Chapter One

1-1Introduction

Cardiac catheterization is an invasive procedure that performed with diagnostic and therapeutic purposes in certain cardiovascular disease .and it is performed by threading a thin flexible tube through blood vessel to the heart. And procedures perform by cardiologists who specialize in treating cardiovascular disease. The diagnostic catheterization is procedure that involve insertion of thin flexible tube (catheter) into right or left side of heart through groin or arm and allow injection of radio opaque dye then take X- ray picture that make coronary arteries visible on picture (coronary angiography) also it could shows plague that build up inside coronary artery and restrict blood flow Coronary Artery Disease (CAD) (*Piessens1995)*

In addition, Intravenous Ultrasound (IVUS) is one of unique method that done through cardiac catheterization for diagnostic purpose. And it is use echo cardiograph and a very high frequency waves (called Ultrasound) which emitted by transducer and this wave bounce of various type of tissues structure in the body and echo of this waves then converted into a picture. transducer have been miniaturized to less than hundreds of inch and place on the tip of catheter and this catheter can be slipped in to coronary artery over the same guide wire that used to position angioplasty balloon and a tiny camera give us cross sectional view of artery using shades of gray or color (*Schrader 1999)*

Intravenous Ultrasound is more better than the routine image as (coronary angiograph, X-ray, MRI….etc) because it is provide more accurate information and details about measurement of both diameter of artery and diameter of lumen channel and diameter of plague and length of diseased area also it could be use in assessing selection and sizing of stents and balloons and confirms accurate stent placement. And optimal stent deployment. Thus it is effect treatment decision and reducing complication and incidence of the stent (*Schrader 1999)*

Although Intravenous Ultrasound was first used over 20 years ago the current concerns over stent thrombosis and patient outcome have spurred a new interest. the resent study sponsored by Johnson and Johnson, showed that current DES deployment techniques led to some form of geographic miss in 66.5% of patient that mean two-thirds of stents are not optimally placed, which translates into a negatively impacted patient outcomes, with significantly higher restenosis, thrombosis and myocardial infarction rates in patients where the stent was not placed properly. The study concluded that a reexamination of stent placement techniques including the uses of Intravenous Ultrasound is certainly warranted modern Intravenous Ultrasound system are completely integrated into the cardiac catheterization lab and with a proper training the cardiologist can add this new imaging technology to the standard diagnostic angiogram with a minimum impact on the patient (*Schrader 1999)*

Fractional flow reverse (FFR) is the guided wire based procedure that can accurately measure blood pressure and flow through specific part of coronary artery and it is done through standard diagnostic catheter and it is been seen showing useful in assessing wither perform angioplasty or stinting. Based on placement of catheter the diagnostic cardiac catheterization can be categorize as left and right cardiac catheterization.

The left cardiac catheterization it is performing by arterial route to confirm and provide more accurate diagnosis for left ventricular function, out flow tract obstruction, valvular disease and coronary artery disease. (*Kong 1994)*

The right heart catheterization insert through venous route to asses cardiac output, left ventricular pressure, pulmonary pressure wage right heart and pulmonary hypertension. Therapeutic catheterization it is procedure that involve in treatment of many cardiovascular condition. The cardiologist can treat Coronary Artery Disease during cardiac catheterization by procedure called angioplasty by which a catheter with balloon at it tips is threaded to the blocked coronary artery once placed a balloon inflated pushing the plague sometimes stint is placed in the artery during angioplasty. A balloon valvotomy is non surgical procedure perform in cardiac catheterization to increase the opening of narrowed (stenosed) valve. Also cardiac catheterization use in insertion of the cardiac pacemakers…etc (*Kong 1994)*

Implanted Cardioverter defibrillator (ICD) is a battery powered device placed under the skin that keep tract of your heart rate. Thin wires connect the Implanted Cardioverter Defibrillator to your heart. If any abnormal heart rhythm is detected the device will deliver an any electric shock to restore a normal heart beat to stop your heart is beating chaotically and much too fast. Implanted Cardioverter Defibrillator has been very useful in preventing sudden death in patient with high risk of life threatening ventricular arrhythmias. And it is play important role in catheterization lab (*Kong 1994)*.

1:2 Problem of the study:

The main problem of this study is lies in identifying advantages and disadvantages of cardiac catheterization in diagnosis and treatment of coronary arteries disease.

1:3: Objectives:

1-3-1General objective:

To reveal the advantages and disadvantages of cardiac catheterization in diagnosis and treatment of coronary arteries diseases.

1-3-2 Specific objective :

To investigate the process of cardiac catheterization in diagnosis and treatment of coronary arteries diseases.

1-4 Important of study:

Coronary artery disease is narrowing of the small blood vessels that supply the heart. It is caused by plaque building up in the vessel walls and can result in serious complication such as angina, MI and damage of heart muscle and death.

Because of it is prevalence, timely and accurate diagnosis of coronary artery disease (CAD) has been a global health concern and is the leading cause of death diagnostic cardiac catheterization can confirm or exclude the presence of a condition that is suspected from patient history, physical examination and for evaluation by such noninvasive methods as ECG, chest X-ray Echocardiography and excessive test.

Diagnose the cardiac catheterization can be use to clarify a confusing or obscure situation in patient whose clinical finding and non invasive testing are unclear. Finally it is confirm a suspected abnormality that might require the surgeon attention.

1-5 Overview of study:

The study consists of five chapters:

Chapter one is introductions, objectives, problems, significant of the study and scope of the study

Chapter two theoretical background, litterateur review and previous studies.

Chapter three material and methods

Chapter four results

Chapter five discussions, conclusions and recommendations

Chapter two

Theoretical background and previous studies

2-1 Anatomy of coronary artery:

The two coronary arteries originate from the left side of the heart at the beginning (root) of the aorta, just after the aorta exits the left ventricle. The left coronary artery originates from the left aortic sinus, while the right coronary artery originates from the right aortic sinus. No artery arises from the posterior aortic sinus. Coronary arteries supply blood to the myocardium and other components of the heart. The first portion of the aorta after it arises from the left ventricle gives rise to the coronary arteries. There are three dilations in the wall of the aorta just superior to the aortic semilunar valve. Two of these, the left posterior aortic sinus and anterior aortic sinus, give rise to the left and right coronary arteries, respectively. The third sinus, the right posterior aortic sinus, typically does not give rise to a vessel. Coronary vessel branches that remain on the surface of the artery and follow the sulci of the heart are called epicardial coronary arteries (***Kong 1994)***

2-1-1The left coronary artery

The left coronary artery distributes blood to the left side of the heart, the left atrium and ventricle, and the interventricular septum. The circumflex artery arises from the left coronary artery and follows the coronary sulcus to the left. Eventually, it will fuse with the small branches of the right coronary artery. The larger anterior interventricular artery, also known as the left anterior descending artery (LAD), is the second major branch arising from the left coronary artery. It follows the

anterior interventricular sulcus around the pulmonary trunk. Along the way it gives rise to numerous smaller branches that interconnect with the branches of the posterior interventricular artery, forming anastomoses. An anastomosis is an area where vessels unite to form interconnections that normally allow blood to circulate to a region even if there may be partial blockage in another branch. The anastomoses in the heart are very small. Therefore, this ability is somewhat restricted in the heart so a coronary artery blockage often results in myocardial infarction causing death of the cells supplied by the particular vessel (***Kong 1994)***

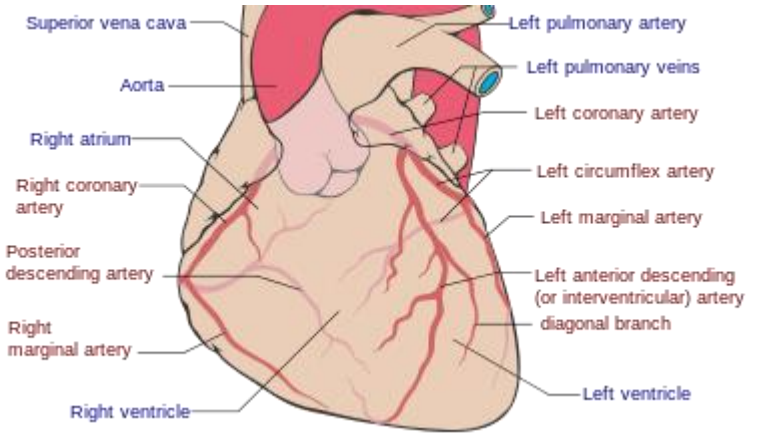
2-1-2 The right coronary artery:

The right coronary artery proceeds along the coronary sulcus and distributes blood to the right atrium, portions of both ventricles, and the heart conduction system. Normally, one or more marginal arteries arise from the right coronary artery inferior to the right atrium. The marginal arteries supply blood to the superficial portions of the right ventricle. On the posterior surface of the heart, the right coronary artery gives rise to the posterior interventricular artery, also known as the posterior descending artery. It runs along the posterior portion of the interventricular sulcus toward the apex of the heart, giving rise to branches that supply the interventricular septum and portions of both ventricles (***Sandoval AE 1998).***

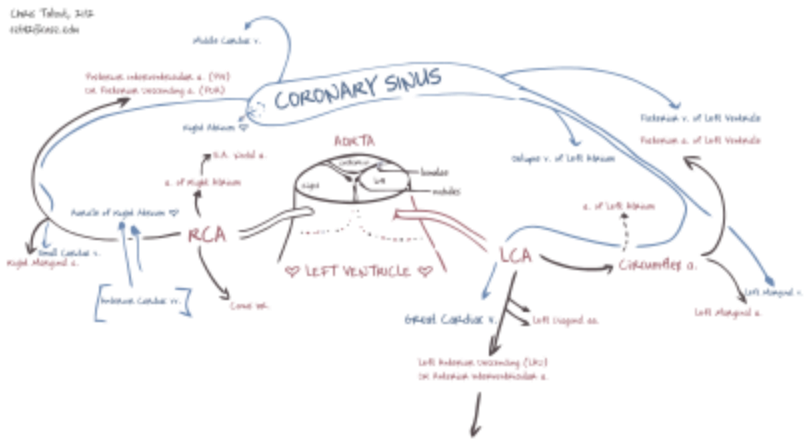
Coronary circulation is the circulation of blood in the blood vessels of the heart muscle (myocardium). The vessels that deliver oxygen-rich blood to the myocardium are known as **coronary arteries**. The vessels that remove the deoxygenated blood from the heart muscle are known as cardiac veins. These include the great cardiac vein, the middle cardiac vein, the small cardiac vein and the anterior cardiac veins ***Sandoval AE 1998).***

As the left and right coronary arteries run on the surface of the heart, they can be called epicardial 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. (See also: circulatory system.) The coronary arteries that run deep within the myocardium are referred to as subendocardial. 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 (***Sandoval AE 1998).***

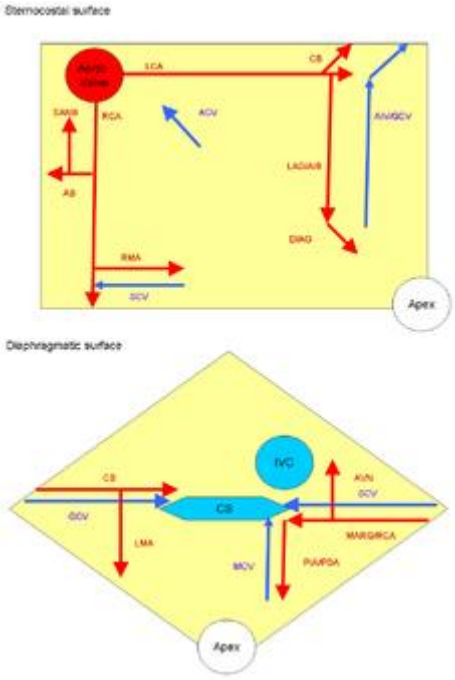
Coronary circulation



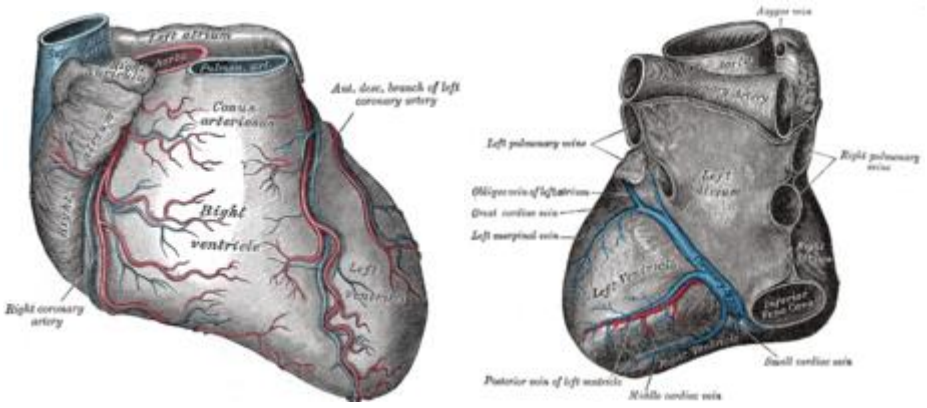
Figuer (2-1) Coronary arteries labeled in red text and other landmarks in blue text **(*Sandoval AE 1998).***



Figuer (2-2) Schematic diagram of the coronary arteries and veins *Sandoval AE 1998).*



Figuer (2-3)Schematic view of the heart **(*Sandoval AE 1998).***



Figuer (2-4) An anterior left coronary artery **.** Base and diaphragmatic surface of heart. ***(Gowda S 1994)***.

Figuer (2-5) Cast of coronary arteries (right = yellow, left = red) ***(Nicholas 1994)***

There are some anastomoses between branches of the two coronary arteries. However the coronary arteries are functionally end arteries and so these meetings are referred to as anatomical anastamoses, which lack function, as opposed to functional or physiological anastomoses like that in the palm of the hand. This is because blockage of one coronary artery generally results in death of the heart

tissue due to lack of sufficient blood supply from the other branch. When two arteries or their branches join, the area of the myocardium receives dual blood supply. These junctions are called anastomoses. If one coronary artery is obstructed by an atheroma, the second artery is still able to supply oxygenated blood to the myocardium. However, this can only occur if the atheroma progresses slowly, giving the anastomoses a chance to proliferate.

Under the most common configuration of coronary arteries, there are three areas of anastomoses. Small branches of the LAD (left anterior descending/anterior interventricular) branch of the left coronary join with branches of the posterior interventricular branch of the right coronary in the interventricular groove. More superiorly, there is an anastomosis between the circumflex artery (a branch of the left coronary artery) and the right coronary artery in the atrioventricular groove. There is also an anastomosis between the septal branches of the two coronary arteries in the interventricular septum. ***(Nicholas 1994)***

The photo***)***graph shows area of heart supplied by the right and the left coronary arteries .The left and right coronary arteries occasionally arise by a common trunk, or their number may be increased to three; the additional branch being the posterior coronary artery (which is smaller in size). In rare cases, a person will have the third coronary artery run around the root of the aorta. Occasionally, a coronary artery will exist as a double structure (i.e. there are two arteries, parallel to each other, where ordinarily there would be one) ***(Nicholas 1994)*** .

2-2 Physiology:

2-2-1Coronary artery dominance:

The artery that supplies the posterior descending artery (PDA) determines the coronary dominance. If the posterior descending artery is supplied by the right coronary artery (RCA), then the coronary circulation can be classified as "right-dominant". If the posterior descending artery is supplied by the circumflex artery (CX), a branch of the left artery, then the coronary circulation can be classified as "left-dominant". If the posterior descending artery is supplied by both the right coronary artery and the circumflex artery, then the coronary circulation can be classified as "co-dominant". Approximately 70% of the general population are right-dominant, 20% are co-dominant, and 10% are left-dominant. A precise anatomic definition of dominance would be the artery which gives off supply to the AV node i.e. the AV nodal artery ***(Nicholas 1994)***

2-2-2 Function

The papillary muscles attach the mitral valve (the valve between the left atrium and the left ventricle) and the tricuspid valve (the valve between the right atrium and the right ventricle) to the wall of the heart. If the papillary muscles are not functioning properly, the mitral valve may leak during contraction of the left ventricle. This causes some of the blood to travel "in reverse", from the left ventricle to the left atrium, instead of forward to the aorta and the rest of the body. This leaking of blood to the left atrium is known as mitral regurgitation. Similarly, the leaking of blood from the right ventricle through the tricuspid valve and into the right atrium can also occur, and this is described as tricuspid insufficiency or tricuspid regurgitation. The anterolateral papillary muscle more frequently receives two blood supplies: left anterior descending (LAD) artery and the left circumflex

artery (LCX).It is therefore more frequently resistant to coronary ischemia (insufficiency of oxygen-rich blood). On the other hand, the posteromedial papillary muscle is usually supplied only by the PDA. This makes the posteromedial papillary muscle significantly more susceptible to ischemia. The clinical significance of this is that a myocardial infarction involving the PDA is more likely to cause mitral regurgitation ***(Nicholas 2005)***

2-2-3Changes in diastole:

During contraction of the ventricular myocardium (systole), the subendocardial coronary vessels (the vessels that enter the myocardium) are compressed due to the high interventricular pressures. However, the epicardial coronary vessels (the vessels that run along the outer surface of the heart) remain patent. Because of this, blood flow in the subendocardium stops. As a result most myocardial perfusion occurs during heart relaxation (diastole) when the subendocardial coronary vessels are patent and under low pressure. Flow never comes to zero in the right coronary artery, since the right ventricular pressure is less than the left ventricular pressure ***(Nicholas 1994)*** .

2-2-4 Changes in oxygen demand:

The heart regulates the amount of vasodilatation or vasoconstriction of the coronary arteries based upon the oxygen requirements of the heart. This contributes to the filling difficulties of the coronary arteries. Compression remains the same. Failure of oxygen delivery caused by a decrease in blood flow in front of increased oxygen demand of the heart results in tissue ischemia, a condition of oxygen deficiency. Brief ischemia is associated with intense chest pain, known as angina. Severe ischemia can cause the heart muscle to die from hypoxia, such as during a myocardial infarction. Chronic moderate ischemia causes contraction of

the heart to weaken, known as myocardial hibernation. In addition to metabolism, the coronary circulation possesses unique pharmacologic characteristics. Prominent among these is its reactivity to adrenergic stimulation. The majority of vasculature in the body constricts to norepinephrine, a sympathetic neurotransmitter the body uses to increase blood pressure. In the coronary circulation, norepinephrine elicits vasoconstriction, due to the predominance of beta-adrenergic receptors in the coronary circulation; however metabolic control factors will increase as a result of increased oxygen demand in the heart and will more greatly influence vasodilatation. Thus sympathetic innervations to the coronary arteries ultimately causes vasodilatation ***(Welton 2005)*** .

2-3 Pathology:

2-3-1Coronary artery disease (CAD):

Coronary artery disease (CAD) is a complex disease that causes reduced or absent blood flow in one or more of the arteries that encircle and supply the heart. The disease may be focal or diffuse. Apart from rare congenital anomalies (birth defects), CAD is usually a degenerative disease, uncommon as a clinical problem before the age of 30 years and common by the age of 60 years. One in four people will have a heart attack. The first recognized symptom may be death. Coronary artery disease (CAD) also known as ischemic heart disease (IHD),atherosclerotic heart disease, atherosclerotic cardiovascular disease,[and coronary heart disease is a group of diseases that includes: stable angina, unstable angina, myocardial infarction, and sudden coronary death It is within the group of cardiovascular diseases of which it is the most common type A common symptom is chest pain or discomfort which may travel into the shoulder, arm, back, neck, or jaw Occasionally it may feel like heartburn. Usually symptoms occur with exercise or

emotional stress, last less than a few minutes, and gets better with rest. Shortness of breath may also occur and sometimes no symptoms are present The first sign is occasionally a heart attack. Other complications include heart failure or an irregular heartbeat (***Welton 2000)***

Risk factors include, high blood pressure, smoking, diabetes, lack of exercise, obesity, high blood cholesterol, poor diet, and excessive alcohol, among others. Other risks include depression The underlying mechanism involves atherosclerosis of the arteries of the heart A number of tests may help with diagnoses including: electrocardiogram, cardiac stress testing, and coronary angiogram among others. Prevention is by eating a healthy diet, regular exercise, maintaining a healthy weight and not smoking Sometimes medication for diabetes, high cholesterol, or high blood pressure are also used There is limited evidence for screening people who are at low risk and do not have symptoms Treatment involves the same measures as prevention. Additional medications such as aspirin, beta blockers, or nitrogylcerin may be recommended Procedures such as percutaneous coronary intervention (PCI) or coronary artery bypass surgery (CABG) may be used in severe disease. In those with stable CAD it is unclear if PCI or CABG in addition to the other treatments improve life expectancy or decreases heart attack risk

In 2013 CAD was the most common cause of death globally, resulting in 8.14 million deaths (16.8%) up from 5.74 million deaths (12%) in 1990. The risk of death from CAD for a given age has decreased between 1980 and 2010 especially in the developed world The number of cases of CAD for a given age has also decreased between 1990 and 2010 In the United States in 2010 about 20% of those over 65 had CAD, while it was present in 7% of those 45 to 64, and 1.3% of those 18 to 45. Rates are higher among men than women of a given age. **(*Keeley 1998)***

2-3-1-1 Signs and symptoms of coronary artery dieses:

Chest pain that occurs regularly with activity, after eating, or at other predictable times is termed stable angina and is associated with narrowings of the arteries of the heart. Angina that changes in intensity, character or frequency is termed unstable. Unstable angina may precede myocardial infarction. In adults who go to the emergency with an unclear cause of pain, about 30% have pain due to coronary artery disease **(*Keeley 1998)***.

2-3-1-2 Risk factors

Coronary artery disease has a number of well determined risk factors. The most common risk factors include smoking, family history, hypertension, obesity, diabetes, lack of exercise, stress, and high blood lipids. Smoking is associated with about 36% of cases and obesity 20%. Lack of exercise has been linked to 7–12% of cases. Job stress appears to play a minor role accounting for about 3% of cases. In one study, women who were free of stress from work life saw an increase in the diameter of their blood vessels, leading to decreased progression of atherosclerosis.[Contrastingly, women who had high levels of work-related stress experienced a decrease in the diameter of their blood vessels and significantly increased disease progression Also, having a type A behavior pattern, a group of personality characteristics including time urgency, competitiveness, hostility, and impatience is linked to an increased risk of coronary disease. Risk factors can be classified as: fixed (such as age, sex, family history) and modifiable (such as smoking, hypertension, diabetes mellitus, obesity, etc.) **(*Keeley 1998)***

2-3-2 Blood fats

High blood cholesterol (specifically, serum concentrations) HDL (high density lipoprotein)has a protective effect over development of coronary artery disease.

High blood triglycerides may play a role. High levels of Lipoprotein, a compound formed when LDL cholesterol combines with a substance known as Apoliprotein, Dietary cholesterol does not appear to have a significant effect on blood cholesterol and thus recommendations about its consumption may not be needed. Type A behaviour is associated with competitive drive, restlessness,hostility & a sense of impatience. Added in 1981 as an independent risk factor after a majority of research into the field discovered that TABP's were twice as likely to exhibit CAD as any other personality type (very controversial due to tobacco industry funding of these researches). Hemostatic factors: High levels of fibrinogen and coagulation factor VII are associated with an increased risk of CAD. Factor VII levels are higher in individuals with a high intake of dietary fat. Decreased fibrinolytic activity has been reported in patients with coronary atherosclerosis. **(*Keeley 1998)***

2-3-3 Ischemia:

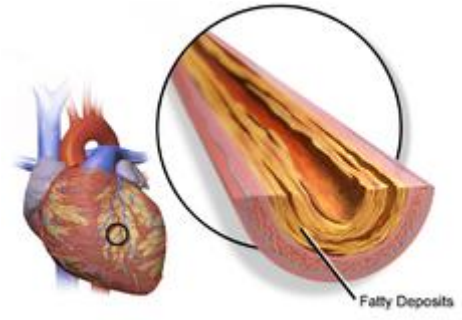
When the heart has inadequate blood supply (ie, ischemia), pressure may be felt in the chest that moves to the left arm; one may feel weak, sweaty, or short of breath or nauseated; palpitations (ie, change in heart rhythm) may occur; or there may be a sensation of pressure or tightness just in the chest, neck, or arms. Many patients mistake the heart warning symptoms for heartburn or gas. If symptoms occur that may represent inadequate blood supply to the heart, one should rest immediately and take nitroglycerin, if available. If symptoms last more than 5 minutes, occur at rest, or keep coming back, one should call 911, chew a full-sized aspirin (325 mg) if not allergic, and continue taking nitroglycerin every 5 minutes as long as it does not cause dizziness or light-headedness **(*Keeley 1998)***.

For excellent patient education resources, see Cholesterol Center. Also, visit patient education articles Chest Pain, Coronary Heart Disease, and Heart Attack. The severity of CAD is defined several ways, including the following, Anatomically, by visualizing the blood vessel branches and any blockages to blood flow along the pathways, Functionally, by estimating blood delivery to tissue supplied by each branch vessel

Clinically, by determining what symptoms correspond to inadequate blood delivery, what level of activity causes them, what relieves them, and the pattern of occurrences. Such patterns are described as unstable if the pattern includes variable or accelerating frequency, variable or increasing severity or changing character of symptoms, or variable or decreasing exercise threshold or if symptoms continue or recur just after a heart attack. In addition, one examines the consequences, including the location and extent of reversible and of permanent impairment, motion and thickening of affected segments of the heart, and whether the damage is causing or sustaining life-threatening arrhythmias (***Machleder 2007)***.

One also evaluates the patient's overall cardiac performance, which is typically expressed as the ejection fraction (EF), or percentage of the contents the left ventricle pumps forward in a heartbeat, and exertion tolerance, graded 1-4 (1=normal, 4=bedridden), ST-segment deviation on electrocardiogram at presentation greater than 0.5 mm, At least 2 anginal events in prior 24 hours, Use of aspirin in prior 7 days, Elevated serum cardiac markers.(***Machleder 2007)***

Coronary artery disease



Figure(2-6) Illustration depicting atherosclerosis in a coronary artery.

Classification and external resources (*Welton 2005)*

2-3-4 Pathophysiology:

Micrograph of a coronary artery with the most common form of coronary artery disease (atherosclerosis) and marked luminal narrowing. Masson's trichrome. Limitation of blood flow to the heart causes ischemia (cell starvation secondary to a lack of oxygen) of the myocardial cells. Myocardial cells may die from lack of oxygen and this is called a myocardial infarction (commonly called a heart attack). It leads to heart muscle damage, heart muscle death and later myocardial scarring without heart muscle regrowth. Chronic high-grade stenosis of the coronary arteries can induce transient ischemia which leads to the induction of a ventricular arrhythmia, which may terminate into ventricular fibrillation leading to death. Typically, coronary artery disease occurs when part of the smooth, elastic lining inside a coronary artery (the arteries that supply blood to the heart muscle) develops atherosclerosis. With atherosclerosis, the artery's lining becomes hardened, stiffened, and swollen with all sorts of "gunge" - including calcium deposits, fatty deposits, and abnormal inflammatory cells - to form a plaque. Deposits of calcium phosphates (hydroxyapatites) in the muscular layer of the blood vessels appear to play not only a significant role in stiffening arteries but also for the induction of an early phase of coronary arteriosclerosis. This can be seen in a so-called metastatic mechanism of calciphylaxis as it occurs in chronic kidney disease and haemodialysis **(Rainer 2008).**

Although these patients suffer from a kidney dysfunction, almost fifty percent of them die due to coronary artery disease. Plaques can be thought of as large "pimples" that protrude into the channel of an artery, causing a partial obstruction to blood flow. Patients with coronary artery disease might have just one or two plaques, or might have dozens distributed throughout their coronary arteries. However, there is a term in medicine called cardiac syndrome X, which describes

chest pain (Angina pectoris) and chest discomfort in people who do not show signs of blockages in the larger coronary arteries of their hearts when an angiogram (coronary angiogram) is being performed. No one knows exactly what causes cardiac syndrome X. One explanation is microvascular dysfunction. It is not completely clear why women are more likely than men to have it; however, hormones and other risk factors unique to women may play a role **(Rainer 2008).**

2-3-5 Assessment of tissue viability:

The amount of impairment or damage caused by stenosis obstructing a coronary artery depends on how much of the myocardium the vessel supplies, the severity of the stenosis and any superimposed spasm, the level of demand in the tissue it supplies, and the condition of the tissue it supplies. When demand exceeds supply, the tissue becomes ischemic, which means blood supply is insufficient to maintain normal metabolism. Myocardial ischemia may cause chest pain, fatigue, shortness of breath, or another form of reduced exertion tolerance.

Ischemia may have no symptoms but may be detected as impaired blood delivery, impaired contractile function (wall motion or wall-thickening abnormality on dynamic cardiac imaging series), or interference with the movement of ions (resulting in depolarization and repolarization abnormalities on EKGs as ST-segment shifts, changes in ST and T waves, and/or rhythm abnormalities); and/or it may be detected when a blood test shows a release of enzymes (creatine kinase-MB [CK-MB], troponin-I, troponin-T) from the heart muscle. Ischemia may deplete high-energy phosphate carriers (eg, creatine, adenosine) that are needed for muscle contraction. Depletion may occur to the point that impaired motion may persist even when ischemia is relieved. Transiently impaired contractile function of

muscle that persists after the relief from ischemia is called stun, and long-term dysfunction of viable muscle is called hibernation (Rainer 2008).

Dead tissue converted to scar likewise loses contractile function. Therefore, a key issue when a region of heart wall shows loss of function is the determination of whether the myocardium is still viable. Persistent wall-motion abnormality at rest shown by imaging (echocardiography, MRI, CT, x-ray angiography) can raise the issue of tissue viability and, in particular, whether repairing a blockage in the blood supply is likely to be beneficial. If a region is thin and akinetic (no motion), it is more likely to scar (dead myocardium) than if it is not. However, when in doubt, viability tests are appropriate. For example, viability can be identified by performing phosphorus-31 MRI and by reporting for each region the relative concentrations of creatine phosphate; inorganic phosphate; and adenosine monophosphate, diphosphate, and triphosphate **(Rainer 2008).** .

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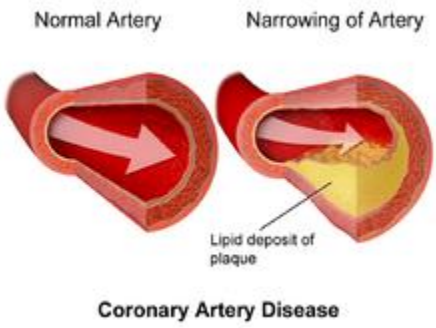

Figure **(2-7)** Illustration depicting coronary artery disease (Rainer 2008).

2-4 Diagnosis:

2-**4-1Coronary angiogram**: Coronary angiography shows where vessels originate, how they branch, whether they have obstructions or dissections or thrombi, the degree of any obstructions, and which territories they supply. See the x-ray angiograph below. X-ray angiography is the criterion standard for delineating the coronary anatomy, but it is inferior to MRI and CT in identifying myocardium with impaired blood delivery, in assessing the functional consequences, and in identifying the development of microvascular collaterals. For symptomatic patients, stress echocardiography can be used to make a diagnosis for obstructive coronary artery disease. The use of echocardiography is not recommended on individuals who are exhibiting no symptoms and are otherwise at low risk for developing coronary disease. CAD has always been a tough disease to diagnose without the use of invasive or stressful activities. The development of the Multifunction Cardiogram (MCG) has changed the way CAD is diagnosed. The MCG consists of a 2 lead resting EKG signal is transformed into a mathematical model and compared against tens of thousands of clinical trials to diagnose a patient with an objective severity score, as well as secondary and tertiary results about the patient's condition. The results from MCG tests have been validated in 8 clinical trials[which resulted in a database of over 50,000 patients where the system has demonstrated accuracy comparable to coronary angiography (90% overall sensitivity, 85% specificity). This level of accuracy comes from the application of advanced techniques in signal processing and systems analysis combined with a large scale clinical database which allows MCG to provide quantitative, evidence-based results to assist physicians in reaching a diagnosis. The MCG has also been awarded a Category III CPT code by the American Medical Association in the July 2009 CPT update The diagnosis of "Cardiac Syndrome X" - the rare coronary

artery disease that is more common in women, as mentioned, an "exclusion" diagnosis. Therefore, usually the same tests are used as in any patient with the suspicion of coronary artery disease, Baseline electrocardiography (ECG), Exercise ECG – Stress test, Exercise radioisotope test (nuclear stress test, myocardial scintigraphy), Echocardiography (including stress echocardiography), Coronary angiography, Intravascular ultrasound, Magnetic resonance imaging (MRI) (Rainer 2008).

X-ray angiography is considered the criterion standard for evaluating coronary artery stenosis. Flow limitations may be estimated by using the TIMI (Thrombolysis in Myocardial Infarction)score and confirmed by using a flow wire or by performing IVUS. If x-ray angiography fails to depict a culprit lesion and if cardiac ischemia is inducible, the patient may have syndrome X (microvascular disease) (Rainer 2008). .

X-ray angiography requires the use of iodine, which may cause serious allergic reactions, including anaphylaxis and also renal failure. Use of large volumes of saline and the antioxidant acetylcysteine may help prevent renal failure. The catheterization procedure can induce vessel spasm and/or tear the lining of a vessel, resulting in occlusion and, possibly, death in a patient who may not have had coronary artery disease (CAD). The procedure can also result in embolism, which may cause stroke or limb loss. Nerve damage, infection, and other complications are possible as well. The death rate is approximately .1%.

Nuclear imaging produces low-resolution images that may depict an apparent defect resulting from breast tissue, hiccups, paradoxical septal motion, or other confounding factors. Nuclear imaging may fail to depict disease because of submaximal stress. (Rainer 2008).

The diagnosis of coronary disease underlying particular symptoms depends largely on the nature of the symptoms. The first investigation is an electrocardiogram (ECG/EKG), both for "stable" angina and acute coronary syndrome. An X-ray of the chest and blood tests may be performed. In "stable" angina, chest pain with typical features occurring at predictable levels of exertion, various forms of cardiac stress tests may be used to induce both symptoms and detect changes by way of electrocardiography (using an ECG), echocardiography (using ultrasound of the heart) or scintigraphy (using uptake of radionuclide by the heart muscle). If part of the heart seems to receive an insufficient blood supply, coronary angiography may be used to identify stenosis of the coronary arteries and suitability for angioplasty or bypass surgery.

Diagnosis of acute coronary syndrome generally takes place in the emergency department, where ECGs may be performed sequentially to identify "evolving changes" (indicating ongoing damage to the heart muscle). Diagnosis is clear-cut if ECGs show elevation of the "ST segment", which in the context of severe typical chest pain is strongly indicative of an acute myocardial infarction (MI); this is termed a STEMI (ST-elevation MI), and is treated as an emergency with either urgent coronary angiography and percutaneous coronary intervention (angioplasty with or without stent insertion) or with thrombolysis ("clot buster" medication), whichever is available. In the absence of ST-segment elevation, heart damage is detected by cardiac markers (blood tests that identify heart muscle damage). If there is evidence of damage (infarction), the chest pain is attributed to a "non-ST elevation MI" (NSTEMI). If there is no evidence of damage, the term "unstable angina" is used. This process usually necessitates admission to hospital, and close observation on a coronary care unit for possible complications (such as cardiac arrhythmias – irregularities in the heart rate) (Rainer 2008)..

Depending on the risk assessment, stress testing or angiography may be used to identify and treat coronary artery disease in patients who have had an NSTEMI or unstable angina. There are various risk assessment systems for determining the risk of coronary artery disease, with various emphasis on different variables above. A notable example is Framingham Score, used in the Framingham Heart Study. It is mainly based on age, gender, diabetes, total cholesterol, HDL cholesterol, tobacco smoking and systolic blood pressure. Prevention involves, exercise, decreasing obesity, treating hypertension, a healthy diet, decreasing cholesterol levels, and stopping smoking. Medications and exercise are roughly equally effective. In diabetes mellitus, there is little evidence that very tight blood sugar control improves cardiac risk although improved sugar control appears to decrease other problems like kidney failure and blindness. The World Health Organization (WHO) recommends "low to moderate alcohol intake" to reduce risk of coronary artery disease although this remains without scientific cause and effect proof. A diet high in fruits and vegetables decreases the risk of cardiovascular disease and death. Vegetarians have a lower risk of heart disease, possibly due to their greater consumption of fruits and vegetables Evidence also suggests that the Mediterranean diet and a high fiber diet lower the risk (Rainer 2008). .

The consumption of trans fat (commonly found in hydrogenated products such as margarine) has been shown to cause a precursor to atherosclerosis and increase the risk of coronary artery disease. Evidence does not support a beneficial role for omega-3 fatty acid supplementation in preventing cardiovascular disease (including myocardial infarction and sudden cardiac death). There is tentative evidence that menaquinone (Vitamin K_2), but not phylloquinone (Vitamin K_1), intake may reduce the risk of CAD mortality Secondary prevention is preventing further sequelae of already established disease. Lifestyle changes that have been

shown to be effective to this goal include, Weight control, Smoking cessation, Avoiding the consumption of trans fats (in partially hydrogenated oils)

Exercise. In people with coronary artery disease, aerobic exercise, like walking, jogging, or swimming, can reduce the risk of mortality. Aerobic exercise can help decrease blood pressure and the amount of blood cholesterol (LDL) over time. It also increases HDL cholesterol which is considered as "good cholesterol". Separate to the question of the benefits of exercise; it is unclear whether doctors should spend time counseling patients to exercise. The U.S. Preventive Services Task Force, found "insufficient evidence" to recommend that doctors counsel patients on exercise, but "it did not review the evidence for the effectiveness of physical activity to reduce chronic disease, morbidity and mortality", it only examined the effectiveness of the counseling itself. The American Heart Association, based on a non-systematic review, recommends that doctors counsel patients on exercise.

Selective injection image of the left coronary arteries. D1 = first diagonal, LAD = left anterior descending artery, LCX = left circumflex, LM = left main coronary artery, and OM1= first obtuse marginal. Contrast-labeled blood to the heart is used to identify the territory at risk. The results of this assessment of the delayed arrival compares favorably to the findings of radionuclide stress imaging, and stress induction of ischemia is not required to identify the zone at risk. Compared with radionuclide images of blood delivery, MRIs and CT scans improve resolution, depiction of the functional effect and the relationship to the coronary supply, and identification of the area at risk without stress. The advantage of radionuclide imaging is primarily its predictive value; stress echocardiography has similar predictive value. MRI and CT have been less available than other studies; therefore, data on their value are relatively limited.

Lesions that cause blockages in the coronary arteries may be stable or unstable. Unstable lesions activate blood clotting and/or vascular spasm. Indications that CAD may be unstable include recent onset or familiar symptoms that are increasing in frequency, in duration, or in severity or with decreasing exertion tolerance or at rest. The term "chest pain" is a code phrase — the symptoms of CAD do not have to be in the chest and do not have to include pain. I prefer the phrase "heart warning" symptoms. When a warning light is activated, you should resolve the problem quickly even if it is low in intensity.

Unstable symptoms of CAD may represent a threatened heart attack. After as little as 5 minutes, a wall of the heart may stop functioning but still be salvageable — that is called stun. After as little as 10-20 minutes permanent damage may accumulate, summarized by the phrase "time is muscle." If the symptoms are new or if they are familiar but unstable or are not reliably fully resolved in 5 minutes, emergency help is recommended because "time is muscle." Intervention completed within 60 minutes improves outcome. The symptoms of a threatened heart attack may be very mild ***(Tunick 1994)*** .

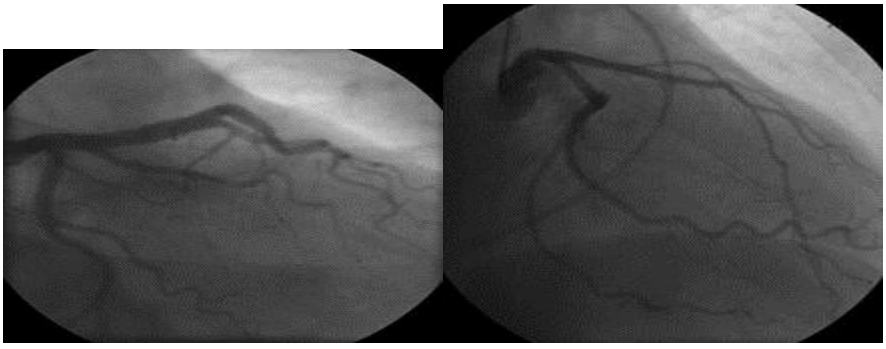

Figure (2-8) shows Coronary angiogram of a man (Rainer 2008).

2-4-2 MRI

At present, achieving the best resolution on images of the coronary arteries requires catheterization, injection of an iodinated contrast agent, and use of a radiographic technique. As an alternative, multidetector-row CT (MDCT) or MRI may be used to clarify coronary anatomy and to determine whether a vessel is occluded. Stress imaging has a complementary role in depicting zones with inducible ischemia (blood supply inadequate for the demands of the tissue). Stress may be produced with exercise, an infusion of a medication that increases the strength of cardiac contractions (eg, dobutamine), or an infusion of a medication (eg, adenosine, dipyridamole) that dilates the vessels and thereby reduces the delivery of blood to diseased branches. More than a decade ago, MRI was shown to be capable of imaging the coronary arteries and demonstrating stenoses without catheterization or injection of contrast material. MDCT is now proving to be a fast and useful alternative for defining the coronary anatomy. MRI takes more time than MDCT and generally provides less detail of the coronary anatomy, but it avoids ionizing radiation and the use of iodinated contrast agent ***(Tunick1994)*** .

2-4-3 Computed Tomography (CT):

CT imaging of the coronary arteries is achievable with fast CT and EBT systems triggered or gated by ECG to accumulate data when the heart is in diastole. 64-section multidetector-row CT is the newest technology.

With a section thickness of 1 or 0.5 mm or less, the coronary anatomy is laid out in a 3D volume. Image processing can greatly facilitate visualization of the course of vessels and branches and the presence and degree of stenoses. The coronary-artery tree may be viewed as a solid rendering of the surface of the heart, but portions may be obstructed from view. Proper viewing of each coronary-artery branch

should include clean views in which the LV blood pool, aortic root, and all extracardiac structures are removed, and vascular projections are limited to the zones that include the vessel of interest and a margin for partial-volume effects..

CT also enables superb evaluation of blood delivery. In principle, CT combined with catheterization permits accurate definition of the extent of collateral-dependent myocardium. Multidetector-row CT angiography (CTA) has shown potential as an alternative to x-ray angiography for the identification of coronary blockages. In a study of 15,207 intermediate likelihood patients without known CAD, the severity of CAD on coronary CTA was predictive of the need for invasive coronary artery catheterization or revascularization. This suggests that coronary CTA may be an effective gatekeeper for invasive catheterization (***Tunick 1994)***.

2-4-4Nuclear Medicine:.

Nuclear medicine study does not depict the coronary arteries, but it does demonstrate various metabolites useful in identifying perfusion defects and tissue viability. Thallium-201 and technetium-99m sestamibi are widely used and may be combined to shorten the study of myocardial uptake of radioactive tracer at rest and during stress.Although a rest-and-stress thallium study takes more than 4 hours, a combined study performed with thallium and sestamibi may be completed in less than 2 hours***. (Agarwal R 1993)*** .

Stress nuclear imaging is widely used to assess the patient's exercise tolerance and to identify zones of inducible ischemia (jeopardized myocardium), which is useful information, even after x-ray angiography is performed. PET offers similar rest-stress data and is superior for identifying viable myocardium. Jeopardy and viability are important issues, because if the myocardium is not at risk or if it is not

viable, revascularization (bypass or angioplasty) will not help that part of the heart. Echocardiography to identify wall motion abnormalities has a similar predictive accuracy in patients with intermediate suspicion of CAD, estimated at 80-90%. Echocardiography avoids radiation exposure, which may cause as much as 1 new cancer for every thousand patients studied, but radionuclide imaging (thallium, sestamibi) is preferred if the patient already has old wall motion abnormalities or has poor echo windows (lung blocks the views). Exercise stress echo may be performed before and after treadmill exercise or during exercise on a supine bicycle. The latter requires more cooperation but allows imaging at every stage, so it may avoid false negatives from rapid recovery or from involvement of all areas (balanced ischemia) ***(Tunick 1994)*** .

2-4-5 Imaging guidance of interventional procedures:

X-ray angiography is widely used to guide interventions, such as balloon angioplasty, atherectomy, laser treatment, stent placement, and other procedures. Current practice indicates the use of x-ray angiography in patients with potentially treatable lesions to confirm the findings and to perform interventions. Both tasks may be accomplished in a single procedure. Cardiac catheterization is recommended for patients with mild angina (class I or II) plus an EF of less than 45%, including patients with noninvasive test results indicating a high risk, those with an uncertain diagnosis after noninvasive testing, patients with serious ventricular arrhythmias, and those who survive an episode of sudden death. The only indication with submaximal support is mild angina with reduced EF; this is a class all recommendation. The classification of indications by the American College of Cardiology indicates the weight of evidence in support of the recommendation. Mild angina with no reduction in EF might be managed with medication as a therapeutic trial.

As an experiment, MRI, CT, or echocardiography may be used to guide interventional procedures. MRI does not involve ionizing radiation; therefore, imaging may be active throughout the procedure. However, special guide wires and other equipment compatible with the magnet and the rapidly changing magnetic field must be used, and staff must be trained to ensure that no magnetic objects are brought near the magnet.

CT uses ionizing radiation and is slower than x-ray angiography, but it provides 3D information that may facilitate localization, especially for newer interventions such as the intramyocardial injection of angiogenic growth factors or stem cells. 3D ultrasonography similarly facilitates accurate injections, with convenience of portability and without a need for lead shielding from x-rays ***(Schrader R 1999)*** . .

The flow of contrast agent–labeled blood offers useful information. TIMI criteria may be applied to determine whether the distribution of contrast material is TIMI 0 (incomplete, fails to fill branches and distal part of the vessel), TIMI 1 (slow but complete), or TIMI 2 (brisk and complete). When imaging is performed at a rate of 30 frames per second, the number of frames it takes for a vessel to completely fill may be assessed. The normal number is approximately 21 frames. Filling takes longer in patients with disease than in healthy people, not only in the diseased vessel but also in normal vessels***(Schrader R 1999)*** .

2-4-5 Ultrasonography

Echocardiography can be used to identify the left main coronary artery. In some patients, much of the RCA and LAD can be viewed; however, in most patients, the imaging window is inadequate for useful coronary imaging from outside the chest. coronary arteries, combined with transthoracic or esophageal ultrasonography, can be useful in identifying perfusion territories.

Pizzuto et al found that transthoracic Doppler echocardiography can improve the diagnostic accuracy of multidetector computed tomography (MDCT) for detecting left anterior descending (LAD) coronary artery stenosis. In 144 consecutive patients, coronary anatomy was assessed with MDCT, and echocardiography was used to calculate coronary flow reserve (CFR), by measuring the ratio of hyperemic to baseline peak flow velocity; results of both methods were verified with invasive coronary angiography.

In a univariate model, the prediction of significant LAD stenosis was slightly, but significantly, better with coronary flow reserve (sensitivity 90%, specificity 96%, positive predictive value 84%, negative predictive value 97%, diagnostic accuracy 94%) than with MDCT (sensitivity 80%, specificity 93%, positive predictive value 71%, negative predictive value 95%, diagnostic accuracy 90%). When the findings from transthoracic Doppler echocardiography and MDCT agreed, the diagnostic accuracy increased (96%). In the 13 patients missed by MDCT, transthoracic Doppler echocardiography proved 100% accurate at predicting significant LAD stenosis ***(Agarwal R 1994)***. .

2-4-6 Who cardiac catheterization work:

The team responsible for your care will usually include a cardiologist (heart specialist), nurse, cardiac technician and a radiographer (a specialist in using imaging technology).The procedure will usually be carried out in an X-ray room or a catheterization laboratory. Before the procedure is carried out, you should tell your cardiologist if you have any allergies and if you are taking any medication, either for a heart problem or another medical condition. You will be told whether to continue taking your medication or if you need to stop. You should not stop taking prescribed medication unless you are advised to do so, You

may also be asked not to eat or drink anything for a few hours before the procedure.

The procedure will be carried out under local anesthetic, so you will be awake while the procedure is carried out, but the area where the catheter is inserted (either the groin or arm) will be numbed.You may also be given the option of having a sedative to make you feel sleepy and relaxed while remaining awake and being aware enough to respond to instructions, such as being asked to take a deep breath and hold it at certain points during the procedure.

General anesthetic is sometimes used when young children need to have the procedure because they may find it too difficult to stay still while it is being carried out. You will be attached to an electrocardiogram (ECG) machine throughout the procedure. An ECG records your heart's rhythms and electrical activity. A number of electrodes (small metallic discs) are placed on your arms, legs and chest. The electrodes are connected to a machine that records the electrical signals of each heartbeat.

Provided that you do not need to have a further procedure such as balloon angioplasty, cardiac catheterisation and coronary angiography should take about half an hour. Below is a step-by-step guide to what you can expect during the procedure. The healthcare professionals who are with you will explain what is happening.After entering the catheterisation laboratory, you will be asked to lie on a special table. If the catheter is being inserted into your groin, your groin may be shaved and cleansed with antiseptic fluid. You will be covered with a sterile sheet and given an injection of local anaesthetic to numb the skin of your groin or arm, so the procedure should not be painful. A small cut (incision) will be made in your groin or arm and a fine tube called a sheath will be inserted to hold the blood

vessel open. The catheter will be moved through your blood vessels and into your heart using X-ray guidance. A small amount of dye called contrast medium will be injected through the catheter and the pressure in your heart will be easured. As the dye is injected, you may feel a hot flushing sensation that passes quickly. You may also experience a warm sensation in your groin that feels as if you have wet yourself, or you may have a metallic taste in your mouth. This is nothing to worry about and you will be warned when to expect it. You will not feel the catheter being guided through your blood vessels. However, you may be aware of the odd missed or extra heartbeat.

A series of X-ray images will be taken of your heart and the blood vessels around it. These are called angiograms and will be stored on a computer. In certain circumstances – for example, if your arteries are blocked – your cardiologist may decide to carry out a balloon angioplasty (an interventional procedure to widen blocked arteries). This will be carried out immediately and will add about an extra hour to the procedure. This usually should have been discussed with you beforehand, unless it is required as an emergency procedure. The catheter and sheath will be removed once the procedure is complete.

If the catheter was inserted into your groin, the nurse or cardiologist may apply pressure to the entry site for about 10 minutes to stop any bleeding. Alternatively, a number of different plugs or clips may be used to seal or close up the wound. If the catheter was inserted through your arm, a tight dressing will be applied for around two to three hours.

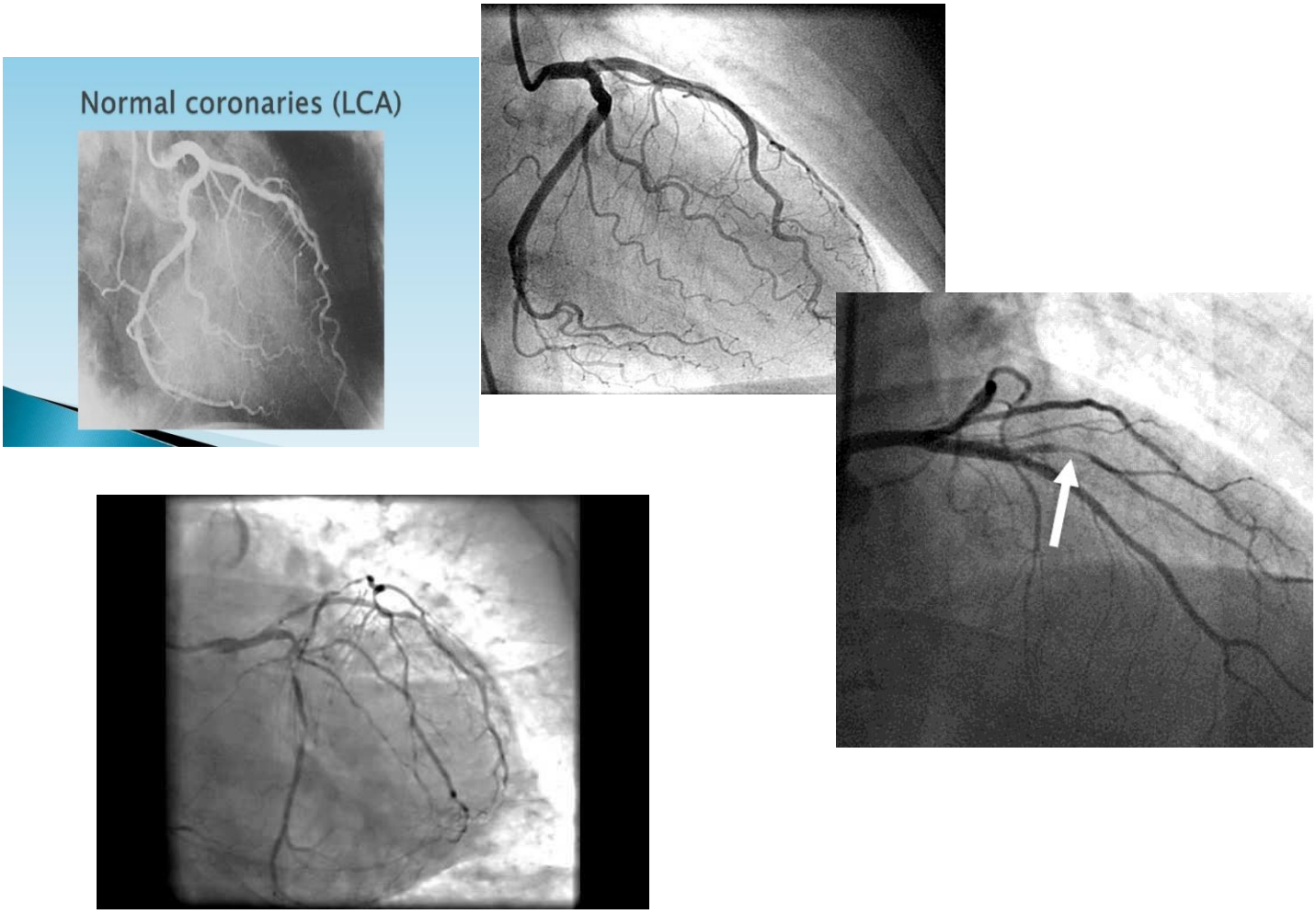

Figure (2-9) Illustration of coronary angiography

2:2 previous study concerning the problem of study:

Claude Bernard in the 1840s with multiple groups working independently on similar technologies. Invasive and interventional cardiology is currently closely associated with cardiologists (physicians who treat the diseases of the heart), though the development and most of its early research and procedures were performed by diagnostic and interventional radiologists.

The history of invasive cardiology begins with the development of cardiac catheterization in 1711, when Stephen Hales placed catheters into and left ventricles of a living horse. Variations on the technique were performed over the subsequent century, with formal study of cardiac physiology being performed by. The technique of angiography itself was first developed in 1927 by the Portuguese physician Egas Moniz at the University of Lisbon for cerebral angiography, the viewing of brain vasculature by X-ray radiation with the aid of a contrast medium introduced by catheter.

Werner Forssmann, in 1999, created an incision in one of his left antecubital veins and inserted a catheter into his venous system. He then guided the catheter by fluoroscopy into his right atrium. Subsequently he walked up a flight of stairs to the radiology department and documented the procedure by having a chest roentgenogram performed. Over the next year, catheters were placed in a similar manner into the right ventricle, and measurements of pressure and cardiac output (using the Fick principle) were performed.

In **the early 1940s, André Cournand**, in collaboration with Dickinson Richards, performed more systematic measurements of the hemodynamics of the heart. For their work in the discovery of cardiac catheterization and hemodynamic

measurements, Cournand, Forssmann, and Richards shared the Nobel Prize in Physiology or Medicine in 1956.

In 1958, Interventional Radiologist, Dr. Charles Dotter began working on methods to visualize the coronary anatomy via sequential radiographic films. He invented a method known as occlusive aortography in an animal model. Occlusive aortography involved the transient occlusion of the aorta and subsequent injection of a small amount of radiographic contrast agent into the aortic root and subsequent serial x-rays to visualize the coronary arteries. This method produced impressive images of the coronary anatomy. Dotter later reported that all the animals used in the procedure survived

Later that same year, while performing an aortic root aortography, Mason Sones, a pediatric cardiologist at the Cleveland Clinic, noted that the catheter had accidentally entered the patient's right coronary artery. Before the catheter could be removed, 30cc of contrast agent had been injected. While the patient went into ventricular fibrillation, the dangerous arrhythmia was terminated by Dr. Sones promptly performing a precordial thump which restored sinus rhythm. This became the world's first selective coronary arteriogram. Until that time, it was believed that even a small amount of contrast agent within a coronary artery would be fatal.

Until the 1950s, placing a catheter into either the arterial or venous system involved a "cut down" procedure, in which the soft tissues were dissected out of the way until the artery or vein was directly visualized and subsequently punctured by a catheter; this was known as the Sones technique. The percutaneous approach that is widely used today was developed by radiologist Sven-Ivar Seldinger in 1953. This method was used initially for the visualization of the peripheral arteries. Percutaneous access of the artery or vein is still commonly known as the Seldinger

technique. The use of the Seldinger technique for visualizing the coronary arteries was described by Ricketts and Abrams in 1962 and Judkins in 1967.

By the late 1960s, Melvin Judkins had begun work on creating catheters that were specially shaped to reach the coronary arteries to perform selective coronary angiography. His initial work involved shaping stiff wires and comparing those shapes to radiographs of the ascending aorta to determine if the shape appeared promising. Then he would place the stiff wire inside a flexible catheter and use a heat-fixation method to permanently shape the catheter. In the first use of these catheters in humans, each catheter was specifically shaped to match the size and shape of the aorta of the subject. His work was documented in 1967, and by 1968 the Judkins catheters were manufactured in a limited number of fixed tip shapes. Catheters in these shapes carry his name and are still used to this day for selective coronary angiography.

The use of a balloon-tipped catheter for the treatment of atherosclerotic vascular disease was first described in 1964 by two interventional radiologists, Charles Dotter and Melvin Judkins, when they used it to treat a case of atherosclerotic disease in the superficial femoral artery of the left leg. Building on their work and his own research involving balloon-tipped catheters, Andreas Gruentzig performed the first success percutaneous transluminal coronary angioplasty (known as PTCA or percutaneous coronary intervention (PCI)) on a human on September 16, 1977 at University Hospital, Zurich. The results of the procedure were presented at the American Heart Association meeting two months later to a stunned audience of cardiologists. In the subsequent three years, Dr. Gruentzig performed coronary angioplasties in 169 patients in Zurich, while teaching the practice of coronary angioplasty to a field of budding interventional cardiologists. It is interesting to note that ten years later, nearly 90 percent of these individuals were still alive. By

the mid 1980s, over 300,000 PTCAs were being performed on a yearly basis, equalling the number of bypass surgeries being performed for coronary artery disease.

Soon after Andreas Gruentzig began performing percutaneous interventions on individuals with stable coronary artery disease, multiple groups described the use of catheter-delivered streptokinase for the treatment of acute myocardial infarction (heart attack).

In the early years of coronary angioplasty, there were a number of serious complications. Abrupt vessel closure after balloon angioplasty occurred in approximately 1% of cases, often necessitating emergency bypass surgery. Vessel dissection was a frequent issue as a result of improper sizing of the balloon relative to the arterial diameter. Late restenosis occurred in as many as 30% of individuals who underwent PTCA, often causing recurrence of symptoms necessitating repeat procedures.

From the time of the initial percutaneous balloon angioplasty, it was theorized that devices could be placed inside the arteries as scaffolds to keep them open after a successful balloon angioplasty This did not become a reality in the cardiac realm until the first intracoronary stents were successfully deployed in coronary arteries in 1986 The first stents used were self-expanding Wallstents. The use of intracoronary stents was quickly identified as a method to treat some complications due to PTCA, and their use can decrease the incidence of emergency bypass surgery for acute complications post balloon angioplasty.

It was quickly realized that restenosis rates were significantly lower in individuals who received an intracoronary stent when compared to those who underwent just balloon angioplasty. Stent technology improved rapidly, and in 1989 the Palmaz-

Through the 1990s and beyond, various incremental improvements were made in balloon and stent technology, as well as newer devices, some of which are still in use today while many more have fallen into disuse. As important as balloon and stent technology had been, it was becoming obvious that the anticoagulation and anti-platelet regimen that individuals received post-intervention was at least as important. Trials in sthe late 1990s revealed that anticoagulation with warfarin was not required post balloon angioplasty or stent implantation, while intense anti-platelet regimens and changes in procedural technique (most importantly, making sure that the stent was well opposed to the walls of the coronary artery) improved short term and long term outcomes Many different antiplatelet regimens were evaluated in the 1990s and the turn of the 21st century, with the optimal regimen in an individual patient still being up for debate.The drug eluting stent era

With the high use of intracoronary stents during PCI procedures, the focus of treatment changed from procedural success to prevention of recurrence of disease in the treated area (in-stent restenosis). By the late 1990s it was generally acknowledged among cardiologists that the incidence of in-stent restenosis was between 15 and 30%, and possibly higher in certain subgroups of individuals. Stent manufacturers experimented with (and continue to experiment with) a number of chemical agents to prevent the neointimal hyperplasia that is the cause of in-stent restenosis.

) at six months. This led to the approval for the stent to be used in Europe in April 2002. Further trials with the Cypher stent revealed that restenosis did occur in some individuals with high risk features (such as long areas of stenosis or a history of diabetes mellitus), but that the restenosis rate was significantly lower than with bare metal stents (3.2 percent compared to 35.4 percent). About a year after approval in Europe, the United States FDA approved the use of the Cypher stent as

the first drug-eluting stent for use in the general population in the United StatesWith the significantly lower restenosis rates of drug eluting stents compared to bare metal stents, the interventional cardiology community began using these stents as soon as they became available. Cordis, the manufacturer of the Cypher drug eluting stent, was not able to keep up with the demand for these stents when they first entered the market. This fueled a rationing of Cypher stents; they were used on difficult anatomy and high risk individuals. At the time there was a fear by the general population that these drug eluting stents would not be used on individuals who could not afford them (as they cost significantly more than the bare metal stents of the era).

Concurrent with the development of the Cypher stent, Boston Scientific started development of the Taxus stent. The Taxus stent was the Express2 metal stent, which was in general use for a number of years, with a copolymer coating of paclitaxel that inhibited cell replication. As with the Cypher stent before it, the first trials of the Taxus stent revealed no evidence of in-stent restenosis at six months after the procedure, while later studies showed some restenosis, at a rate much lower than the bare metal counterpart. Based on these trials, the Taxus stent was approved for use in Europe in 2003.With further study, the FDA approved the use of the Taxus stent in the United States in March 2004.

By the end of 2004, drug-eluting stents were used in nearly 80 percent of all percutaneous coronary interventions.

Chapter three

Materials and Methods

3-1 Materials :

3-1-1 69 Patients, 66 male and 3female age (22-83), and the main affected aged between (40-59 years).

3-1-2 Machine used:

*

Figure (3-1) shows Philips : Philips Allura Xper FD20 system specifications

1.1 Gantry Rock stable gantry design with fast and easy table side controlled operation, with full flexibility in applications by free positioning of the gantry, monitor suspension and operating modules.

1.2 3-2 Method

3-2-1 Technique:

Cardiac catheterization is done in a special operating room that has special X-ray and imaging machines that normal operating rooms don't have.

Cardiac catheterization is usually performed while you're awake, but sedated. An IV line will be inserted in your hand or arm, and will be used to give you any additional medications you might need during your procedure. You will also have monitors (electrodes) placed on your chest to check your heartbeat during the test.

Just before the procedure, a nurse or technician may shave the hair from the site where the catheter will be inserted. Before the catheter is inserted in your artery, you'll be given a shot of an anesthetic to numb the area. You may feel a quick, stinging pain before the numbness sets in.

3-2-1-1 Preparations : Cardiac catheterization is usually performed in the hospital. The test requires some preparations. To prepare for your test:

Don't eat or drink anything for at least 6 hours before your test, or as directed by your doctor. Having food or drink in your stomach can increase your risk of complications from anesthesia. Ask your doctor or nurse if you should take your medications with a small amount of water. If you have diabetes, ask for instructions about diabetes medications and insulin. You will usually be able to have something to eat and drink soon after your test.

Take medications and supplements with test. It's take the original bottles so that doctor will know the exact dose take.

Try to relax. People who are having a cardiac catheterization may feel anxious or nervous. You'll be given medications to help you relax. It's possible that the test will reveal that you need a procedure such as angioplasty right away, or that you could have a side effect from the medication given to you during the catheterization. Being nervous may cause your heart to beat more quickly or irregularly and may complicate the procedure.

Repair of heart defects If doctor is closing a hole in your heart, such as an Atria Septal defect or patent foramen ovale, you will probably have catheters inserted in both the arteries and veins of the groin and neck. A device is then inserted into your heart to close the hole.

3-3 Image interpretations:

The image from computer transfer to the professional radiologist monitor to diagnosis, all radiograph diagnosis by qualified team

3-4 Statistical method done by using SPSS

Chapter Four

This chapter shows the result from 69 patients with tables and graphs

Table (4:1) shows the frequency of gender of the study:

Sex	Frequency	Percent %
Male	66	95.7
Female	3	4.3
Total	69	100.0

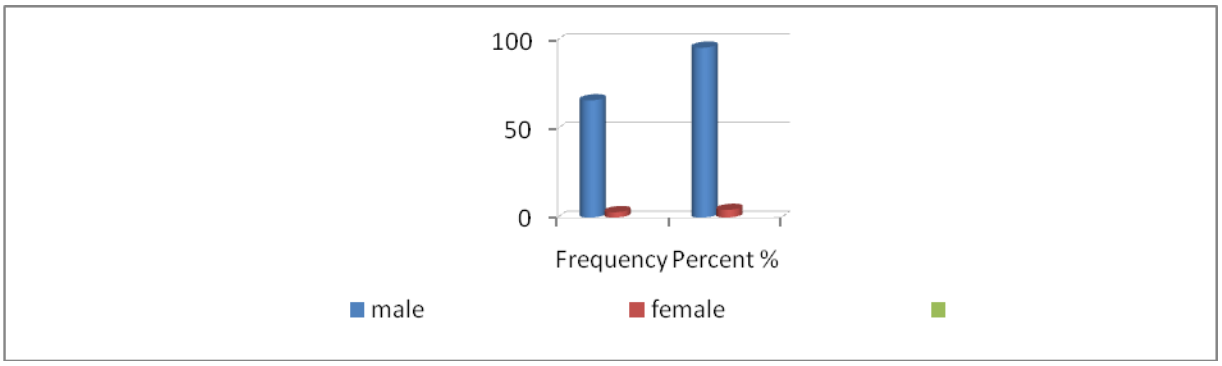

figure (4-1) shows the frequency and percentage of the sex of the patient undergoing the study.

Table (4-2) shows the Race of the study:

Race	Frequency	Percent%
Emirati	10	12.3
Arab	12	19.2
Asian	45	65.8
Other	02	2.7
Total	69	100.0

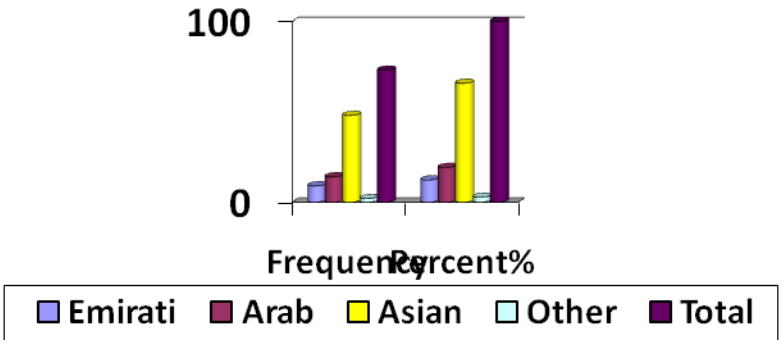

figure (4-2) shows the frequency and percentage of race of patient undergoing study.

Table (4-3) Admit source

Admit source	Frequency	Percent%
Emergency	50	80.7
transfer in from another acute care facility	10	12.3
Other	09	7.0
Total	69	100.0

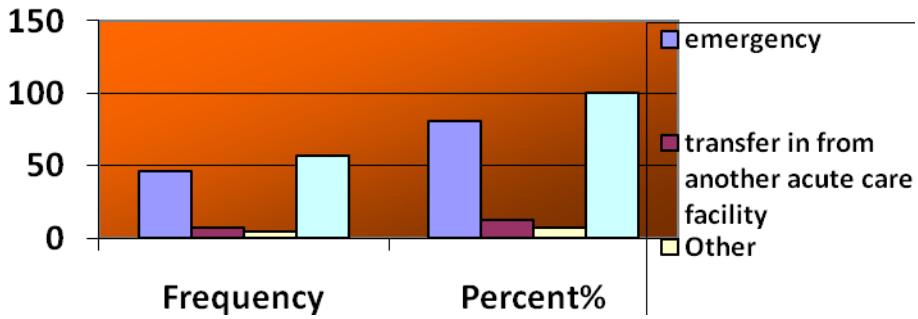

figure (4-3) shows the frequency and percentage of admitted source of patient undergoing study.

Table (4-4) History and risk factor (on arrival to catheter facility)

Family history of premature Coronary Artery Disease:

family history of premature coronary artery disease	Frequency	Percent%
No	65	94.3
Yes	04	5.7
Total	69	100.0

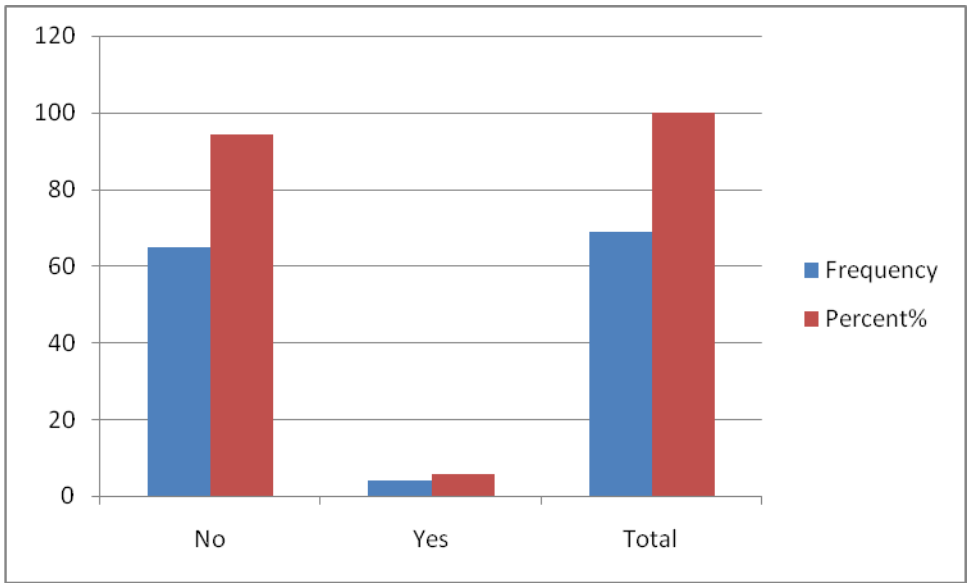

Figure (4-4) Family history of premature Coronary Artery Disease

Table (4-5) Hypertension

Hypertension	Frequency	Percent %
No	34	49.3
Yes	35	50.7
Total	69	100.0

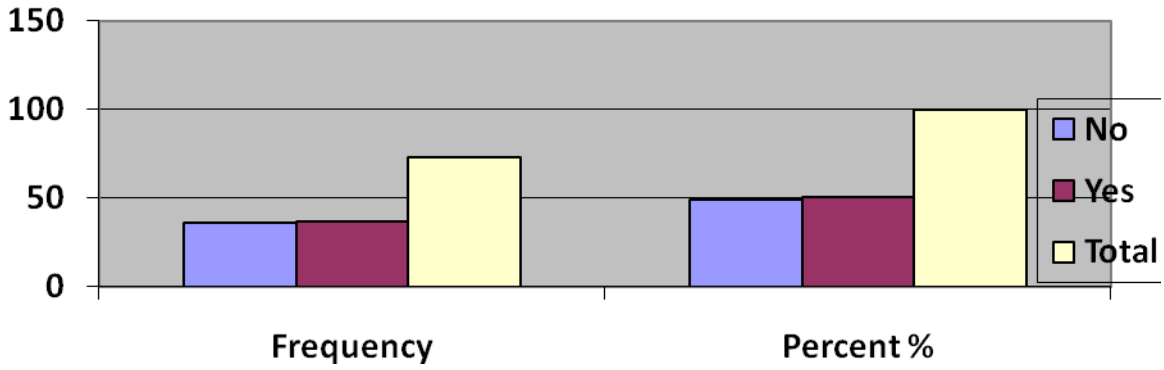

Figure (4-5) shows the frequency and percentage of the hypertension in patient undergoing the study.

Table (4-6)-Dominance Coronary Artery

DOMINANCE CORANARY ARTERY	Frequency	Percent%
Left	50	65.0
Right	12	23.7
Co – dominance	7	12.3
Total	69	100.0

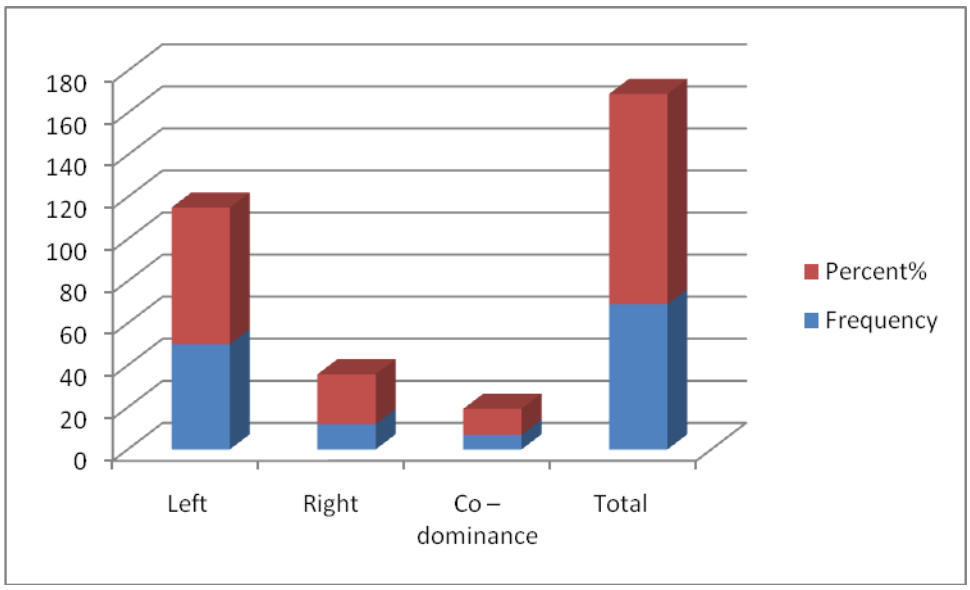

Figure (4-6) shows the frequency and percentage of the Dominance Coronary artery in patient undergoing the study

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Table (4-7) Percutaneous coronary intervention Procedure (complete for each catheterization lab in which a PCI was attempted or performed)

precutanous coronary intervention Procedure status	Frequency	Percent%
Elective	09	5.0
Urgent	18	24.8
Emergency	42	69.2
Total	69	100.0

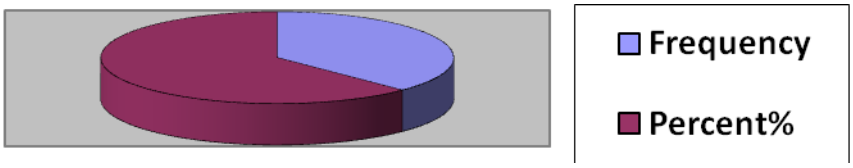

Figure (4-7) shows the frequency and percentage of the precutanous coronary intervention Procedure status in patient undergoing the study.

Table (4-8) Cardiogenic shock at start of precutanous coronary intervention

Cardiogenic shock at start of precutanous coronary intervention	Frequency	Percent%
No	56	98.0
Yes	11	2.0
Total	69	100.0

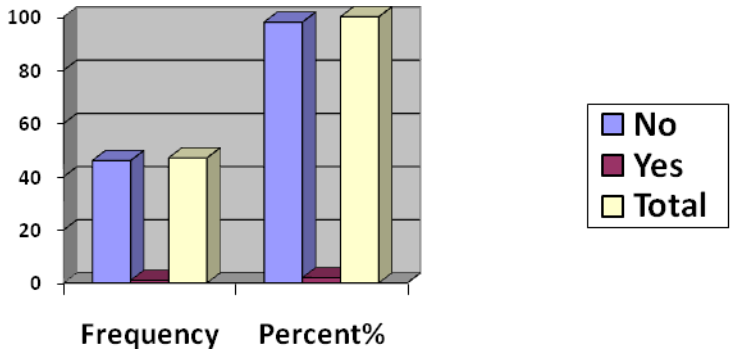

Figure (4-8) shows the frequency and percentage of the Cardiogenic shock at start of precutanous coronary intervention in patient undergoing the study.

Table (4-9) Percutaneous coronary intervention indication

precutanous coronary intervention indication	Frequency	Percent%
Immediate	34	65.6
precutanous coronary intervention for STEMI /> unstable 12hrs from Sx onset	13	7.2
precutanous coronary intervention for STEMI	13	7.2
precutanous coronary intervention for high risk Non-STEMI or unstable Angina	9	20.0
Total	69	100.0

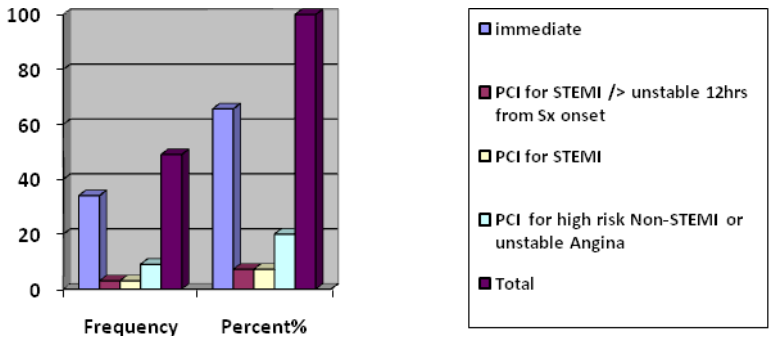

Figure (4-9) shows the frequency and percentage of the precutanous coronary intervention indication in patient undergoing the study

Chapter five

Discussions, conclusions and recommendations

5-1 Discussions:

Retrospectively this study carried out in 69 patient referred to Cardiac catheterizations in Elemarat teaching hospital department from March 2015 to July 2015 Their ages ranging between (22-83 years). Table (4-1), 66 patient are male percentage (95.7%) and 3 patients are female percentage (4.3%) table (4-2) Most of patients come in emergency hospital they are 48 patients percentage (69.6%), 9 patients transfer from acute care facility percentage (18.6%), and 12 patients from other hospital percentage (17.4%) table (4-3).

And these patients has different nationality 9 was Emart patients percentage 12.3% , 14 Arab percentage 19.2, 48 Asian percentage most of patient nationality are Asian patients table and figure (4-2)

.The aim of this study to explain the importance of cardiac catheterization in diagnose and treatment of cardiac diseases.

The main factor lead to cardiac abnormalities in this study was hypertensive history percentage (50.7. %) table (4-4). The study found that 50 patients percentage (65.0%) have left coronary artery disease and 12 patients percentage (23.7%) have right coronary artery defect, and 7 patients percentage (12.3%) have co-dominance, that main this study found that left coronary artery more affected than right one, table

This study found that most of patient was treated by using interventional radiology percentage (84.0%) This study agree with many studies, and the best study was (Melvin 2000)

5-2:Conclusions:

The study conclude that cardiac catheterizations is best imaging modalities in diagnosis and treatment of the coronary artery disease

This study shows that the left coronary artery is more affect than the right one, and the study found that the main factor lead to the coronary artery disease is hypertension.

3-5 Recommendations:

- **Further study with more sample**
- **Another study in Sudanese pt**
- **Using other imaging modalities to compare the results**
- **Cardiac catheterizations istremenrations must be in any emergency hospitals.**
- **All technsion must be awarded by cardiac catheterization tools**

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