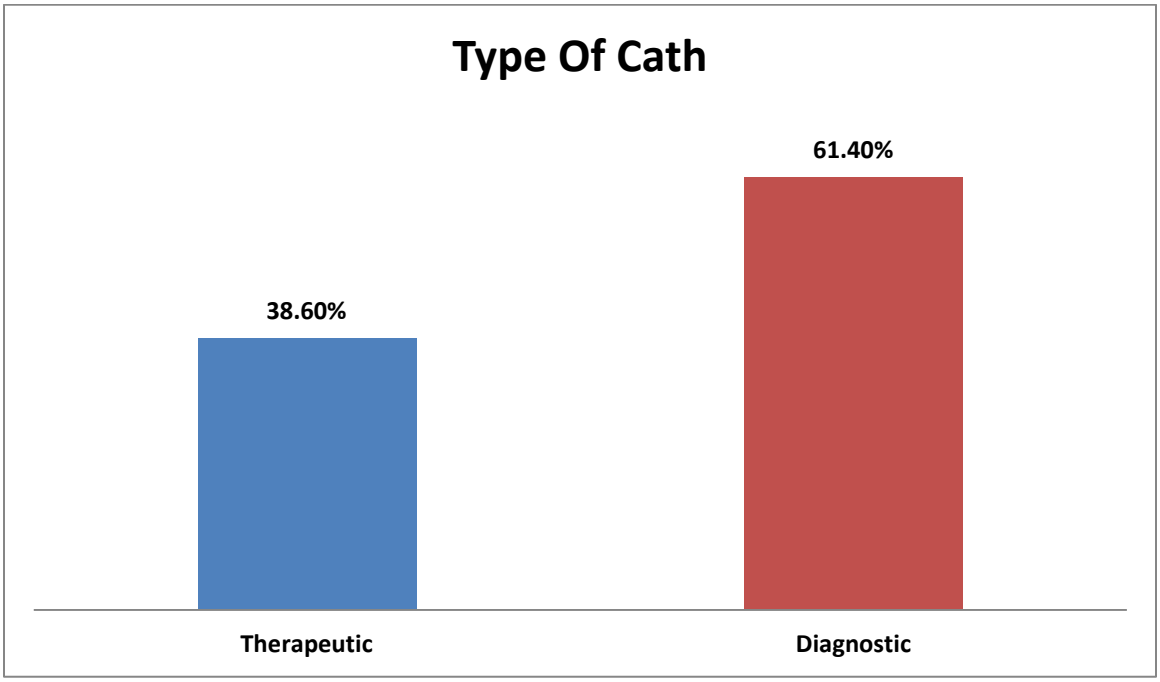


Table (4:4): Show Percent of Right ventricle angiogram

RV Angiogram		
	Frequency	Percent
Abnormal	33	19.3
Normal	138	80.7
Total	171	100.0

Figure (4:4): Show Frequency and Percent of Right ventricle angiogram

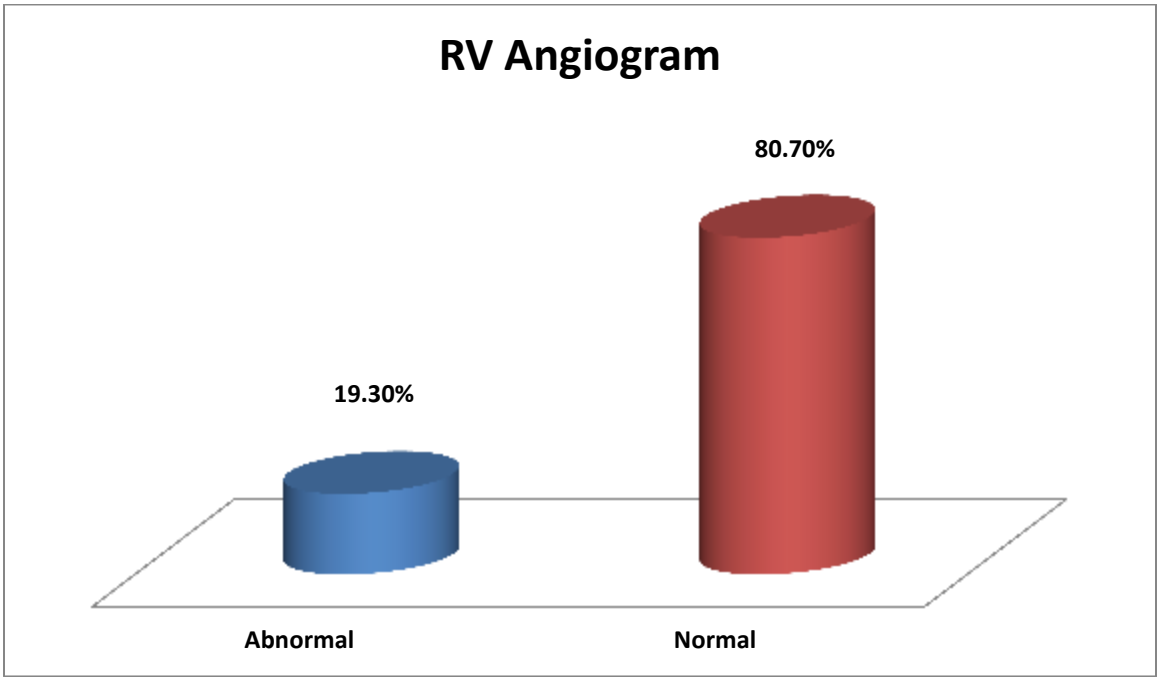


Table (4:5): Show Frequency and Percent of Left ventricle angiogram

LV Angiogram		
	Frequency	Percent
Abnormal	12	7.0
Normal	159	93.0
Total	171	100.0

Figure (4:5): Show Frequency and Percent of Left ventricle angiogram

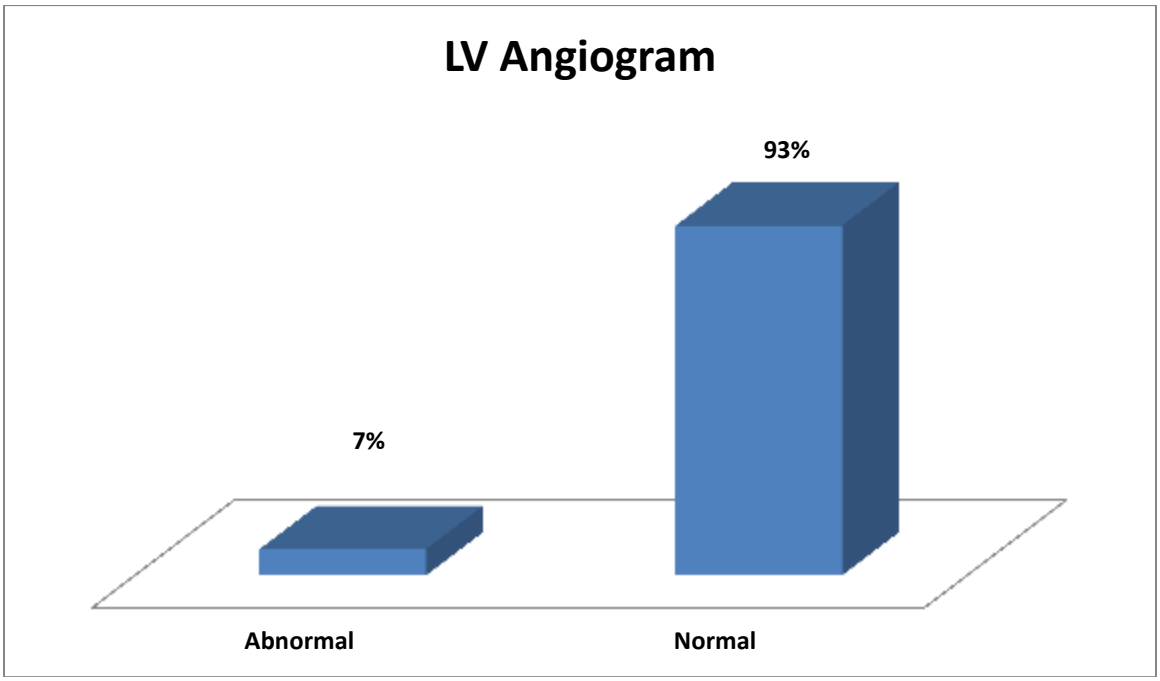


Table (4:6): Show Frequency and Percent of Shunt:

Shunt		
	Frequency	Percent
NO Shunt	170	99.4
Shunt	1	.6
Total	171	100.0

Figure (4:6): Show Percent of Shunt:

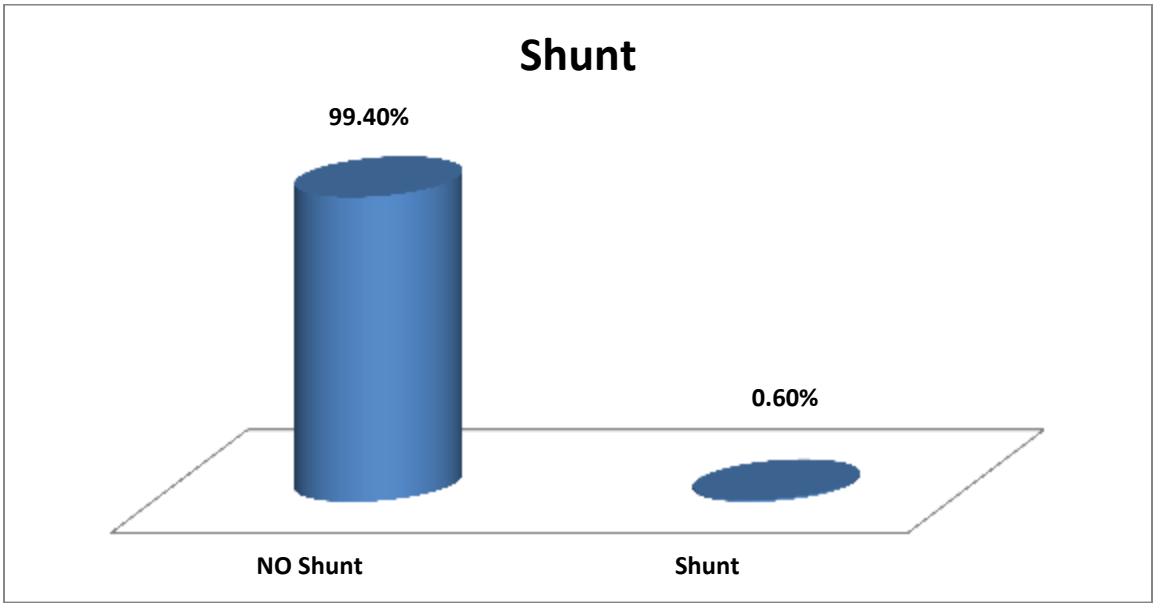


Table (4:7): Show Frequency and Percent of Stenosis

Stenosis		
	Frequency	Percent
No Stenosis	143	83.6
Stenosis	28	16.4
Total	171	100.0

Figure (4:7): Show Percent of Stenosis

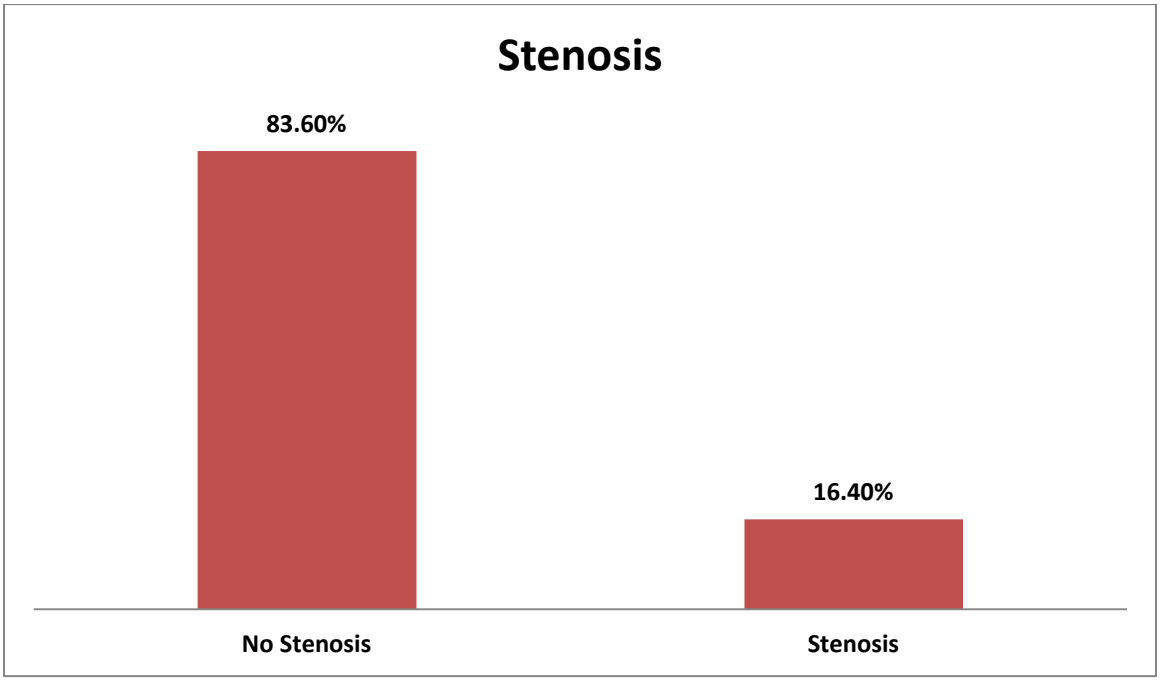


Table (4:8): Show Frequency and Percent of Collaterals

Collaterals		
	Frequency	Percent
No Collateral	153	89.5
Collateral	18	10.5
Total	171	100.0

Figure (4:8): Show Percent of Collaterals

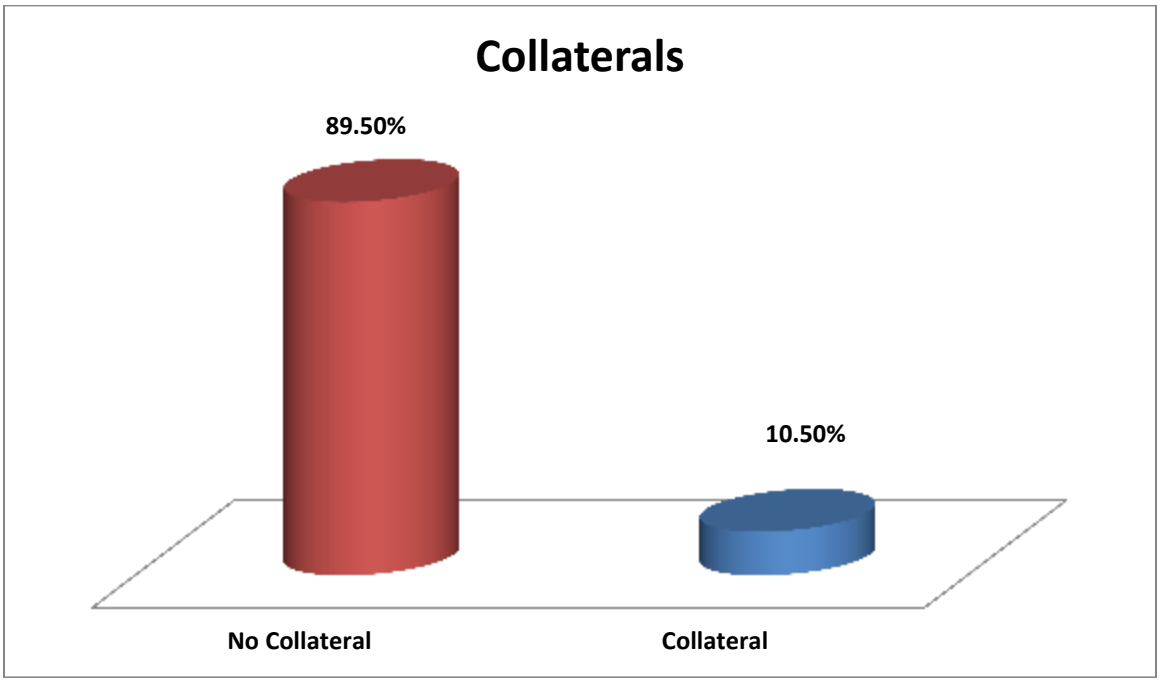


Table (4:9): Show Frequency and Percent of Balloon

Balloon		
	Frequency	Percent
No Balloon	152	88.9
Balloon	19	11.1
Total	171	100.0

Table (4:9): Show Percent of Balloon

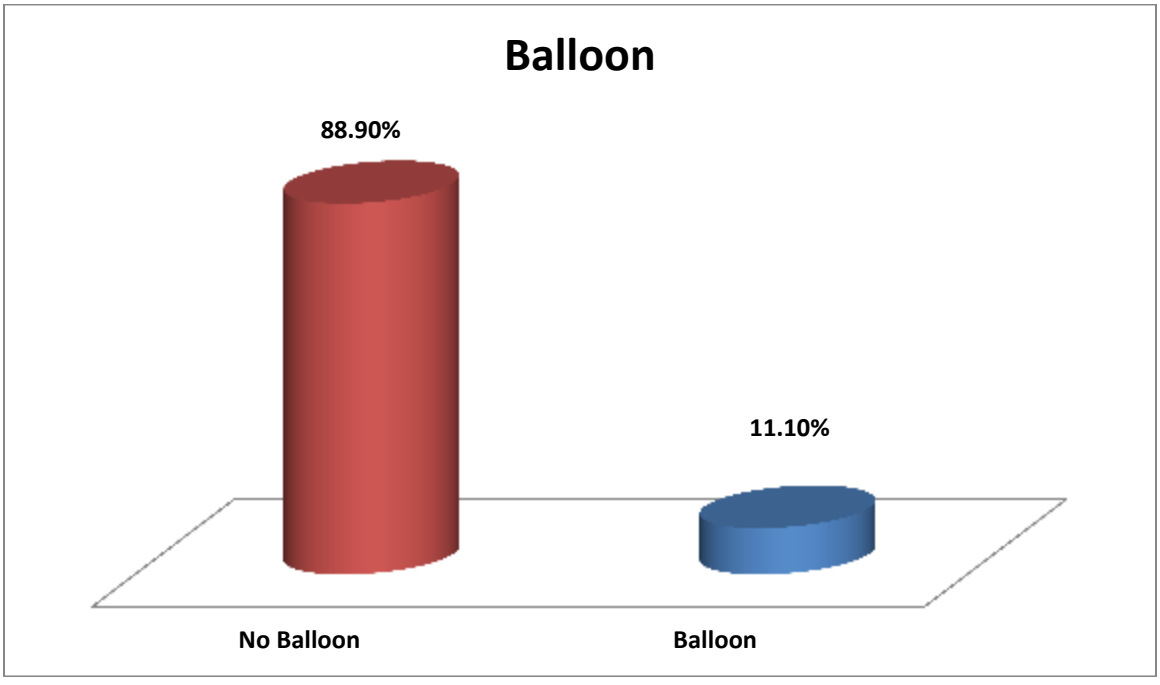


Table (4:10): Show Frequency and Percent of Aortogram

Aortogram		
	Frequency	Percent
Normal	129	75.4
Abnormal	42	24.6
Total	171	100.0

Figure (4:10): Show Percent of Aortogram

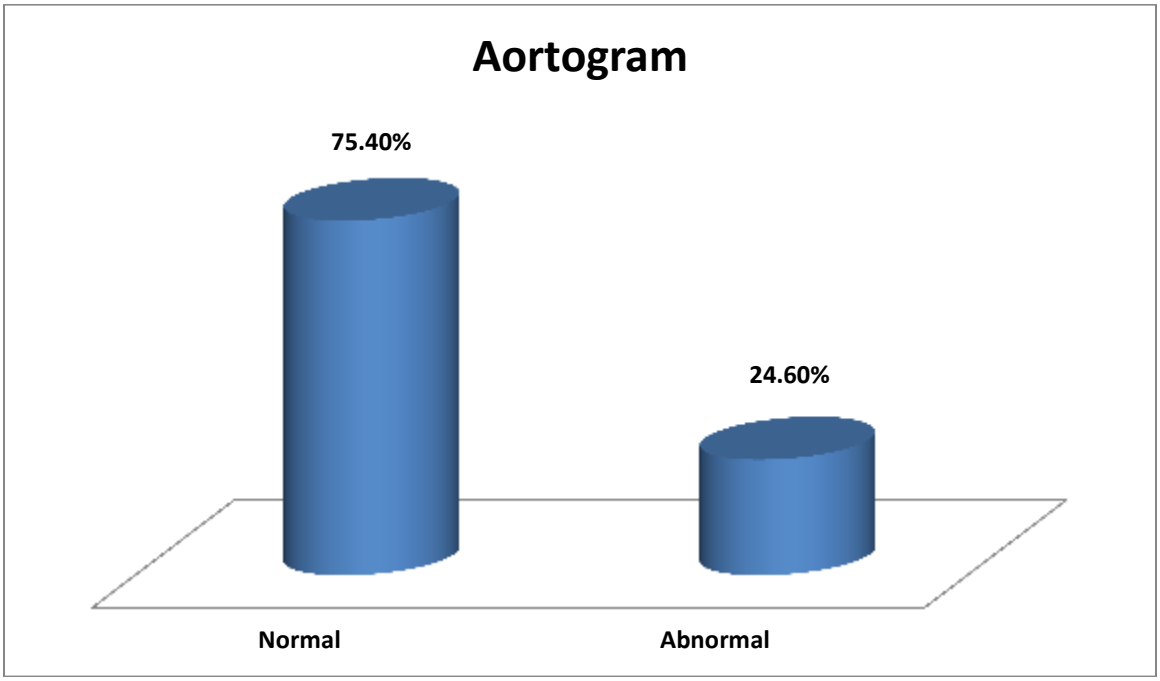


Table (4:11): Show Frequency of Relation between Type of cath and Shunt

		Type Of Cath		Total	Chi Square value	Sig(p-value)
		Therapeutic	Diagnostic			
Shunt	NO Shunt	66	104	170	.632[a]	.427
	Shunt	0	1	1		
Total		66	105	171		

Figure (4:11): Show Frequency of Relation between Type of cath and Shunt

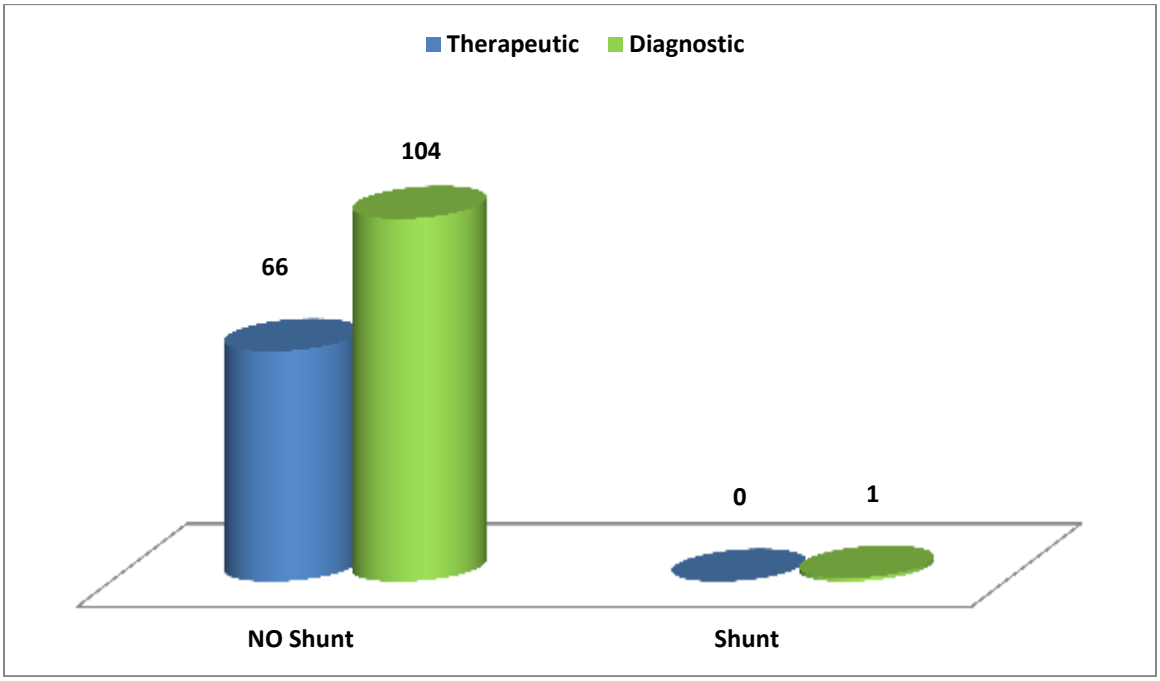


Table (4:12): Show Frequency of Relation between Type of cath and Stenosis

		Type Of Cath		Total	Chi Square value	Sig(p-value)
		Therapeutic	Diagnostic			
Stenosis	No Stenosis	51	92	143	3.168[a]	.075
	Stenosis	15	13	28		
Total		66	105	171		

Figure (4:12): Show Frequency of Relation between Type of cath and Stenosis

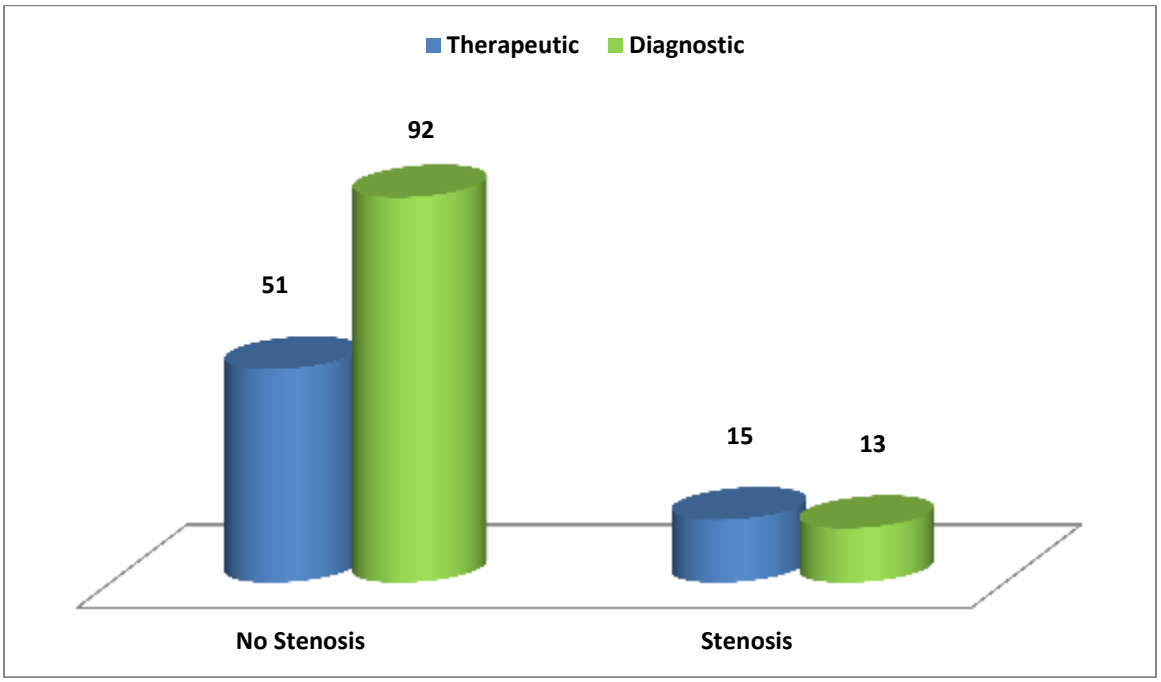


Table (4:13): Show Frequency of Relation between Type of cath and Collaterals

		Type Of Cath		Total	Chi Square value	Sig(p-value)
		Therapeutic	Diagnostic		9.267[a]	.002
Collaterals	No Collateral	65	88	153		
	Collateral	1	17	18		
Total		66	105	171		

Figure (4:13): Show Frequency of Relation between Type of cath and Collaterals

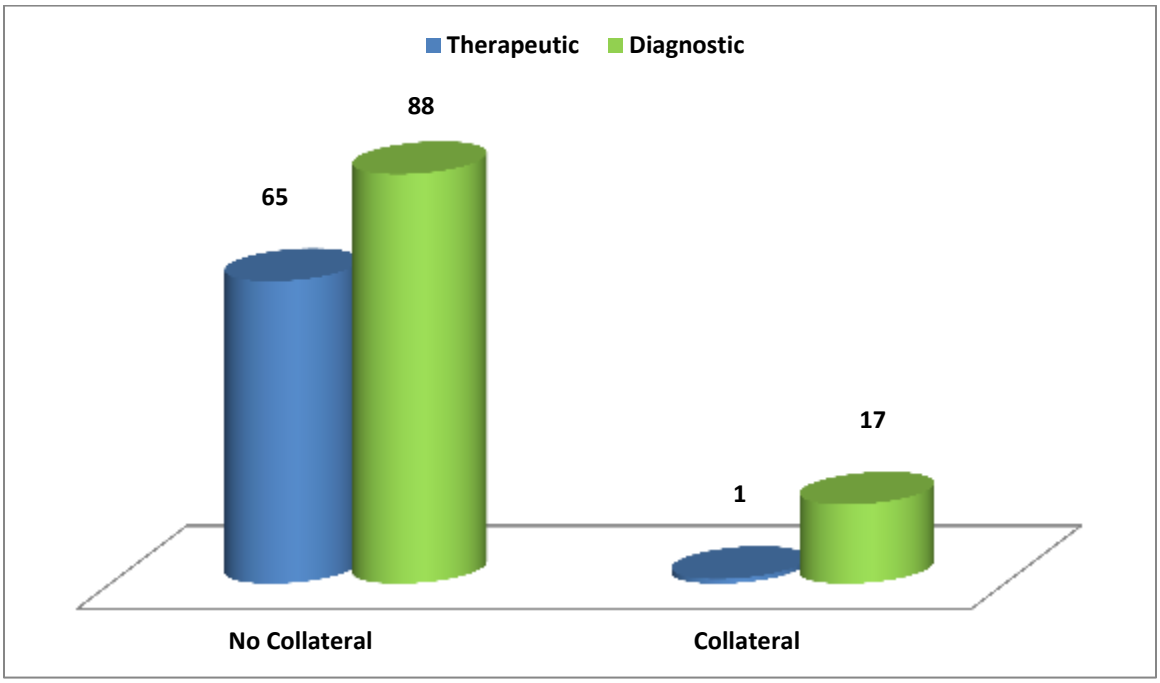


Table (4:14): Show Frequency of Relation between Type of cath and Balloon

		Type Of Cath		Total	Chi Square value	Sig(p-value)
		Therapeutic	Diagnostic			
Balloon	No Balloon	50	102	152	18.766[a]	.000
	Balloon	16	3	19		
Total		66	105	171		

Figure (4:14): Show Frequency of Relation between Type of cath and Balloon

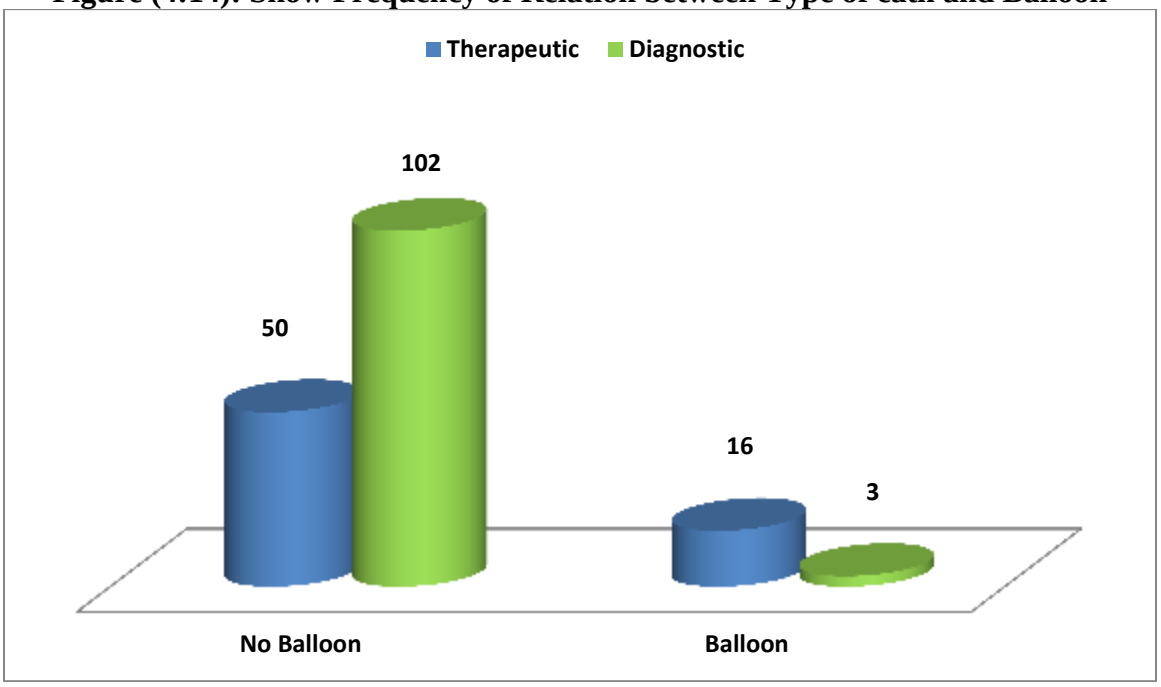


Table (4:15): Show Frequency of Relation between RV Angiogram and Shunt

		RV Angiogram		Total	Chi Square value	Sig(p-value)
		Abnormal	Normal			
Shunt	NO Shunt	33	137	170	.241[a]	.624
	Shunt	0	1	1		
Total		33	138	171		

Figure (4:15): Show Frequency of Relation between RV Angiogram and Shunt

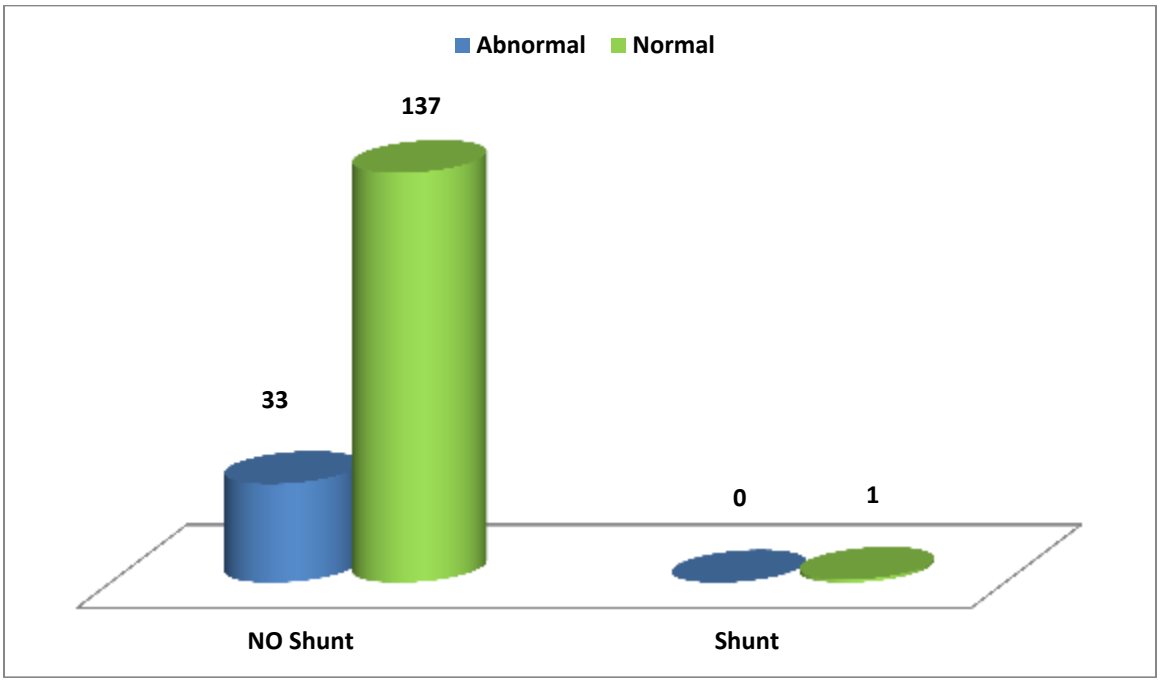


Table (4:16): Show Frequency of Relation between LV Angiogram and Shunt

		LV Angiogram		Total	Chi Square value	Sig(p-value)
		Abnormal	Normal			
Shunt	NO Shunt	12	158	170	.076[a]	.783
	Shunt	0	1	1		
Total		12	159	171		

Figure (4:16): Show Frequency of Relation between LV Angiogram and Shunt

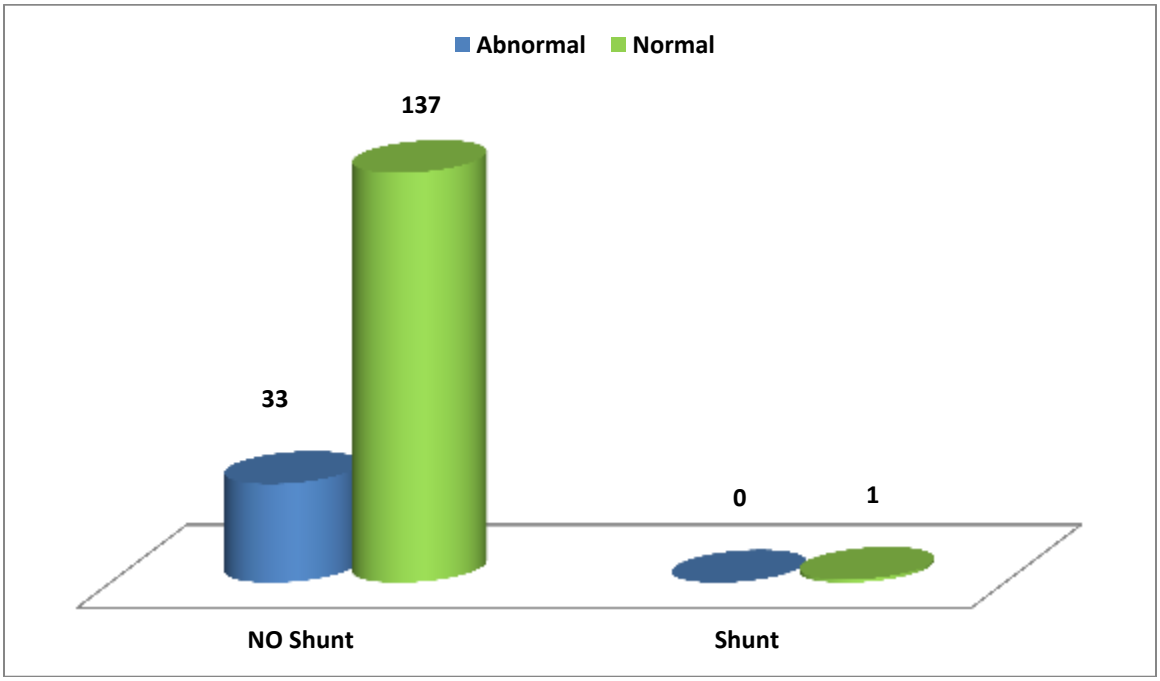


Table (4:17): Show Frequency of Relation between Aortogram and Shunt

		Aortogram		Total	Chi Square value	Sig(p-value)
		Normal	Abnormal			
Shunt	NO Shunt	128	42	170	.327[a]	.567
	Shunt	1	0	1		
Total		129	42	171		

Figure (4:17): Show Frequency of Relation between Aortogram and Shunt

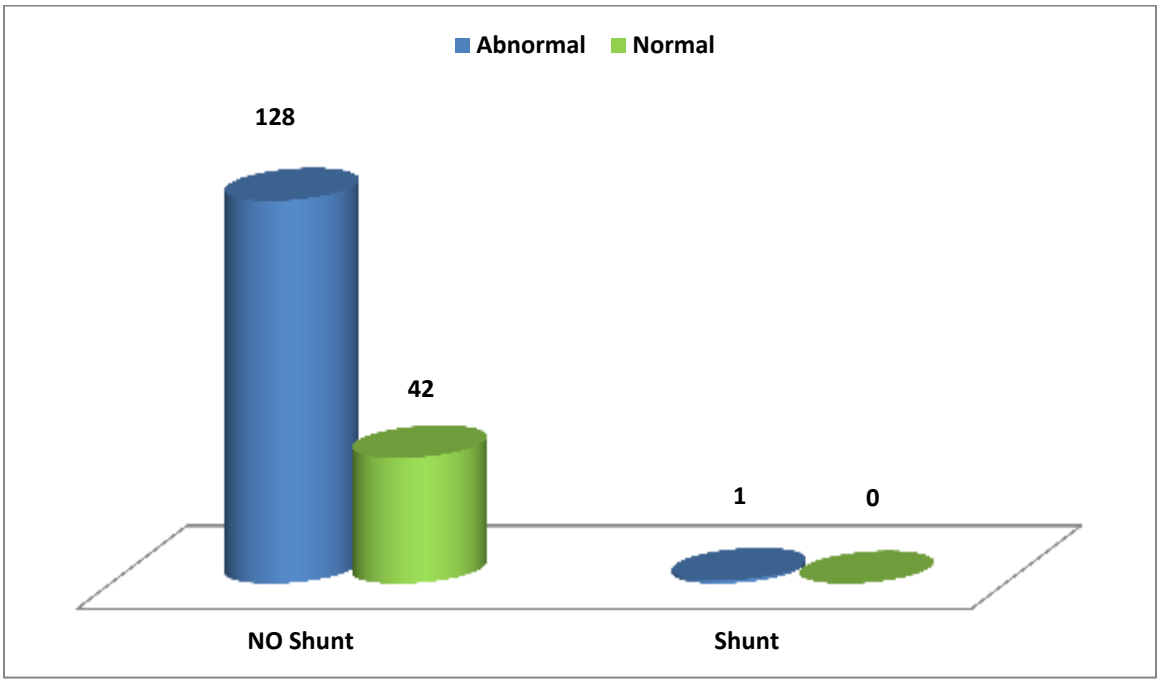


Table (4:18): Show Frequency of Relation between RV Angiogram and Stenosis

		RVAngiogram	Total	Chi Square value	Sig(p-value)	
		Abnormal	Normal			
Stenosis	No Stenos is	29	114	143	.540[a]	.462
	Stenos is	4	24	28		
Total	33	138	171			

Figure (4:18): Show Frequency of Relation between RV Angiogram and Stenosis

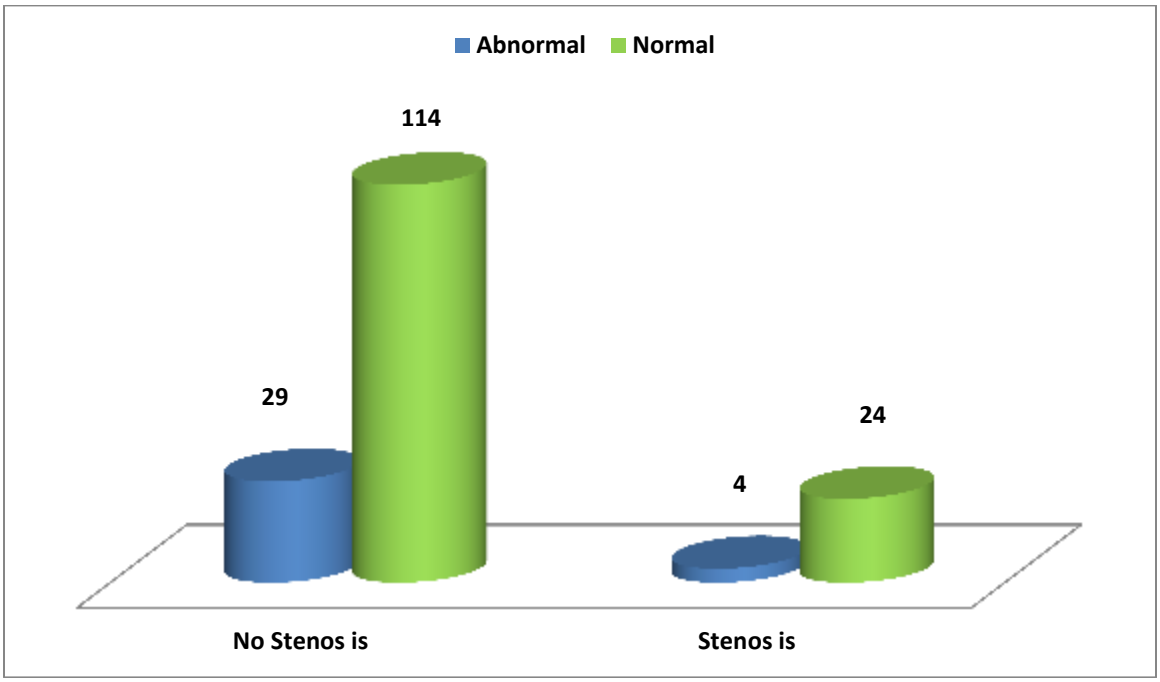


Table (4:19): Show Frequency of Relation between LV Angiogram and Stenosis

		LVAngiogram		Total	Chi Square value	Sig(p-value)
		Abnormal	Normal			
Stenosis	No Stenosis	11	132	143	.609[a]	.435
	Stenosis	1	27	28		
Total		12	159	171		

Table (4:19): Show Frequency of Relation between LV Angiogram and Stenosis

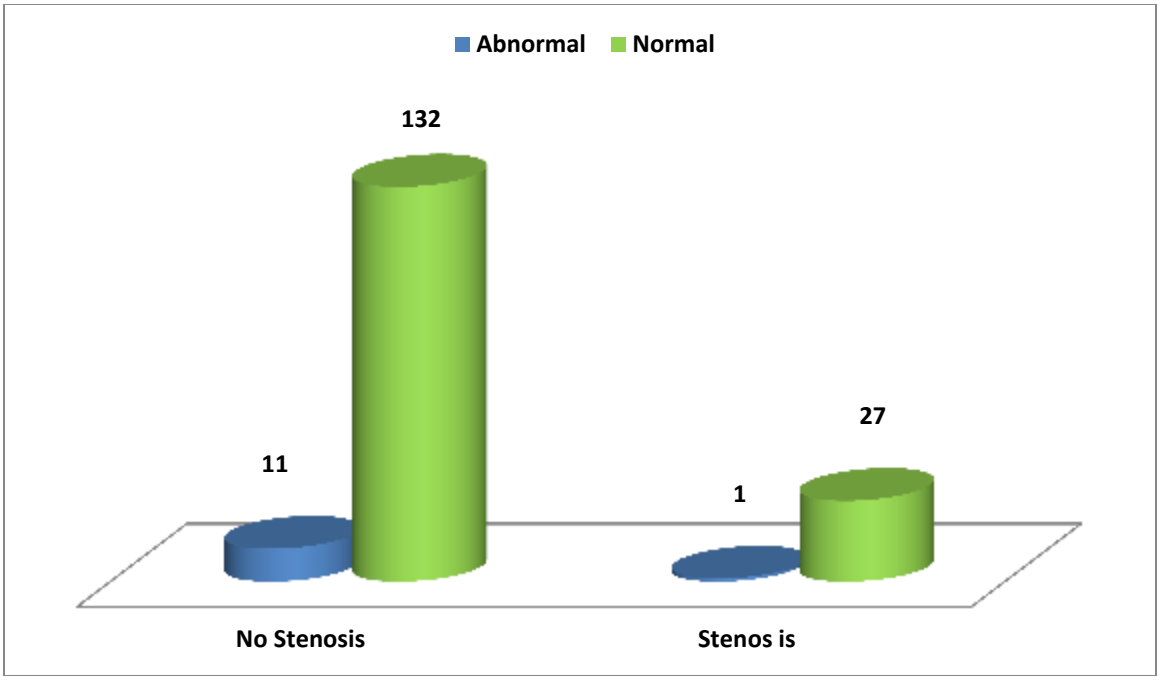


Table (4:20): Show Frequency of Relation between Aortogram and Stenosis

		Aortogram		Total	Chi Square value	Sig(p-value)
		Normal	Abnormal			
Stenosis	No Stenosis	102	41	143	7.962[a]	.005
	Stenosis	27	1	28		
Total		129	42	171		

Figure (4:20): Show Frequency of Relation between Aortogram and Stenosis

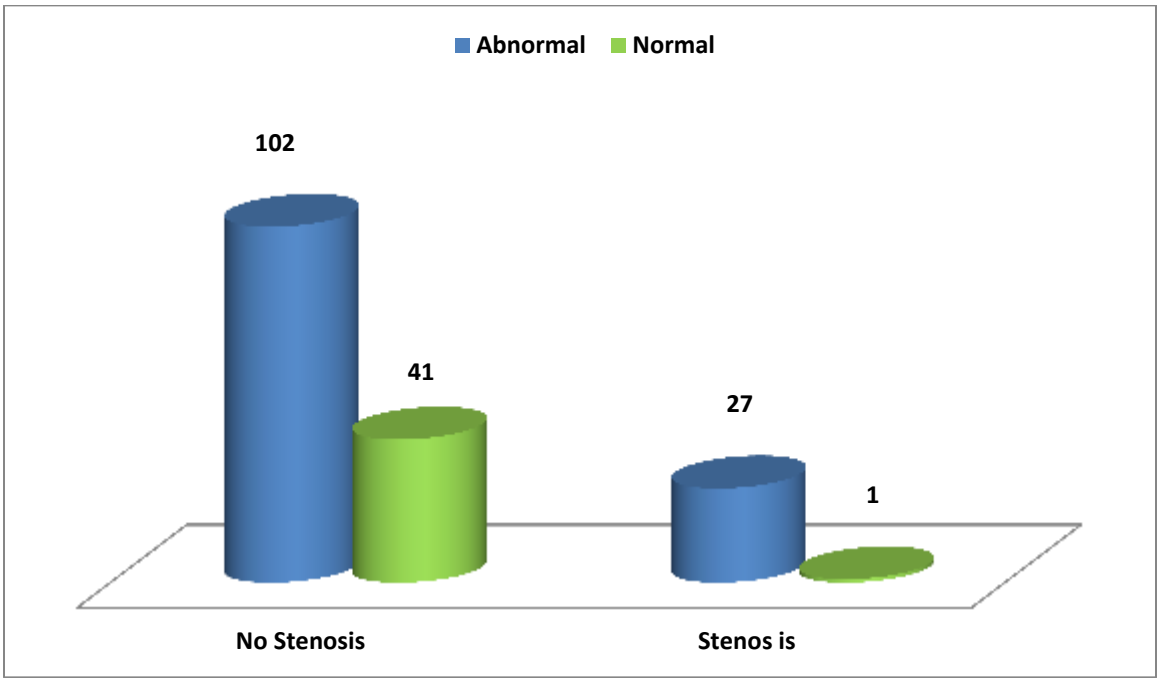


Table (4:21): Show Frequency of Relation between RV Angiogram and Collaterals:

		RV Angiogram		Total	Chi Square value	Sig(p-value)
		Abnormal	Normal			
Collaterals	No Collateral	30	123	153	.089[a]	.765
	Collateral	3	15	18		
Total		33	138	171		

Figure (4:21): Show Frequency of Relation between RV Angiogram and Collaterals:

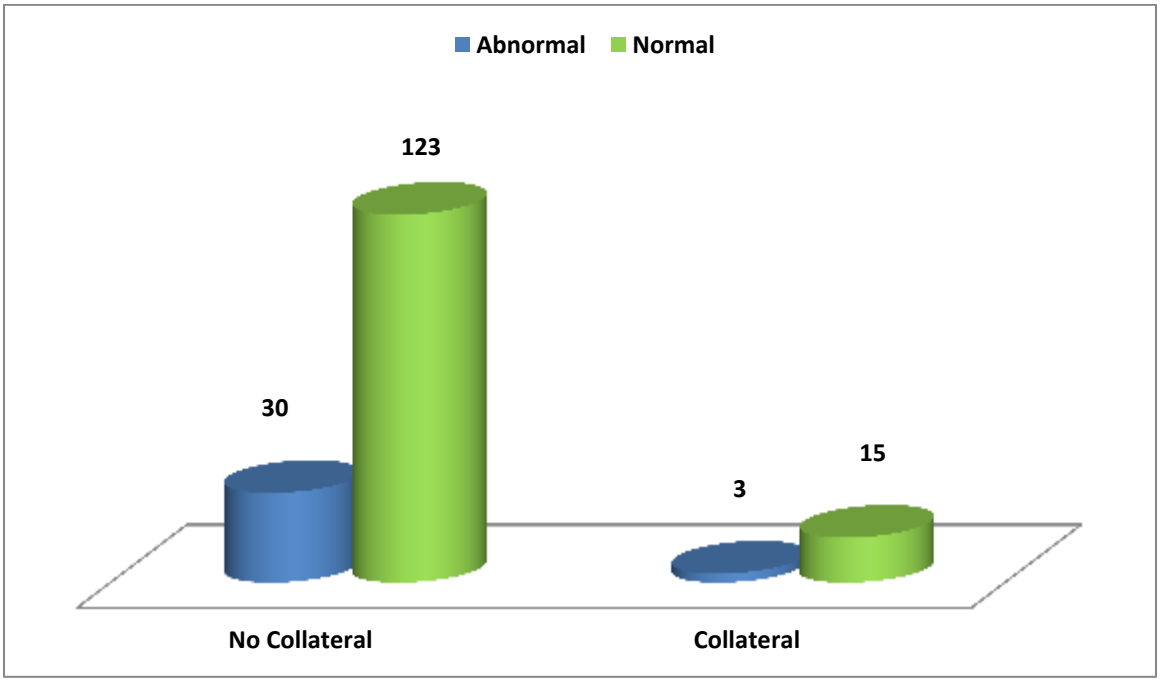


Table (4:22): Show Frequency of Relation between LV Angiogram and Collaterals:

		LV Angiogram		Total	Chi Square value	Sig(p-value)
		Abnormal	Normal			
Collaterals	No Collateral	11	142	153	.066[a]	.797
	Collateral	1	17	18		
Total		12	159	171		

Figure (4:22): Show Frequency of Relation between LV Angiogram and Collaterals

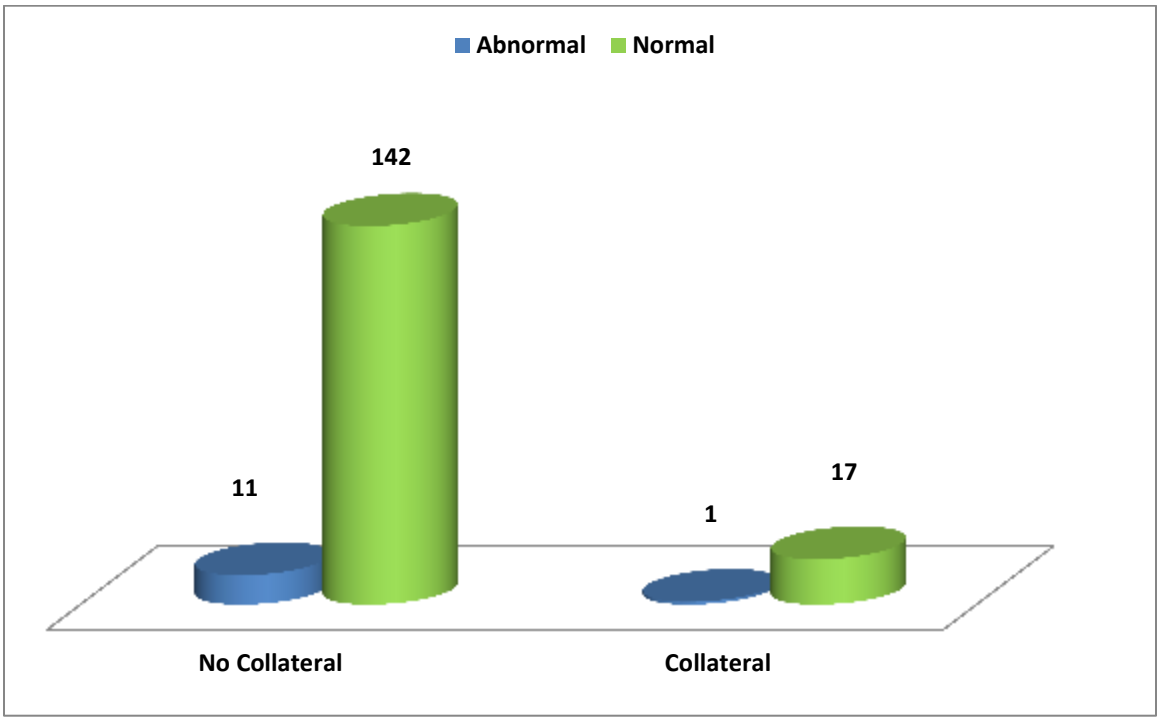


Table (4:23): Show Frequency of Relation between Aortogram and Collaterals:

		Aortogram		Total	Chi Square value	Sig(p-value)
		Normal	Abnormal			
Collaterals	No Collateral	112	41	153	3.922[a]	.048
	Collateral	17	1	18		
Total		129	42	171		

Figure (4:23): Show Frequency of Relation between Aortogram and Collaterals

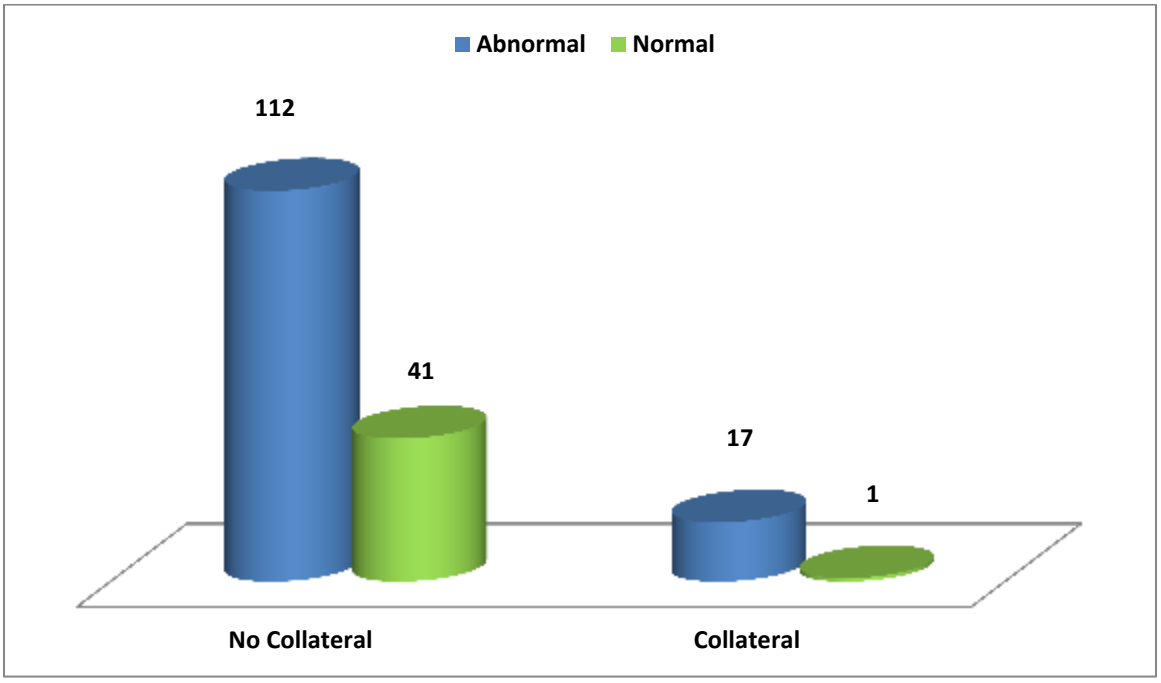


Table (4:24): Show Frequency of Relation between RV Angiogram and Balloon

		RV Angiogram		Total	Chi Square value	Sig(p-value)
		Abnormal	Normal			
Balloon	No Balloon	31	121	152	1.056[a]	.304
	Billon	2	17	19		
Total		33	138	171		

Figure (4:24): Show Frequency of Relation between RV Angiogram and Balloon

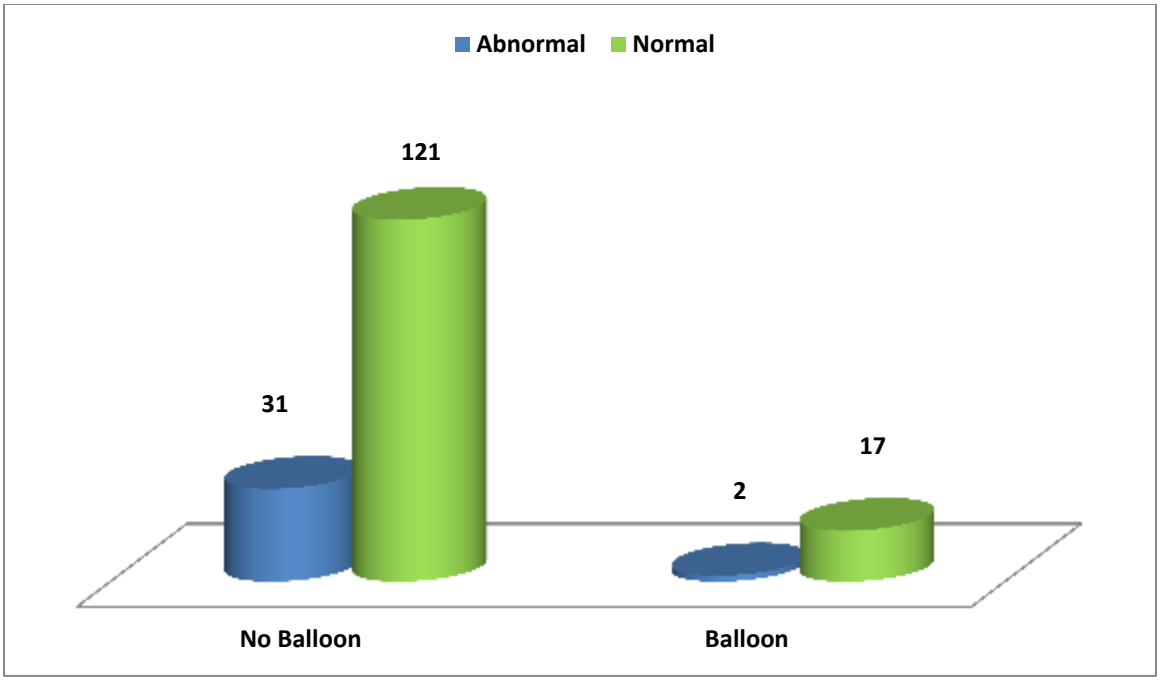


Table (4:25): Show Frequency of Relation between LV Angiogram and Balloon

		LV Angiogram		Total	Chi Square value	Sig(p-value)
		Abnormal	Normal			
Balloon	No Balloon	12	140	152	1.613[a]	.204
	Balloon	0	19	19		
Total		12	159	171		

Table (4:25): Show Frequency of Relation between LV Angiogram and Balloon

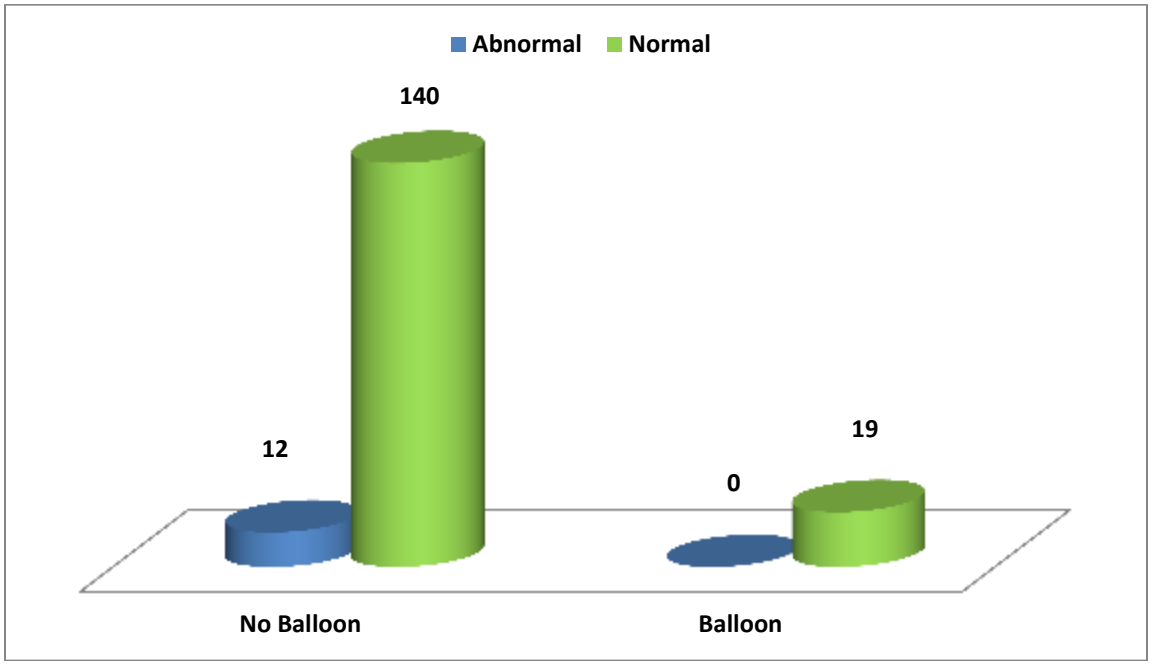
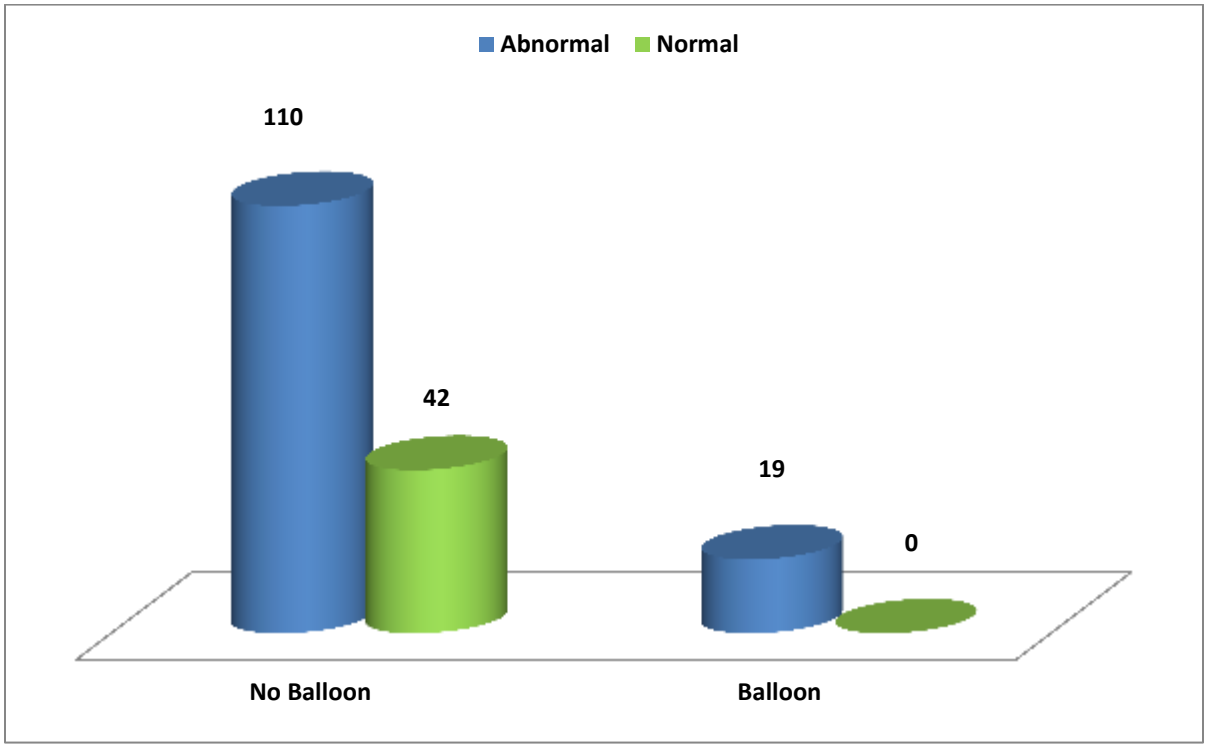


Table (4:26): Show Frequency of Relation between Aortogram and Balloon

		Aortogram		Total	Chi Square value	Sig(p-value)
		Normal	Abnormal			
Balloon	No Balloon	110	42	152	6.959[a]	.008
	Balloon	19	0	19		
Total		129	42	171		

Figure (4:26): Show Frequency of Relation between Aortogram and Balloon



5-1 Discussion

The study discussed from the collective finding data of this study is most commonly in the female than male with distribution of gender 81 male (47.4%) and 90 female (52.6%) thatexplain in table (4-1).

The primary diagnosis frequency of 171 child's come to Sudan heart center during the period 2014 to 2015 showed the ASD 12patients (7% of the patients diagnosed by cath lab),TOF in32 patients (18.7% of patients),PDA in 33 patients(19.3% of patients),VSD in 40 patients(23.4% of patients),TGA in 13 patients(7.6% of patients),TAPR in 1 patients (0.6% of patients),PS in 19 patients (11.1% of patients),RV Fistula in 2 patients(1.2% of patients),Pulmonary Problems in 15 patients (8.8 % of patients) and Heart problems in 4 patients(2.3% 0f patient.

Table (4-3) presented type of cardiac catheterization according to therapeutic cath lab is 66patients (38.6%) and diagnostic cath lab 105 patients **(**61.4%).

Table (4-4) presented right ventricle angiogram view for pediatric cardiac catheterization is abnormal in 33 patients (19.3%) and normal in 138 patients (80.7%).The table (4-5) presented left ventricle angiogram view is normal in 159 patients (7%) and abnormal in 12 patients (93%).

From the table (4-1) of this study is most commonly in the female than male with distribution of gender is 90 female (52.6%) compared to (**Mary K. M. Shann,1969**) was distribution of female is(44.45%).

Table (4-2) showed that the VSD is most commonly of primary diagnosed by cath lab (23%)compared with (Sulafa KM,2007) the TOF is commonly diagnosed by cath lab (23%) and VSD is diagnosed was (15%) in (Sulafa KM,2007)

The similarities study between this study and (**Mary K. M. Shann, 1969**) about VSD is most commonly diagnosed by cath lab.

The similarities study between this study and (**Advisor –Endale Tefera, 2013)** about the female is most commonly distribution of gender and VSD is most commonly diagnosed cardiac catheterization.

From table (4-3) of type of cath lab percent having increase therapeutic cath lab 38%compaired (Sulafa KM, **2007**) is therapeutic cath was 25%.

Table (4-11), (4-12) showed that there is no relation between type of cath and shunt or stenosis respectively. While table (4-13) is an indicator for the relation between type of cath and collaterals and table (4-14) showed the relation between type of cath and balloon used as therapeutic cath.

Table (4-16), (4-17) and (4-18) showed that the usage of RV, LV and aortogram to detect diagnosing shunt is of value and significant relation were detected. Where table (4-20) and (4-23) indicate the good impact of aortogramin the detection of stenosis and collateral significantly

5-2 Conclusions

The study concluded of The primary diagnosis frequency of 171 child's come to Sudan heart center during the period 2014 to 2015 the ASD 12patients (7% of the patients diagnosed by cath lab),TOF in32 patients (18.7% of patients),PDA in 33 patients(19.3% of patients),VSD in 40 patients(23.4% of patients),TGA in 13 patients(7.6% of patients),TAPR in 1 patients (0.6% of patients),PS in 19 patients (11.1% of patients),RV Fistula in 2 patients(1.2% of patients),Pulmonary Problems in 15 patients (8.8 % of patients) and Heart problems in 4 patients(2.3%), cardiac catheterization was use as diagnose and therapeutic in Sudan heart center.

The most common findings were VSD.

The female is most frequencies in distribution of gender for came to cath lab in this study.

The presence of shunt and pulmonary stenosis is independent to the type of cardiac catheterization.

The presence of collateral and balloon is dependent to the type of cath lab.

The RV angiogram and LV angiogram views are not positive to determine presence of shunt and stenosis.

5-3 Recommendations

- In this study recommends the best view to show stenosis and collateral is aortogram.
- In this study recommends the best view to the balloon in therapeutic cath is aortgram.
- In this study recommends in cases of stenosis no need to RV angiogram and LV angiogram.
- The selection of good technique will reduces radiation for the patients.
- For field the study another statics study is needed for adult.

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File no	Gender	Age	Prev.Invest.			Prim.Diagn.	Finding	Hemodynamic			plan	Result
			ECG	CXR	ECHO			Site	Pres.before	Pres.post		

مركز السودان للقلب

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Tel: 232137 -232138 – 232133
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Cath No: 8816
Name: Madeha Asim Mahmood
Age: 7 Yrs **Gender:** F
Date : 16/06/2015
File No: 16761

Pediatric/Congenital Cath Report

Primary Diagnosis:

LA Isomesim ,Mirror Immage, Dextrocadia & ASD.

Brief history:

Seven Years old female, known with the above diagnosi Family were counceled for a high risk procedure and agreed to proceed f Diagnostic Cath.

Access: RFV(5F).RFA(4F)
Anesthesia: Sedation by Salma
Cathters: Berman,MP& Pig Tail

Hemodyanamics:

Site		Pressure ESP	Pressure EDP	Pressure Mean	O2Sat%	with O2%
FA		157	87	113	-	-
RA (Rightside)		24	14	20	-	-
PA	Simultaneous	111	60	37	58%	88%
FA		143	72	96	85.4%	100%
AO		123	78	103	-	-
LV		126	16	-	-	-

QP/QS (RA)	QP/QS(O_2)	PVR (RA) WU	PVR (O2)
0.5	1.4	26.8	12

Angiograms: In RV , azygous and innominate vein.

Plan: v. high risk for sx

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Tel: 232137 -232138 – 232133
Fax: 232135

Cath No: 8815
Name: Mohamd Khalid Mohamed
Age: 3 y Gender: M
Date : 16/06/2015
File No: 16790

Pediatric/Congenital Cath Report

Primary Diagnosis: TGA/VSD/PS and RV dysfunction

Brief history:

This pt pressented with right sideded HF and echo shoewed diagnosis.Family were counceled for a high risk procedure and agreed to pr for Diagnostic Cath.

Access: RFV(5F)
Anesthesia: Sedation by Salma
Cathters: MP, Berman angio

Hemodyanamics:

Site	Pressure ESP	Pressure EDP	Pressur e Mean	O2Sat%	with O2%
RA (LA SAME)	27	18	22		
RV	112	17			
AO (noninvasive)	100	50			60
PVWP	44	18	32		

Angiograms:
Innominate vein angio showed no LSVC. RV angio showed poor contractility, PAs not visualized as catheter slipped to RA.

Plan: Pt is at v high risk for intervention because of the RV dysfunction and the high PVWP.

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SUDAN HEART CENTER Cardiac Catheterization Laboratory Tel: 232137 232138 – 2321333 Fax: 232135	Cath No: 8734 (No cd) Name: Fatima Mohammed Ahmed Age: 12 Years Gender: F Date : 05/05/2015 Center No: 16631

Pediatric/Congenital Cath Report

Diagnosis: Large VSD, PHT è Rt Cerebral Heamorrhage

Brief history:

Twelve Years old female, known with the above diagnosis. She was admitted electively for Diagnostic Cath .Family were counceled and agreed to proceed for the procedure.

Tools:

Acess: RFA (4 F) AND RFV (5 F)
Anesthesia: Sedation Salma
Cathters:. Perman, Pigtail

Findings:

Hemodyanamics:

Site		Pressure ESP	Pressure DP	Pressure Mean
RA		08	02	05
RV		127	0	-
LV		137	0	-
RV		113	0	-
PA	Simultanious (Room Air)	101	55	77
AO		109	67	85
PA	Simultanious (O_2)	98	51	74
AO		107	66	83
RPA		100	48	77

Calculation:

QP/QS in RA = 0.8 & O_2 increased to 1.2 after 10 min O_2 PVR in RA = 24.3 dicreased after 10 min O_2 to 11.1.

Plan: **High risk for surgery (Sildenfil started)**

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