بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of Graduate Studies

Measurement of Normal Diameter of Thoracic Aorta using Computed Tomography

قياس الشريان الأبهر الصدري للسودانيين بإستخدام الأشعة المقطعية المحوسبة

A Thesis Submitted for Partial Fulfillment for the Requirements

of M. Sc. Degree in Diagnostic Radiologic Technology

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2017

بسم الله الرحمن الرحيم

قوله تعالى:

﴿ألحمد لله الذى انزل على عبده الكتاب

ولم يجعل له عوجا﴾

صدق الله العظيم

سورة الكهف آية رقم (1)

Dedication

To my parents

To my family

To my friends

Acknowledgment

Firstly I thank Allah, the creator for offering me to do this work.

I would like to express my deep gratitude to my supervisor **prof Asma Ibrahim,** for her continuous helps precious advice and guidance upon this research .

I would also to appreciate the great help to all those who support me to complete this research.

my senior, Mohammed Alhag

my college, Mohammed Hassen

my brother, Ashraf Yousif

my colleges, at Alamal National Hospital

Abstract

This is a cross sectional descriptive study, deals with measurement of normal diameter of the thoracic aorta in Sudanese population. The study conducted at computed tomography departments of Alribat National hospital , Alamal National hospital diagnostic center and Doctor's spthalized hospital.

A 50 cases were selected randomly, The patients are not suffering from any pathological condition concerning the thoracic aorta.

This study used the tools of computed tomography to measure the normal diameter of the descending thoracic aorta.

The data designed to include the specific variables for the patients and were analyzed by SPSS program.

The mean Length of the thoracic Aorta was 14.71±2.67 cm, The Proximal width of Aorta was 2.51±0.56 cm, the middle width of Aorta was 2.08±0.41 cm, the distal width of Aorta was 2.11±0.45 cm.

The height and weight of the patient has showed no significant difference with the aorta diameter than the other variable (p-value is 0.000) respectively.

Also highly significant difference (P=0.001) was detected between age and distal width of aorta, but low significant difference (P=0.018) was obtained between the height of the patient and distal width of Aorta.

Also lower significant difference (P=0.015) was noticed between weight of the patient and distal width of Aorta.

the study concluded that computed tomography is play a great role in the measurement of normal diameter of descending of thoracic aorta.

مستخلص الدراسة

هدفت هذه الدارسة إلى قياس طول وعرض الشريان الأبهرالصدري لدى السودانيين باستخدام جهاز الاشعة المقطعية.

أجريت هذه الدارسة في مستشفيات الأمل الوطني، الرباط الجامعي والاطباء، في الفترة من أكتوبر الي ديسمبر 2016 م.

تم إجراء الدارسةعلى عدد 50عينة عشوائية طبيعية خضعت لفحص الأشعة المقطعية للصدر باستخدام جهاز أشعة مقطعية متعددة الطبقات.

تم تسجيل العمر، النوع، الوزن، الطول والحجم، وتم تسجيل طول الشريان الأبهر الصدري النازل وعرض الشريان في الجزء العلوي ، وكذالك عرض الشريان في الجزء المتوسط للشريان، والعرض في الجزء السفلي للشريان. أخذت القياسات في المعالم التشريحية الظاهرة.

تم جمع البيانات مع مراعاة المتغيرات(الوزن، الحجم، الطول، والنوع)، وتم تحليل المعلومات بإستخدام برنامج التحليل الاحصائي SSPS.

أوضح التحليل الاحصائي النتائج الآتية: طول الشريان الأبهرالصدري للعينة من السودانيين يبلغ 14,71±2,67 سم، كما أن متوسط عرض الشريان الأبهر الصدري 2,51±0,56 سم، وكذلك عرض الشريان الأبهر الصدري في منتصف الشريان 2,08±0,41 سم، ووجد أيضاً أن عرض الشريان الأبهر الصدر عند نهاية الشريان يبلغ 2,11±0,45 سم.

حيث اوضحت النتائج ان هنالك تاثير واضح للعمر علي عرض الشريان الابهر الصدري .

كما ان هنالك تاثير بسيط لطول ،الشخص وعرض الشريان الابهر الصدر ، كما ان هنالك تاثير بسيط جدا بين الوزن ،وعرض الشريان الابهر الصدري .

Contents

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Abbreviations

3D	3 dimensions
2D	2 dimensions
AV	Arterio ventricular.
CO	Cardiac output.
CT	Computed tomography.
MRI	Magnetic resonans imaging
FOV	Field of view.
KVP	Kilovolts peak
LVEF	Left ventricular ejection fraction.
MAS	Mille ampere second
Cm	Centemter
Mm	Millimeter
MDCT	Multi-Detector Computed Tomography
Na	Sodium.
D AO	Descending aorta
CTA	Cmoputed tomography angiogram
MRA	Magnetic resonance angiography
T12	Twelve thoracic vertebra
T4	Fourth thoracic vertebra.
T5	Five thoracic vertebra.
TEE	Trans esophageal echocardiography
CXR	Chest x.ray
TTE	Transthoracic echocardiogram

Chapter one

Introduction

Chapter One
Introduction

1.1 Introduction:

The aorta is the main artery in the human body. The aorta distributes oxygenated blood to all part of the body through the systemic circulation. It extends from the heart to about the fourth lumber vertebra and it divided into thoracic and abdominal sections. The thoracic section divided into four segments: aortic bulb (root), ascending aorta, aortic arch and descending aorta. The bulb or root portion is at the proximal end of the aorta and is the area from which the coronary arteries originate. Extending from the bulb is ascending portion of the aorta, which terminates at approximately second sternocostal joint and becomes the arch. The arch is unique from the other segments of the thoracic aorta because three arterial branches arise from it: the brachiocephalic artery, the left common carotid artery, and the left subclavian artery. The distal end of arch becomes descending aorta which extends from the isthmus to the level of twelfth dorsal vertebra. Numerous intercostals, bronchial, esophageal, and superior phrenic branches arise from the descending aorta. Then continues downward as the abdominal aorta which extends from diaphragm to the aortic bifurcation. It gives rise to lumbar and musculophrenic arteries, renal and middle suprarenal arteries, and visceral arteries (celiac trunk, the superior mesenteric artery and the inferior mesenteric artery). It ends in a bifurcation into the left and right common iliac arteries. (Kenneth, 2012)

The descending thoracic aorta is the part of the aorta, commence at the left side of the lower border of the 4th ventricle and end the T12.

The descending thoracic aorta provides compliance with elastic recoil to maintain blood pressure and ante grade blood flow throughout diastole. The more distal abdominal aorta functions mainly as a conduit .The varying functions are reflected in the histological structure of the aorta. The elastic/collagen ratio is highest in the thoracic part and decreases distally. With age, the aortic wall structure changes. (C.K worrick1976)

Multiple imaging modalities are available for measuring descending thoracic aorta, including X-ray angiography, transesophageal echocardiography (TEE), computed tomography (CT) and magnetic resonance imaging (MRI). Although all of these modalities have diagnostic value, CT has evolved to be main stay of evaluation owing to its accuracy and reproducibility, as well as its speed, simplicity and true 3- dimensional capabilities. **(Aric wolar,Heidi Gransar….ect 2008..2009)**

Computed tomography (CT) was invented in the 1970s. The chief inventor, Sir Godfery Hounsfield, the Nobel Prize for medicine is earned in 1970. CT was the first fully digital imaging technique that provided cross-sectional images of any anatomical structure.(Pual Adam .,Hardd ellis, 2007)

The measured of descending thoracic aorta diameters with normal values. Especially for the definition and classification of structural abnormalities, such as aneurysm, aortomegaly , ecstasies, stenosis, coarctation , and hypoplasia, the knowledge of normal aortic diameters at different levels is essential.(Johnston,1991)

1.2 Problem of the study:

1. Deficiency of previous studies concerning this topic locally.
2. Increase surgeon mistakes due to unknown of normal diameter of thoracic aorta.

1.3 Objective:

1.3.1 General objective:

To Measure the normal descending thoracic aorta diameter in the Sudanese population .

1.3.2 Specific objective:

1-To detect variation in different group ages regarding thoracic aorta measurements.

2-To find whether there is relationship between the age, length, weight, and gender and dimension of the normal aorta.

3-To establish the reference values for the normal descending thoracic aorta diameters in Sudanese population

1.4 Thesis overview:

In chapter one an introduction, problem of the study and objectives are presented. Chapter two including the literature review and previous studies .The material and methods are presented in chapter three. In Chapter four the results are included followed by discussion, recommendation, conclusion, references and appendix in chapter five.

Chapter Two

Literature review

Chapter Two

Literature review

2.1 Anatomy of the aorta:

The aorta commences at the upper border of the left ventricle .It runs upward and to the right for a short distance and then turns through 180 to run downward close to the vertebra column to end at the level of the 4th vertebra by dividing into the right and left common iliac arteries. The aorta divide into the following parts, the ascending aorta, the arch of the aorta, the descending thoracic aorta, the abdominal aorta.

2.1.1 Anatomy of the descending thoracic aorta:

The descending thoracic aorta is the continuation of the arch of the aorta. It begins on the left side of the inferior border of the body of the T4 vertebra and descend in the posterior mediastinum on the left side of the T5-T4 vertebrae .The descending thoracic aorta approaches the median plane and displaces the esophagus to the right.

The descending thoracic aorta plexus an autonomic nerve network surround it. The descending thoracic aorta lies posterior to the root of the left lung , pericardium and esophagus .

It terminates anterior to the inferior border of the T12 vertebra and enters the abdomen through the aortic hiatus in the diaphragm.

The thoracic duct and azygos vein ascend on its right side and accompany it through hiatus.

The descending thoracic aorta has the following branches:

The intercostals arteries, nine on each side of thoracic aorta, run laterally to supply the structure of the lower nine intercostals spaces .Branches arise from the thoracic aorta to supply bronchi and lungs. The pericardium, lymph nodes of the mediastinum, esophagus and the diaphragm.**(Keith L.moore:2008)**

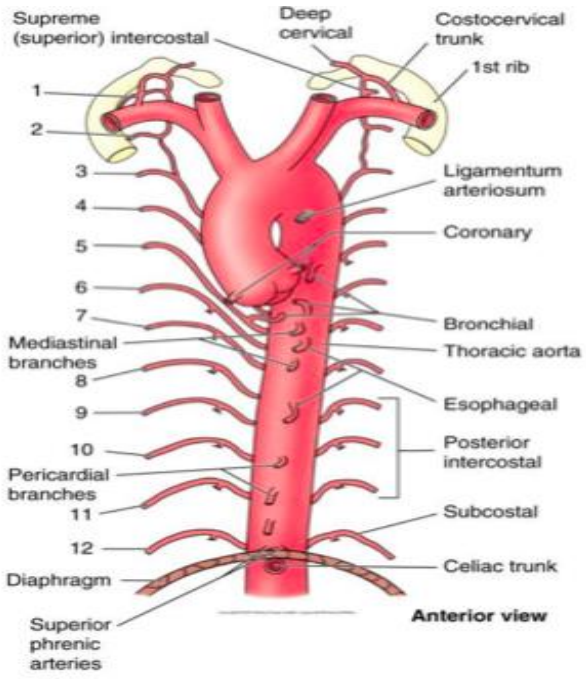

Figure 2.1 diagram the thoracic aorta. (Emanuel Rubin Howard2011)

2.2 The structure of the artery consists of three layers:

Outer coat is called adventitia .It is composed of fibrous tissue containing a few elastic tissue. The middle coat is called tunica media .It is composed of smooth muscle fibers which run in circular direction .the inner coat is called the tunica intimae.

It is composed of a single layer of endothelial cells with underlying elastic tissue, which produces a series of small folds.(1) Figure 2.2 diagram to present artery structure.(1)(Basic anatomy and physiology for radiographer 1976)

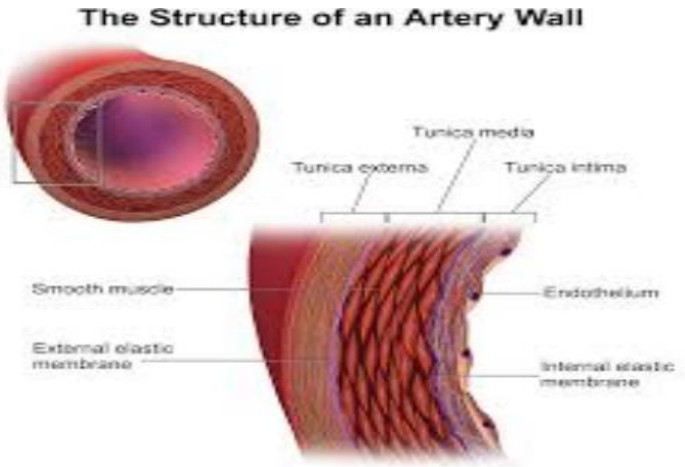

Figure 2.2 diagram the artery structure. **(Emanuel Rubin Howard2011)**

2.3 Anatomy of the heart:

The heart is muscular pump, lies obliquely in the middle mediastinum, more to the left than to the right, and it is roughly cone-shaped, having an apex, base and four surfaces.

The apex of the heart is formed by the left ventricle and points forwards, downwards and to the left, being overlapped by the left lung and pleura.

The base of the heart faces upward, backwards and to the right and is mainly formed by the left atrium. It is separated from the thoracic vertebrae by the esophagus and descending thoracic aorta.

The anterior surface of the heart is formed by the anterior part of the atrium, the right ventricle and part of the left ventricle and it lies behind the sternum and the costal cartilages of the 3rd to 6th ribs.

The line of division between the right and left ventricles is marked by inter ventricular groove and running in this groove is a branch of the left of the coronary artery.

The diaphragmatic surface is formed by the left ventricle and a small part of the right ventricle and it lies mainly on the central tendon of the diaphragm.

The left surface is formed by the left ventricle and a small part of the left atrium and it faces upwards, backward and to the left. (C.K worrick1976)

2.4.1 Champers of the heart:

The right atrium Forms the right surface of the heart, lying in front and to the right of the left atrium. The cavities of the right and left separated by the inter arterial septum.

The superior vena cava opens into the upper posterior part of the right atrium and the inferior vena cava opens into the lower posterior part of the right atrium.

The right ventricle Forms most of the stern costal surface and part of the diaphragmatic surface of the heart, and extends from the anterior border of the right atrium almost the apex of the heart.

The cavities of the right and left ventricles separated by inter ventricular septum which forms the posterior wall of the right ventricle.

The left atrium Forms most of the base of the heart and it lies behind and to the left of the right atrium.

The walls of the left atrium are rather thicker than those of the right atrium.

The left ventricle forms the left surface of the heart. The mitral valve lies in the upper posterior of the left ventricle and is composed of two triangular cusps . (C.K worrick1976)

2.4.2 Blood supply of the heart:

Heart muscle is supplied with arterial blood by the right and left coronary arteries, which arise from the aorta just above the aortic valve. The coronary veins drain the blood from the heart muscle and they mostly drain into the coronary sinus, which opens into the right atrium.

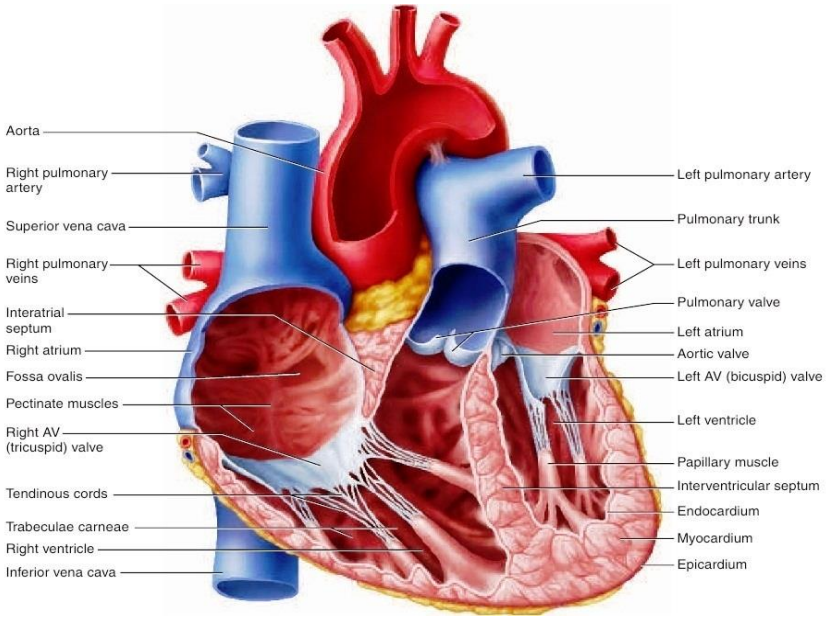

Figure 2.3 diagram the heart. **(Emanuel Rubin Howard2011)**

2.4.3 Arterioventicular and semilunar valves:

Although adjacent myocardial cells are joined together.

The atria and ventricles are separated into two functional units by a sheet of connective tissue.

The AV valve located between the right atrium and right ventricle has three flaps, and is therefore called the tricuspid valve.

The AV valve between the left atrium and left ventricle has two flaps and is thus called the bicuspid valve.

The AV valves allow blood to flow from the atria to the ventricles, but they normally prevent the backflow of blood into the atria.

Semiluner valves are located at the origin of the pulmonary artery and aorta.

These valves open during ventricular contraction, allowing blood to enter the pulmonary and systemic circulation. (C.K worrick1976)

2.5 Composition of the blood:

Blood consist of formed elements that are suspended and carried in fluid called plasma.

The total blood volume in average –size adults is about 5 liters, constituting about 8% of the total body weight. Is bright because of a high concentration of ox hemoglobin in the red blood cells.

The formed elements constitute approximately 45% of the total blood volume, and the plasma accounts for remaining 55 %.

Plasma is a straw colored liquid consisting of water and dissolved solutes. The major solute of plasma in terms of its concentration is Na+, plasma contains many other ions, as well as organic molecules such as metabolites, hormones, enzymes, antibodies and other proteins.

Plasma proteins constitute 7% to 9% of the plasma. The three types of the proteins are albumins, globulins and fibrinogen. **(Keith L.moore:2008)**

2.6 Function of the circulatory system:

2.6.1 Transportation:

All of the metabolisms are transported by the circulatory system.

These substances can be categorized as follows:

A-Respiratory red blood cells or erythrocytes transport oxygen to the cells.(Stuart Ira Fox,2011)

In the lungs, oxygen from the inhaled air attaches to hemoglobin molecules within the erythrocytes and is transported to the cells for aerobic respiration.

Carbon dioxide produced by cell respiration is carried by the blood to the lungs for elimination in the exhaled air. **(Stuart Ira Fox,2011)**

B- Nutritive: The digestive system is responsible for the mechanical and chemical breakdown of food so that it can be absorbed through the intestinal wall into the blood and lymphatic.

The blood then carries these absorbed products of digestion through the liver to the cells of the body.

C- Excretory: Metabolic wastes (such as urea), excess water and ions, and other molecules not needed by the body are carried by the blood to the kidneys and excreted in the urine.

2.6.2 Regulation:

The circulatory system contributes to both hormonal and temperature regulation.

A- Hormonal: The blood carries hormones from their site of origin to distant target tissues where they perform a variety of regulatory functions.

B- Temperature: Temperature regulation is aided by the diversion of blood from deeper to more superficial cetaceous vessels or vice versa . when the ambient temperature is high, diversion of blood from deep to superficial vessels helps cool the body , and when the ambient temperature is low ,the diversion of blood from superficial to deeper vessels helps keep the body warm.

2.6.3 Protections:

The circulatory system protects against blood loss from injury and against pathogens, including foreign microbes and toxins introduced into the body.

A- Clotting: The clotting mechanism protects against blood loss when vessels are damaged.

B- Immune: The immune function of the blood is performed by the leukocytes (white blood cells) that protect against many disease-causing agents (pathogens). (Stuart Ira Fox,2011)

2.7 Function of the artery:

In the aorta and other large arteries, there are numerous layers of elastic fibers between the smooth muscle cells of the tunica media. These large elastic arteries expand when pressure of the blood rises as a result of the ventricles contraction. They recoil like a stretched rubber band when the blood pressure falls during relaxation of the ventricles .This elastic recoil

drives the blood during the diastolic phase, the longest phase of the cardiac cycle, when the heart is resting and providing a driving pressure**.** **(Stuart Ira Fox,2011)**

2.8 Pathology of blood vessels:

2.8.1 Homeostasis:

Is the arrest of hemorrhage and is a response to vascular injury. This process involves local vasoconstriction, tissue swelling, coagulation, platelet adhesion, aggregation and activation, resulting in a haemostatic plugs extending intra vascular and extra vascular at a site of injury.

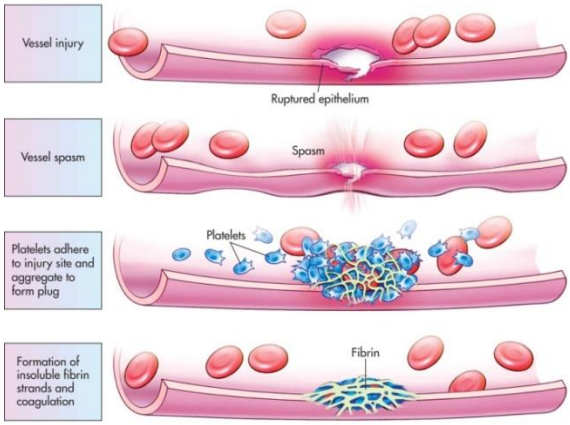

Figure 2.5 diagram the homeostasis . . (Emanuel Rubin Howard2011)

2.8.2 Thrombosis:

Is a pathologic process that provokes formation of a blood clot, or thrombus, within the circulation .A thrombus is an aggregate of coagulation blood that contains platelets, fibrin, leukocytes and red blood cells.

Thrombi are formed when antithrombotic system fails to balance prothrombotic processes figure 2.6 diagram present thrombosis.

(Emanuel Rubin Howard2011)

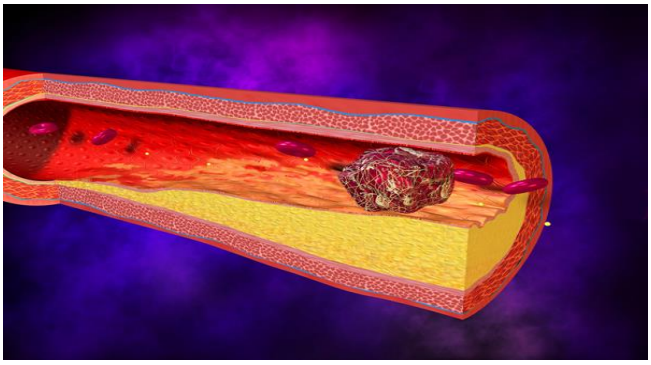

Figure 2.6 diagram the thrombosis. . (Emanuel Rubin Howard2011)

2.8.3 Atherosclerosis:

In atherosclerosis inflammatory and immune cells, smooth muscle cells lipid and connective tissue progressively accumulate in the intimae of large and medium sized elastic and muscular arteries. The classical atherosclerotic lesion is best described as a fibrosis inflammatory lipid plaque (athermo) which develops over several decades .With continued growth, the encroaches on the media of the arterial wall and narrows the lumen of the vessel, thereby producing stenosis. The epidemiology of atherosclerosis and subsequent ischemic heart disease.

figure 2.7 diagram present the atherosclerosis.

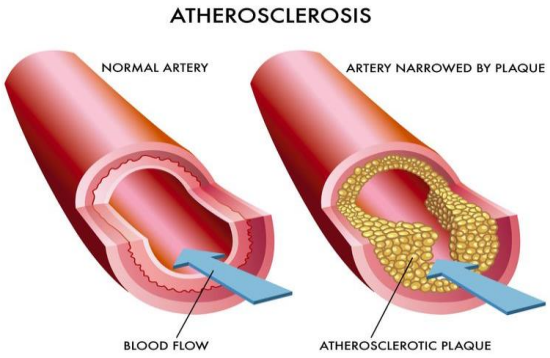

Figure 2.7 diagram the atherosclerosis.

(Emanuel Rubin Howard2011)

2.8.4 Aneurysm:

Arterial aneurysms are localized dilation of blood vessels caused by congenital and acquired weakness of the media. They are not rare, and their incidence tends to rise with age.

Aneurysms are classified by location, configuration and etiology the location refers to the type of vessel.

The gross morphology of aneurysms reveals several different pathologic features. (Emanuel Rubin Howard2011)

2.8.4.1-Fusiform aneurysms: Are avoiding swelling parallel to the long axis of the vessel.

2.8.4.2- Saccular aneurysms: Bubble like arterial wall out pouching at sites of weakened media.

2.8.4.3- Dissecting aneurysms: dissecting hematomas, in which blood from hemorrhage into the media separates the layers of the vascular wall.

2.8.4.4- Arteriovenous aneurysms: Direct communication between an artery and vein.

2.8.4.5- Mycotic aneurysms: Aneurysms related to an infection process.

The wall of aneurysm is formed by the stretched remnants of the arterial wall .Thoracic aorta aneurysms most commonly are associated with hypertension and Marfan syndrome. These aneurysms manifest with signs and symptoms referable to:

-Encroachment on medistional structures.

(e.g., respiratory difficulties due to esophageal compression)

-Persistent cough from irritation of the recurrent laryngeal nerves.

-Pain caused by erosion of bone.

-Cardiac disease due to valvular insufficiency.

-Aortic rupture. (Emanuel Rubin Howard2011)

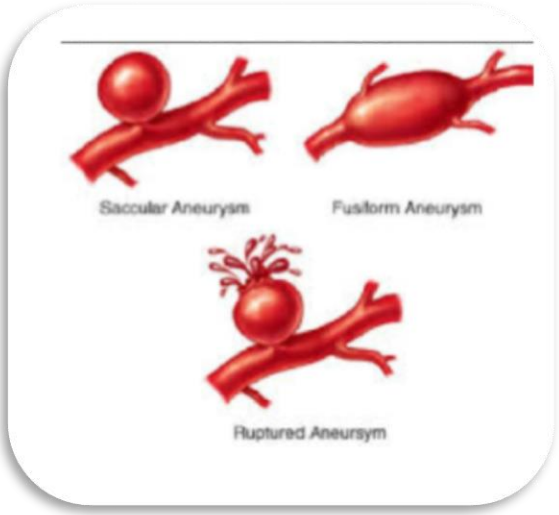

Figure 2.8 present the type of aneurysm. (Emanuel Rubin Howard2011)

2.8.5 Hypertensive vascular disease:

Hypertensive is present in 95% or more of ascending aortic dissection or rupture.

Blacks are particularly plagued by hypertension and are more likely than whites to experience severe complication.

At least three fourths of patients with dissecting aortic aneurysm, intracerebral hemorrhage or myocardial wall rupture also have elevated blood pressure.

The definition of hypertension depends on a statistical estimate of the distribution of systolic and diastolic blood pressure in general population. Both systolic and diastolic pressures are important in determining the risk of cardiovascular disease, especially atherosclerosis.

Blood pressure varies widely, depending on age, exertion, emotional state, time of day and other poorly understood factors. Acommonly used set of clinical guidelines defines normal blood pressure as less than 120 systolic and 80 diastolic.

Hypertension is defined as 140 or greater systolic or 90 or greater diastolic. Blood pressure falling in between this range is considered pre hypertension and is associated with increased risk of coronary vascular disease and development of clear cut hypertension.

In 95% of patients with hypertension, the cause is not clearly identifiable. Thus, most hypertensive persons are said to have essential or primary hypertension. Whatever the etiology, treatment of hypertension prolongs life. Etiology factors, blood pressure are the product of cardiac output and systemic vascular resistance to blood flow.

Both of this function is critically influenced by renal function and sodium homeostasis. The most widespread hypothesis holds that primary hypertension result from an imbalance in the interactions between these mechanisms. (Emanuel Rubin Howard2011)

2.9 Images modalities of thoracic aorta :

2.9.1 Echocardiography

Is a sonogram of the heart, uses standard two-dimensional, three-dimensional, and Doppler ultrasound to create images of the heart. A standard echocardiogram is also known as a transthoracic echocardiogram (TTE), or cardiac ultrasound. In this case, the echocardiography transducer (or probe) is placed on the chest wall (or thorax) of the subject, and images are taken through the chest wall. This is a non-invasive, highly accurate and quick assessment of the overall health of the heart. The alternative way to perform an echocardiogram is a trans esophageal echocardiogram, or TEE. A specialized probe containing an ultrasound transducer at its tip is passed into the patient's esophagus. This allows image and Doppler evaluation from a location directly behind the heart. Trans esophageal echocardiograms are most often utilized when transthoracic images are

suboptimal and when a more clear and precise image is needed for assessment. This test is performed in the presence of a cardiologist, registered nurse, and ultrasound technician. Conscious sedation and/or localized numbing medication may or may not be used in order to make

the patient more comfortable during the procedure. **(Journal of American College of Cardiology, etrieved August 17, 2012). (WebMD, 2014)<**

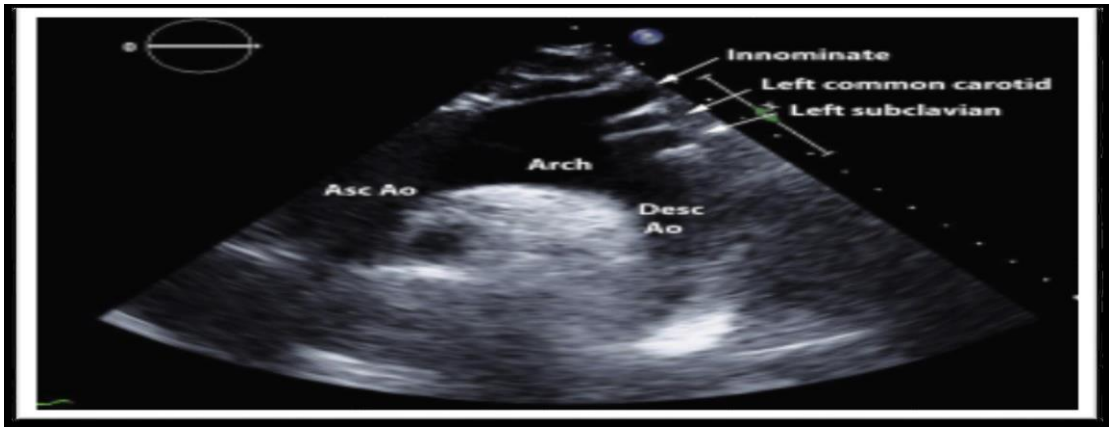

Fig (2.9) Transthoracic echocardiographic suprasternal notch view of the distal ascending aorta (Asc Ao), aortic arch, supraaortic vessels (arrows), and proximal descending thoracic aorta (Desc Ao). (Journal of the American Society of Echocardiography February 2015)

2.9.2 Three-Dimensional Echocardiography

Real-time 3D TEE, a relatively new technology, appears to offer some advantages over 2D TEE in a growing number of clinical applications.

However, as of this writing, there is limited information regarding the clinical application of this novel technology to the thoracic aorta.

Moreover, 3D TEE has some limitations. Like 2D TEE, it often fails to adequately visualize the distal ascending aorta and the aortic arch and its branches, because of interposition of the trachea. In addition, spatial imaging of the thoracic aorta is limited because of the 90_ image sector, which is too narrow to include long segments of the thoracic aorta and therefore limits topographic orientation. In summary, recent advances in 3D TEE provide an opportunity to reconsider the role of TEE for diagnosing and monitoring patients with aortic diseases.

Future experience will be required to verify its benefits and establish its value relative to CT and MRI**. . (WebMD, 2014)**

2.9.3 Aortogram (angiogram)

An angiogram is an X-ray test that uses a special dye and camera (fluoroscopy) to take pictures of the blood flow in an artery (such as the aorta) or a vein (such as the vena cava). An angiogram can be used to look at the arteries or veins in the head, arms, legs, chest, back, or belly. Common angiograms can look at the arteries near the heart (coronary angiogram), lungs (pulmonary angiogram), brain (cerebral angiogram), head and neck (carotid angiogram), legs or arms (peripheral), and the aorta (aortogram). During an angiogram, a thin tube called a catheter is placed into a blood vessel in the groin (femoral artery or vein) or just above the elbow (brachial artery or vein). The catheter is guided to the area to be studied. Then an iodine dye (contrast material) is injected into the vessel to make the area show clearly on the X-ray pictures. This method is known as conventional or catheter angiogram. The angiogram pictures can be made into regular X-ray films or stored as digital pictures in a computer. (WebMD, 2014)

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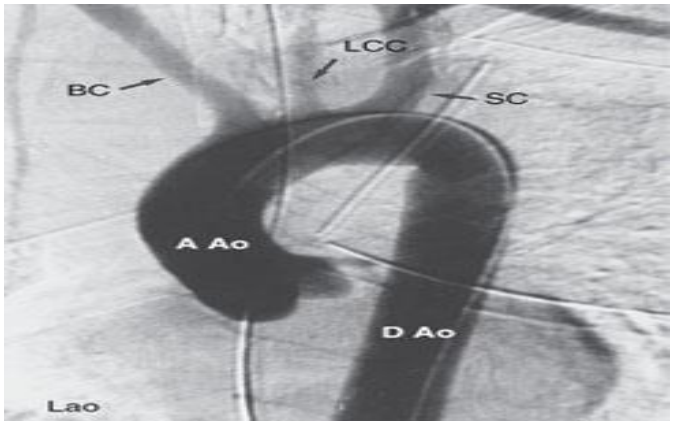


Fig (2.10) angiography of the arch of the aorta.(medicine.academic.ru, 2011)

2.9.4Computed tomography angiography (CTA)

Is a computed tomography technique used to visualize arterial and venous vessels throughout the body. CTA can be used to examine blood vessels in many key areas of the body, including the brain, kidneys, pelvis, and the lungs. Under some circumstances the coronary arteries may be examined by CTA, but CTA has not replaced invasive catheter coronary angiography. The procedure is able to detect narrowing of blood vessels in time for corrective therapy to be done. This method displays the anatomical detail of blood vessels more precisely than magnetic (MRI) or ultrasound. Today, many patients can undergo CTA in place of a conventional catheter angiogram. CTA is a useful way of screening for arterial disease because it is safer and much less time-consuming than catheter angiography and is a cost-effective procedure. There is also less

discomfort because contrast material is injected into an arm vein rather than into a large artery in the groin. (American College of Chest Physicians and American Thoracic Society, 2013**)**

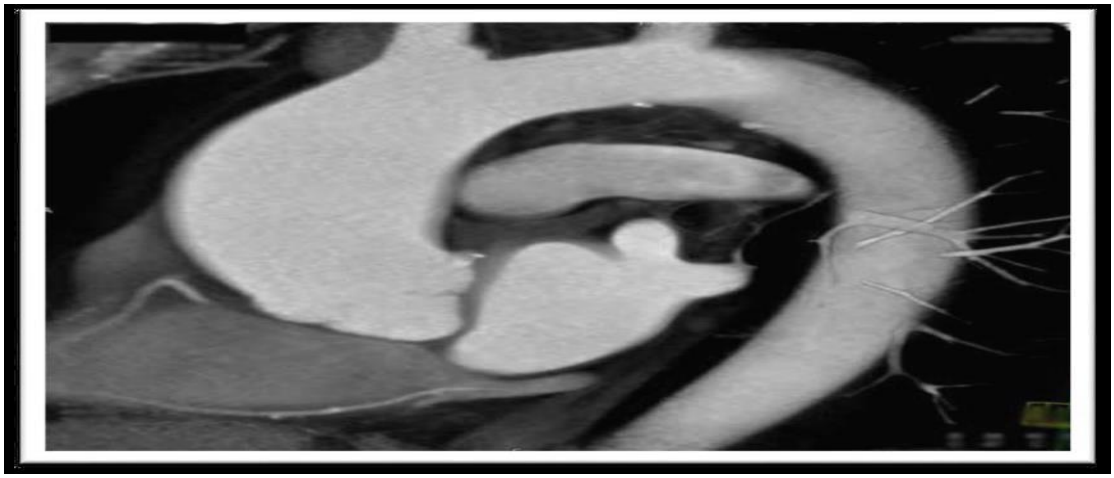


Fig (2.11) 3-D image of the aorta in the CT chest

(RadiologyInfo.org, 2016)

2.9.5 Magnetic resonance angiography (MRA)

Is a group of techniques based on magnetic resonance imaging (MRI) to image blood vessels. Magnetic resonance angiography is used to generate images of arteries (and less commonly veins) in order to evaluate them for stenosis (abnormal narrowing), occlusions, aneurysms (vessel wall dilatations, at risk of rupture) or other abnormalities. MRA is often used to evaluate the arteries of the neck and brain, the thoracic and abdominal aorta, the renal arteries, and the legs. A variety of techniques can be used to generate the pictures of blood vessels, both arteries and veins, based on flow effects or on contrast (inherent or pharmacologically generated). The most frequently applied MRA methods involve the use intravenous contrast agents, particularly those containing gadolinium to shorten the T1 of blood to about 250 ms, shorter than the T1 of all other tissues (except fat). Short-TR sequences produce bright images of the blood. However, many other techniques for performing MRA exist, and can be classified into two general groups: 'flow-dependent' methods and 'flow-

independent' methods. Flow-dependent angiography is based on blood flow. They take advantage of the fact that the blood within vessels is flowing to distinguish the vessels from other static tissue. That way, images of the vasculature can be produced. Flow dependent MRA can be divided into different categories: There is phase-contrast MRA (PC-MRA) which utilizes phase differences to distinguish blood from static tissue and time-of-flight MRA (TOF MRA) which exploits that moving spins of the blood experience fewer excitation pulses than static tissue. (Eur Radiol, 2013)

Fig (2.12) Contrast-enhanced (CE-MRA) of the aorta.

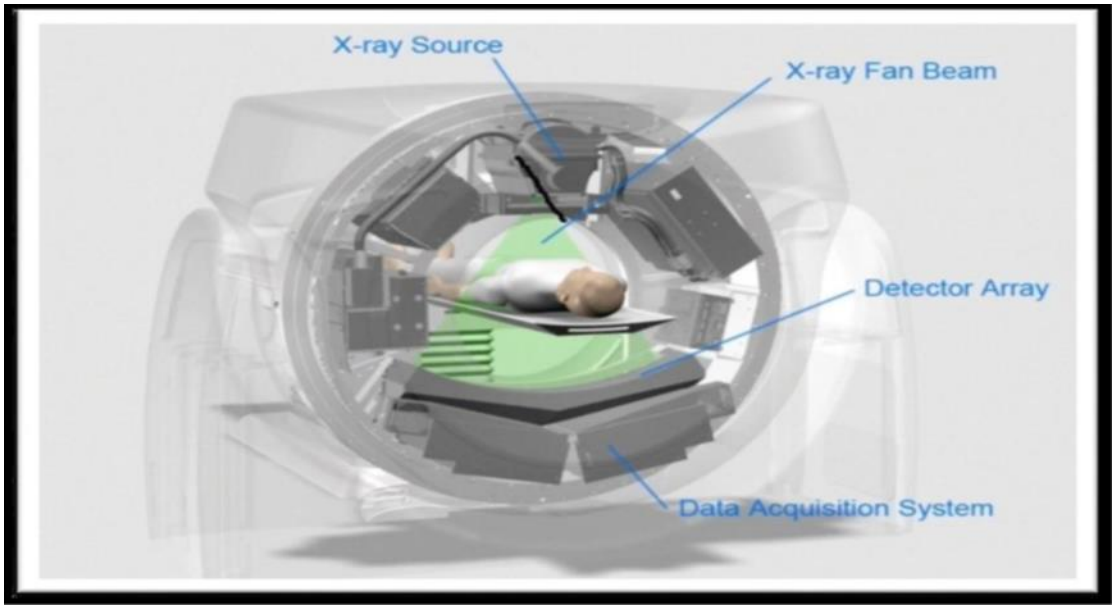
(Matthias et al, 2014)

2.9.6 CT chest

CT chest (computed tomography) is an imaging method that uses x-rays to create cross-sectional pictures of the chest and upper abdomen. (Gerald et al, 2013) Chest CT scans are used for a multitude of reasons. They may be done to check for certain cancers in various different ways including to detect abnormal tumors, can also be ordered after a mammogram exam, Some chest CT scans are tailored to look for heart disease, aneurysms of the aorta or pulmonary emboli, can be used to guide doctors or surgeons during a procedure, such as a biopsy, can be used to detect cysts or infections in the body, They can also identify the bone structures within the body and can accurately measure the density of bone, and is often

used to quickly inspect a patient after an accident in order to identify traumatic internal injuries. (Gerald et al, 2013).

The technologist begins by positioning patient on the CT examination table, usually lying flat on his back. Straps and pillows may be used to help you maintain the correct position and to help you remain still during the exam. Many scanners are fast enough that children can be scanned without sedation. In special cases, sedation may be needed for children who cannot hold still. Motion will cause blurring of the images and degrade the quality of the examination the same way that it affects photographs. If a contrast material is used, it will be injected into a vein shortly before scanning begins. Next, the table will move quickly through the scanner to determine the correct starting position for the scans. Then, the table will move slowly through the machine as the actual CT scanning is performed. Depending on the type of CT scan, the machine may make several passes. You may be asked to hold his breath during the scanning. Any motion, whether breathing or body movements, can lead to artifacts on the images. This loss of image quality can resemble the blurring seen on a photograph taken of a moving object. When the examination is completed, you will be asked to wait until the technologist verifies that the images are of high enough quality for accurate interpretation. The actual CT scanning takes less than 30 seconds and the entire process is usually completed within 30 minutes. (Gerald et al, 2013**)**



Figure,2;13 diagram of CT machine. .(Lukáš et al, 2014).

2.10. Benefits and Risks of Computed Tomography

2.10.1. Benefits

 CT is fast, which is important for patients who have trouble holding their breath.

 CT scanning is painless, noninvasive and accurate.

 A major advantage of CT is its ability to image bone, soft tissue and blood vessels all at the same time.

 Unlike conventional x-rays, CT scanning provides very detailed images of many types of tissue as well as the lungs, bones, and blood vessels

 CT examinations are fast and simple; in emergency cases, they can reveal internal injuries and bleeding quickly enough to help save lives.

 CT has been shown to be a cost-effective imaging tool for a wide range of clinical problems.

 CT is less sensitive to patient movement than MRI.

 CT can be performed if you have an implanted medical device of any kind, unlike MRI.

 CT imaging provides real-time imaging, making it a good tool for guiding minimally invasive procedures such as needle biopsies and needle aspirations of many areas of the body, particularly the lungs, abdomen, pelvis and bones.

 A diagnosis determined by CT scanning may eliminate the need for exploratory surgery and surgical biopsy.

 No radiation remains in a patient's body after a CT examination.

 X-rays used in CT scans should have no immediate side effects.

 Low-dose CT scans of the chest use a lower dose of radiation than conventional chest CT.(RadiologyInfo.org,2016)

2.10.2. Risks

 There is always a slight chance of cancer from excessive exposure to radiation. However, the benefit of an accurate diagnosis far outweighs the risk.

 The effective radiation dose for this procedure varies. See the Safety page for more information about radiation dose.

 Women should always inform their physician and x-ray or CT technologist if there is any possibility that they are pregnant. See the Safety page for more information about pregnancy and x-rays.

 CT scanning is, in general, not recommended for pregnant women unless medically necessary because of potential risk to the baby in the womb.

 The risk of serious allergic reaction to contrast materials that contain iodine is extremely rare, and radiology departments are well-equipped to deal with them.

 In some patients with reduced kidney function, the dye used in CT scanning may worsen kidney function.

 Because children are more sensitive to radiation, they should have a CT exam only if it is essential for making a diagnosis and should not have

repeated CT exams unless absolutely necessary. CT scans in children should always be done with low-dose technique. (RadiologyInfo.org,2016)

Movement artifact deteriorates the image quality this is prevented by a standard breath-hold technique; alternatively if this is not possible scan during quiet respiration. (**19Steb by steb ct scan 2008)**

2.11 Previous studies:

Arik, et al 2008 had done statistical study about aortic size assessment by noncontrast cardiac computed tomography to determine normal limits for ascending and descending thoracic aorta diameters in a large population of asymptomatic, low risk adult subjects. Their methods were done in 4,039 adult patients undergoing coronary artery calcium (CAC) scanning during the period from July 2004 to March 2007, systematic measurements of the ascending and descending thoracic aorta diameters were made at the level of the pulmonary artery bifurcation. The final analysis groups for ascending and descending thoracic aorta included 2,952 and 1,931 subjects, respectively. Subjects were then regrouped by gender, age, and body surface area (BSA) for ascending and descending aorta, separately. The mean diameters for the final analysis group were 33 ± 4 mm for the ascending and 24 ± 3 mm for the descending thoracic aorta.

Mao, et al 2008 had done study about normal thoracic aorta diameter on cardiac computed tomography in healthy asymptomatic adult to establish the normal criterion of ascending aortic diameter (AAOD) measured by 64 Multi-Detector Computed Tomography and Electron Beam Computed Tomography based on gender and age. 1442 consecutive subjects who were referred for evaluation of possible coronary artery disease underwent coronary CT angiography and coronary artery calcium scanning (55+11 years, 65% male) without known coronary heart disease, hypertension, chronic pulmonary and renal disease, diabetes and severe aortic calcification. The ascending aortic diameter, descending aortic diameter, pulmonary artery and chest anterioposterior diameter, posterior border of sternal bone to anterior border of spine, were measured at the slice level of mid right pulmonary artery. The linear correlation analysis was done between AAOD and all parameters.Thier result AAOD had

significant linear association with age, gender, descending aortic diameter and pulmonary artery diameter. The mean Intra-luminal AAOD was 31.1 ± 3.9mm and 33.6 ± 4.1 mm in females and males respectively. Their concluded with the ascending aortic diameter increases with age and male gender.

FY, et al 2008 had done study to establish reference values for thoracic aortic diameters MDCT in adults without evident cardiovascular disease. There method were done in 103 (43% women, age 51 +/- 14 years) adults free of cardiac or aortic structural disease underwent MDCT examination to determine aortic dimensions. There results were at the end-diastolic diameter 95% confidence intervals were 2.5-3.7 cm for the aortic root, 2.1-3.5 cm for the ascending aorta, and 1.7-2.6 cm for the descending thoracic aorta. Aortic diameters were significantly greater at end systole than end diastole, Aortic root and ascending aortic diameter increased significantly with age and body surface area.

Acids Radiol 2008 from united state, to establish the normal of thoracic aorta diameter measured by 64 (MDCT) .The result show that the diameter was 33.5and 36.0 mm in females and males.

Italian society of ital cardiol.1997, to measure the proximal thoracic aorta from childhood to adult age. T(he result of this study was: the mean values and range of aortic diameter were 1.5 -3.4 cm.

Alfred Hager 2006 Germany ,to measure diameter of the thoracic aorta with computed tomography. The result of this of the this study was 2.77± 0.37 cm at the proximal transverse arch, and 2.43±0.35 cm at the diaphragm.

Charles T.Dotter1950 December New York, to measure the length of thoracic aorta . The result of this study was 6.76±15.80 the mean length being ±5.07.

Mashaer Ghazy 2016 sudan (SUST), The study revealed that the adult Sudanese thoracic aorta diameter was 35.11± 7.45 mm for ascending thoracic aorta and 23.96 ± 3.2 mm for descending thoracic aorta. The measurements were larger than international measurements.

The study showed a significant relation between descending aortic diameter and age. Equation had been established to predict the Sudanese thoracic aorta diameter.

Chapter three

Materials and Methods

Chapter
Materials and Methods

3.1 Materials

3.1.1 Study samples

A total of fifty patients were included in this study, their age from15 to 70 years old, without any signs of cardiovascular disease. Patients were in both genders were selected for chest CT. Patients age, gender, wight and lenght descending thoracic aorta diameter was recorded.

3.1.2 Area and duration

This was cross sectional descriptive analytical study. It was achieved at radiology department for Alamal National Hospital, El- Ateba specialize Hospital and El-Rebat National Hospital e Khartoum- Sudan during the period from October 2016 to December 2016

3.1.3 Machine characteristics

3.1.4 Machines used:

1-TOSHIBA aquiline 64 slices/ JABAAN 2008.
2-SIMENES aquiline 8 slice /MARFENA 2003.
3-NEYSOFT aquiline‹64sclice CHAINA2001.

3.2 Methods

The patient lies in a supine position on the scan table with the arms elevated above the head, feet first, patient take full inspiration and hold it. examination, and were asked to remove radiopaque materials and wea hospital gown during the study..

3.2.1 Methods of scanning:

CT scans were obtained with the patient in supine positions during full inspiration. The scan ranges were from 90 to 180 kvp and 100 to 220 Mas.

3.2.2 Methods of measurement:

The measurements were taken from the operator council of the CT machine; the axial images were obtained at the level of T3 proximal width and middle width at level of t7; and distal width at end of descending thoracic aorta at level of T12; to measured descending thoracic aorta length at coronal images made in (mm), and used as a reference appled in Alferd Hager 2006 Germany..

3.2.3 Method data collection:

By using data collection sheets designed to include all the variables to satisfy the study, and CT examination finding normal thoracic aorta

3.2.4 Method of data analysis:

The data was analyzed by SPSS programmers using the possible statistical values, the P-Value 0.005.

3.2.5 Method of Data presentation:

The data was presented in tables and graphs**.**

3.2.6 Ethical consideration:

All cases in this study were the patients who had already sent to computed tomography investigation. No individual patient details throughout this study.

Chapter Four

Results

Chapter Four

Result

Table (4.1): Distribution of Age among the population in 50 cases:

Age group (years)	Frequency	%
>20	5	10
20-39	12	24
40-59	21	42
≥60	12	24
Total	**50**	**100%**
Mean ± SD	**14.71±2.67**	

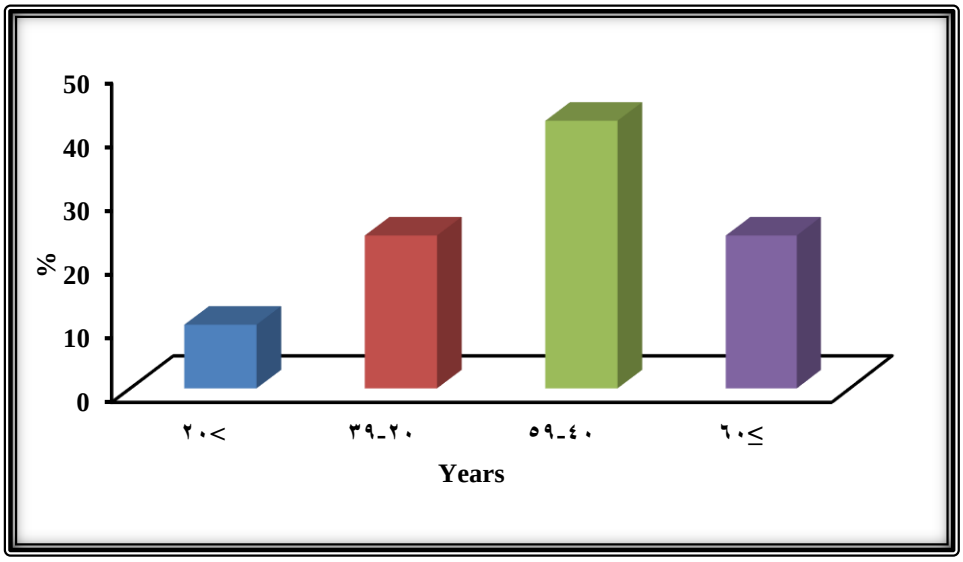


Figure. (4.1)Shows Age distribution

Table (4.2) Distribution of Sex among the population:

Sex	Frequency	%
Males	30	60
Females	20	40
Total	**50**	**100%**

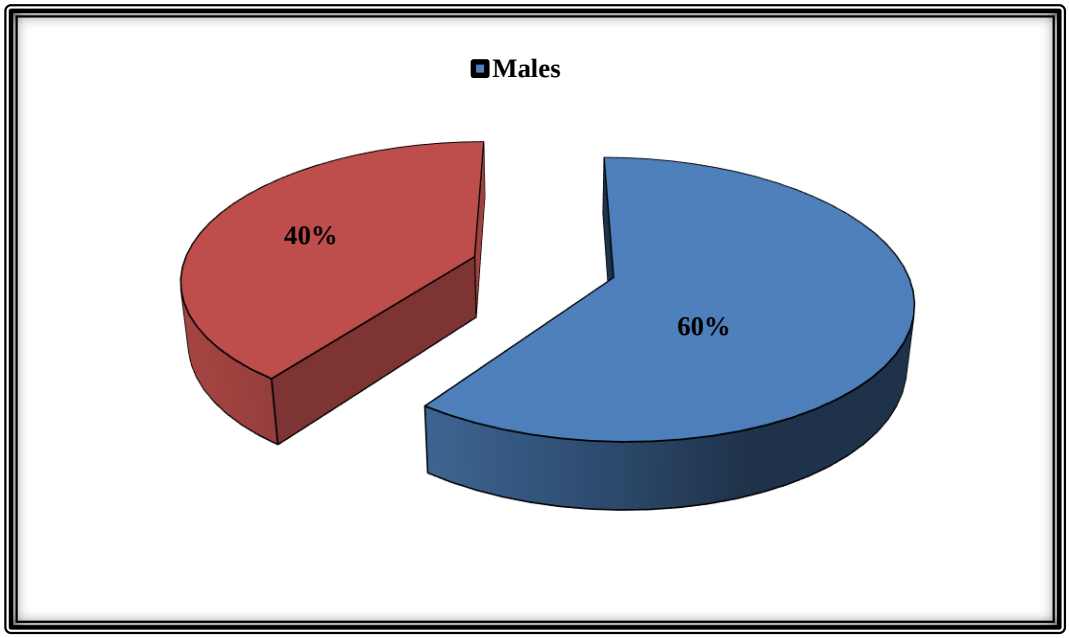
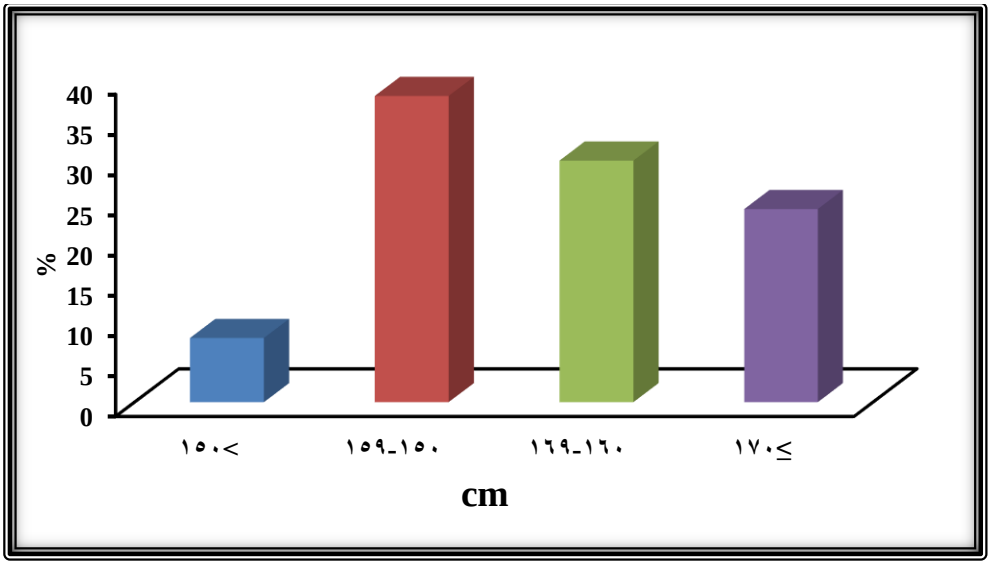


Figure (4.2)show sex distribution

Table (4.3): Distribution of Height among the population:

Height (cm)	Frequency	%
>150	4	8
150-159	19	38
160-169	15	30
≥170	12	24
Total	**50**	**100%**
Mean±SD	**160.42±11.93**	



Figure(4.3) shows Hight distrubution

Table (4.4): Distrbution Weight among the population:

Weight (kegs)	Frequency	%
>50	6	12
50-59	16	32
60-69	12	24
70-79	11	22
≥80	5	10
Total	**50**	**100%**
Mean±SD	**60.90±17.18**	

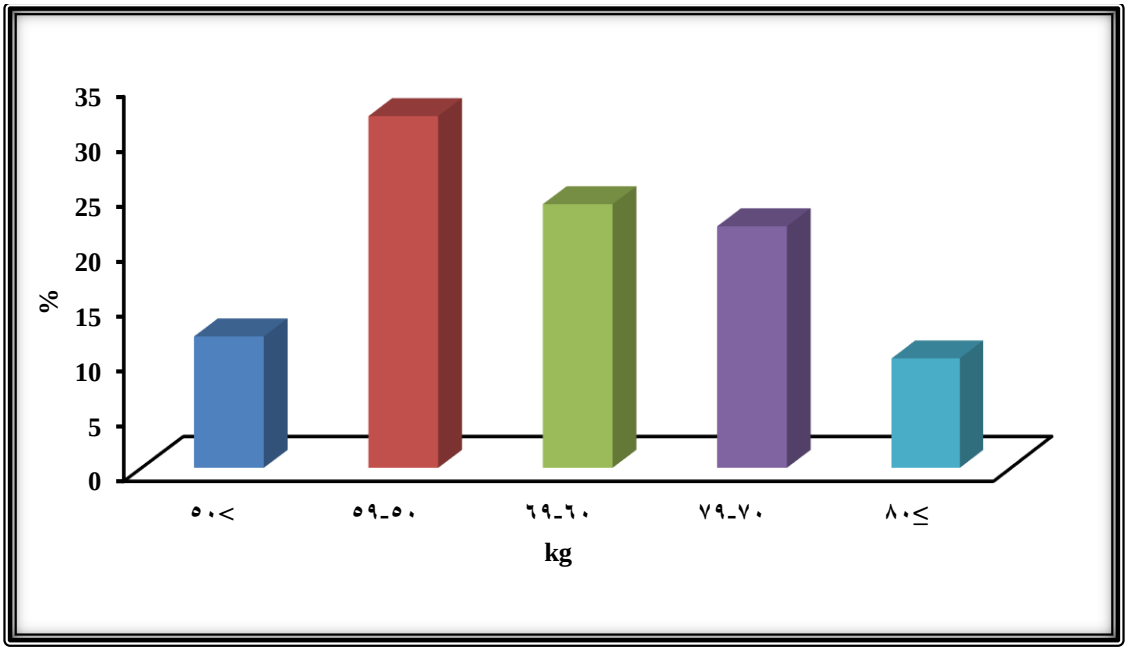
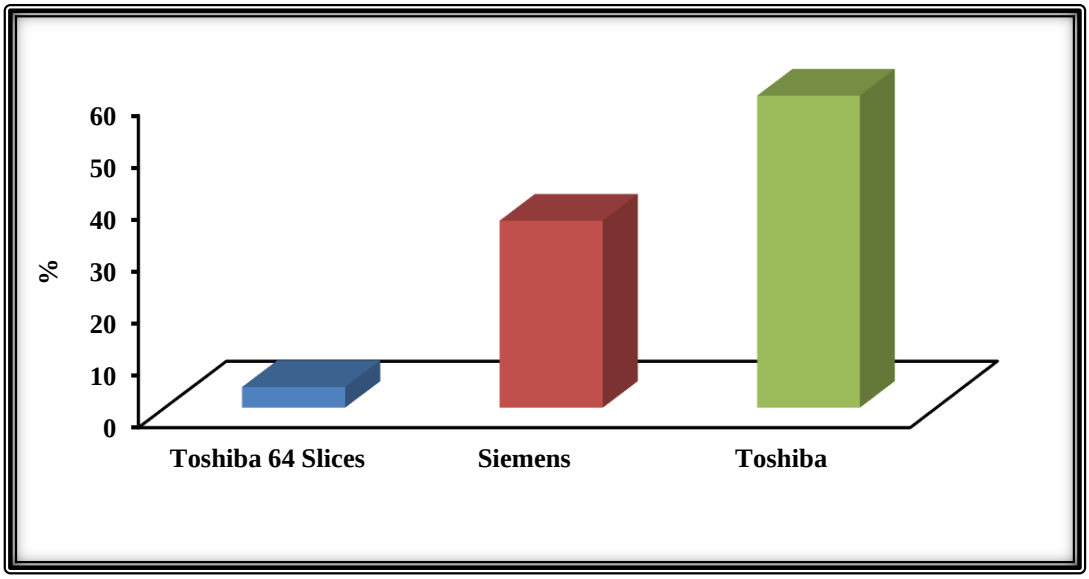


Figure (4.4) Shows Weight distribution

Table (4.5): Disrtibution Type of machine:

Type of machine	Frequency	%
Toshiba 64 Slices	30	60
Siemens	18	36
Toshiba	2	4
Total	**50**	**100%**



Figure(4.5)Shows Type of machines used

Table (4.6): Distribution Length of Aorta among population:

Length (cm)	Frequency	%
>12½	12	24
12.5-14.9	18	36
15.0-17.4	9	18
≥17½	11	22
Total	**50**	**100%**
Mean±SD	**14.71±2.67**	

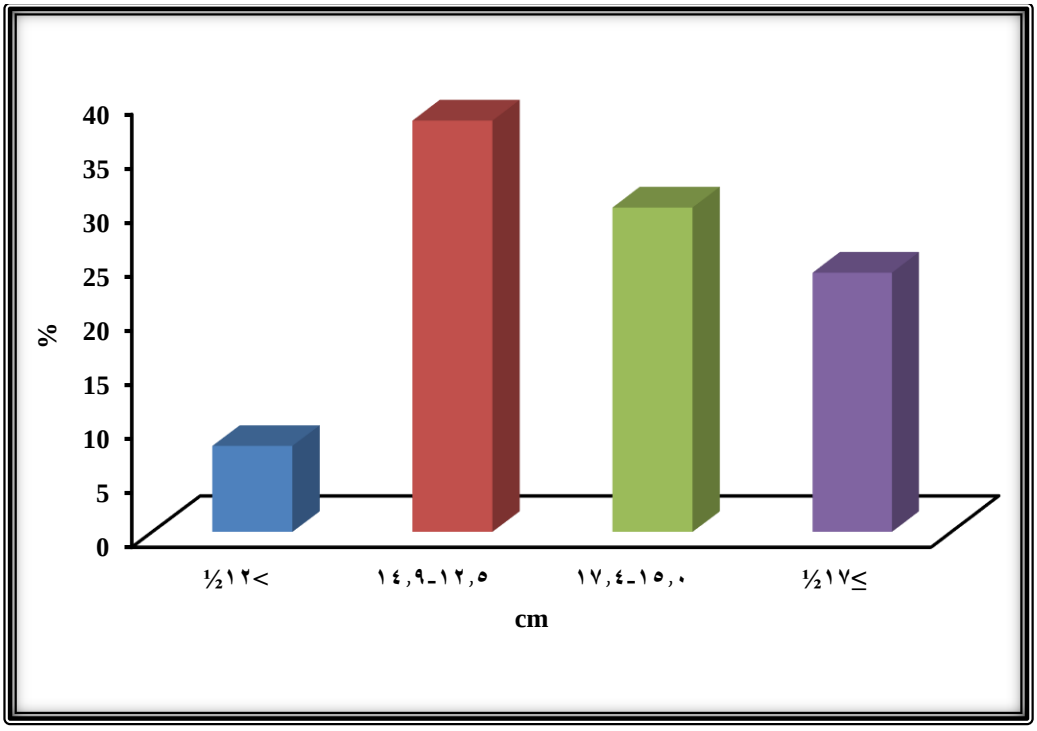


Figure (4.6) Shows length of aorta distribution

Table (4.7): Distribution Proximal width of Aorta among population:

Proximal (cm)	Frequency	%
>2.0	6	12
2.0-2.4	22	44
≥2.5	22	44
Total	**50**	**100%**
Mean±SD	**2.51±0.56**	

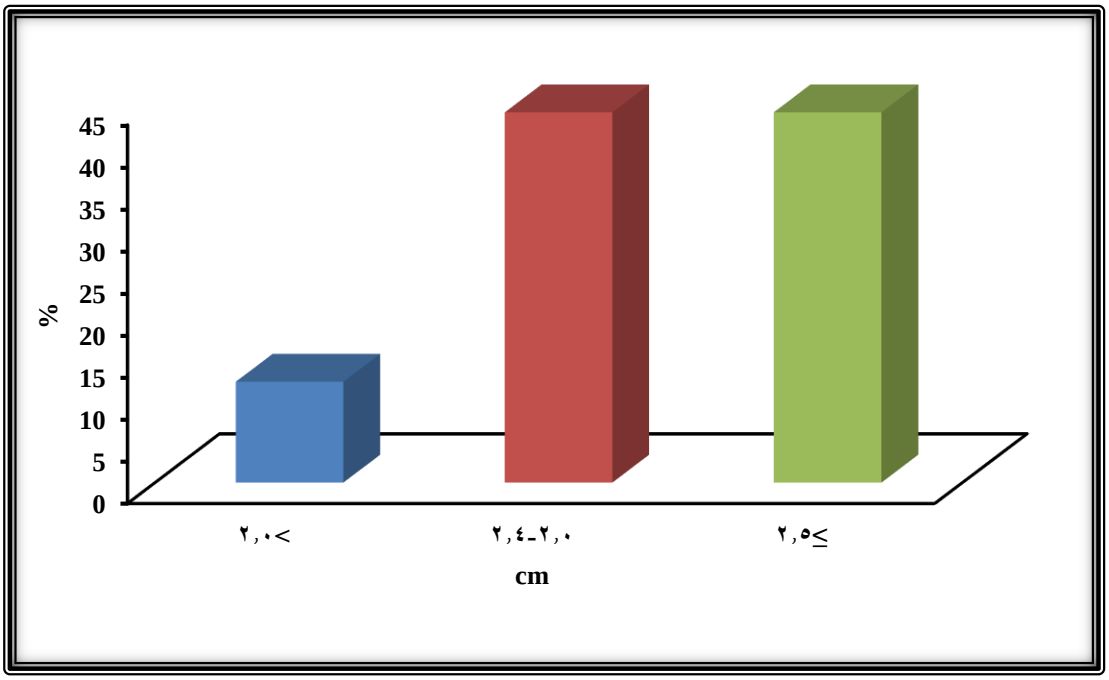
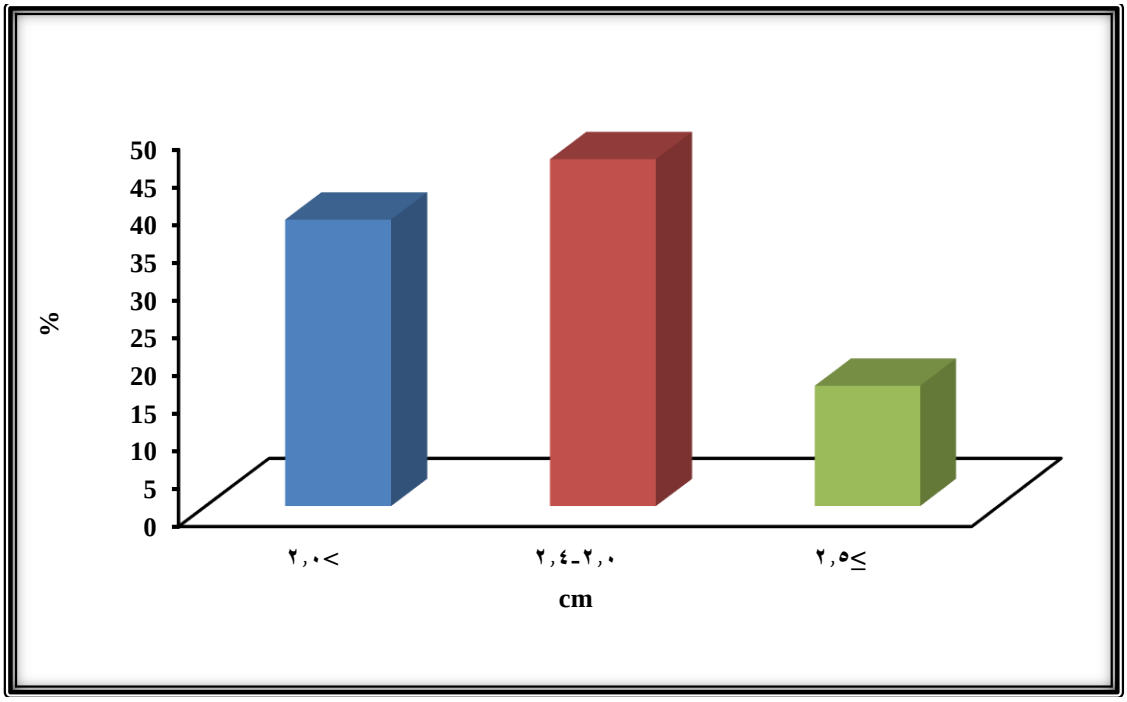


Figure (4.7) Shows Proximal width 0f aorta distribution

Table (4.8): Distribution Middle width of Aorta among population

Middle (cm)	Frequency	%
>2.0	19	38
2.0-2.4	23	46
≥2.5	8	16
Total	50	100%
Mean±SD	**2.08±0.41**	



Figure(4.8) Shows Middle width of aorta distribution

Table (4.9): Distribution Distal width of Aorta

Distal (cm)	Frequency	%
>2.0	17	34
2.0-2.4	24	48
≥2.5	9	18
Total	**50**	**100%**
Mean±SD	**2.11±0.45**	

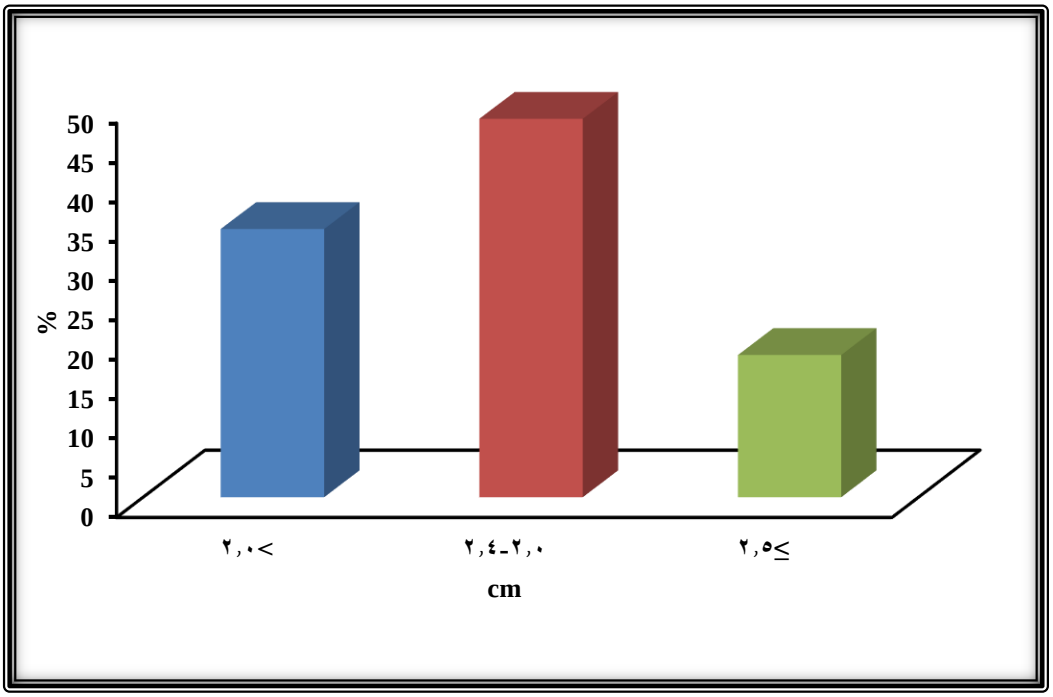


Figure (4.9) Shows Distal width of aorta distribution

Table (4.10): Relationship between age and dimensions of Aorta

Variable	Mean±SD	P-value
Age (years)	**44.34±16.70**	
Length of Aorta (cm)	14.71±2.67	0.017*
Proximal width of Aorta (cm)	2.51±0.56	0.038*
Middle width of Aorta (cm)	2.08±0.41	0.049*
Distal width of Aorta (cm)	2.11±0.45	0.001**

Table (4.11): Relationship between sex and dimensions of Aorta

Variable	Mean±SD	P-value
Sex	**Males (60%); Females (40%)**	
Length of Aorta (cm)	14.71±2.67	0.082NS
Proximal width of Aorta (cm)	2.51±0.56	0.176NS
Middle width of Aorta (cm)	2.08±0.41	0.056NS
Distal width of Aorta (cm)	2.11±0.45	0.243NS

Table (4.12): Relationship between height and dimensions of Aorta

Variable	Mean±SD	P-value
Height (cm)	**160.42±11.93**	
Length of Aorta (cm)	14.71±2.67	0.002**
Proximal width of Aorta (cm)	2.51±0.56	0.0**
Middle width of Aorta (cm)	2.08±0.41	0.005**
Distal width of Aorta (cm)	2.11±0.45	0.018*

Table (4.13): Relationship between weight and dimensions of Aorta

Variable	Mean±SD	P-value
Weight (kgs)	**60.90±17.18**	
Length of Aorta (cm)	14.71±2.67	0.006**
Proximal width of Aorta (cm)	2.51±0.56	0.0**
Middle width of Aorta (cm)	2.08±0.41	0.004**
Distal width of Aorta (cm)	2.11±0.45	0.015*

Chapter Five

Discussion, Conclusions and Recommendations

Chapter Five

Discussion, Conclusions and Recommendations

5.1 Discussion:

50 cases were selected as a sample size from three hospitals , Alamal national hospital , Alrabat National Hospital and Alateba Espiscilize Hospital , who were their aorta was normal otherwise they had a pathology in the chest, were investigated by CT for chest.

The study was attempted to compare the measurement of the normal diameter of the descending thoracic aorta in sundaes population by using computed tomography.

Age of patients understudy were distributed as 5 out of 50 (10%) were below 20 years, followed by 12 out of 50 (24%) between 20-39 years, 21 out of 50 (42%) between 40-59 years and the rest 12 out of 50 (24%) their ages 60 years or above. Height mean±SD was 14.71±2.67 years. (Table (4.1) fig. (4.1))

The majority of patients under investigation 30 out of 50 (60%) were males, while 20 out of 50 (40%) were females. (Table (4.2) fig. (4.2))

Height of interviewed patients distributed as 4 out of 50 (8%) were below than 150 cm, 19 out of 50 (38%) between 150-159 cm, 15 out of 50 (30%) between 160-169 cm and 12 out of 50 (24%) their heights 170 cm and above. Height mean±SD was 160.42±11.93 cm. (Table (4.3) fig. (4.3))

Weights of patients understudy were distributed as 6 out of 50 (12%) weighed less than 50 kilograms, 16 out of 50 (32%) weighed 50-59 kilograms, 12 out of 50 (24%) weighed 60-69 kilograms, 11 out of 50 (22%) weighed 70-79 kilograms, whereas 5 out of 50 (10%) weighed 80

kilograms or above. Weight mean±SD was 60.90±17.18 kilograms. (Table (4.4) fig. (4.4))

The type of machines used in the study. 2 out of 50 (4%) were Toshiba 64 slices, 18 out of 50 (36%) were Siemens and 30 out of 50 (60%) were Toshiba 64 slice. . (Table (4.5) fig. (4.5))

Length of Aorta of interviewed patients were distributed as 12 out of 50 (24%) their Aorta length was 12½ cm, 18 out of 50 (36%) their length between 12.5-14.9 cm, 9 out of 50 (18%) between 15.0-17.4 cm, and 11 out of 50 (22%) were 17½ cm or above. Length of Aorta mean±SD was 14.71±2.67 cm. (Table (4.6) fig. (4.6)). This disagree with the study of Charles T.Dotter1950 December New York.

Proximal width of Aorta distributed as 6 out of 50 (12%) their proximal below 2 cm, 22 out of 50 (44%) were 2.0-2.4 and ≥2.5 cm, respectively. Proximal width of Aorta mean±SD was 2.51±0.56 cm. (Table (4.7) fig. (4.7)). This agree with the studies of Italian society of ital cardiol. 1997and Alfred Hager 2006 Germany.

Middle width of Aorta of patients under investigation was distributed as 19 out of 50 (38%) their middle width of Aorta was. Mean±SD of middle width of Aorta of was 2.08±0.41 cm.

Below 2 cm, 23 out of 50 (46%) between 2.0-2.4 cm and the rest 8 out of 50 (16%) were ≥2.5 cm or above. (Table (4.8) fig. (4.8),distal width of Aorta of was 2.08±0.41 cm. of Aorta distributed as 17 out of 50 (34%) were fewer than 2.0 cm, 24 out of 50 (48%) between 2.0-2.4 cm and 9 out of 50 (18%) were ≥2.5 cm. Mean±SD of distal width of Aorta was 2.11±0.45 cm. (Table (4.9) fig. (4.9)). This agree with the studies of Acad Radiol 2008 from united state,Italian society of ital cardiol.1997 and Alfred Hager 2006 Germany.

5.2 Conclusions:

The study concluded that detailed analysis of thoracic aorta diameter in group of healthy Sudanese population; dimensions of the aorta are influenced by the age, length and weight of the patient, but not by the sex. The result of this study showed that the diameter of descending thoracic Aorta was(2.51±0.56 cm) to the reference study of Alfred Hager Germany 2006.(2.43±0.55 cm)

There was significant difference observed between age of patients understudy and length and width of aorta. There is no significant relationship between sex and type of machine and dimensions of Aorta.

Relationship between height and dimensions of Aorta showed highly significant difference with length of Aorta, proximal width of Aorta and middle width of Aorta.

Highly significant difference between weight of investigated patients and length of Aorta, proximal width of Aorta and middle width of Aorta, but significant difference was noticed with distal width of Aorta.

Finally, Although all of the modalities have diagnostic value, CT has evolved to be main stay of evaluation owing to its accuracy and reproducibility, as well as its speed, simplicity and true 3- dimensional capabilities ,and with observing results, the computed tomography is play a great role in the measurement of normal diameter of descending of thoracic aorta.

5.3 Recommendations:

1-Farther studies to measure the whole Aorta in Sudanese population with different modalities .

2-Further studies to measure the thoracic aorta in different levels.

3-Further studies with increase number of casese and habits .

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Appendix

Appendix (1)

Figure show the length measurement of the descending thoracic aorta in CT sagittal plane

Figure show the proximal width measurement of the descending thoracic aorta in CT axial plane

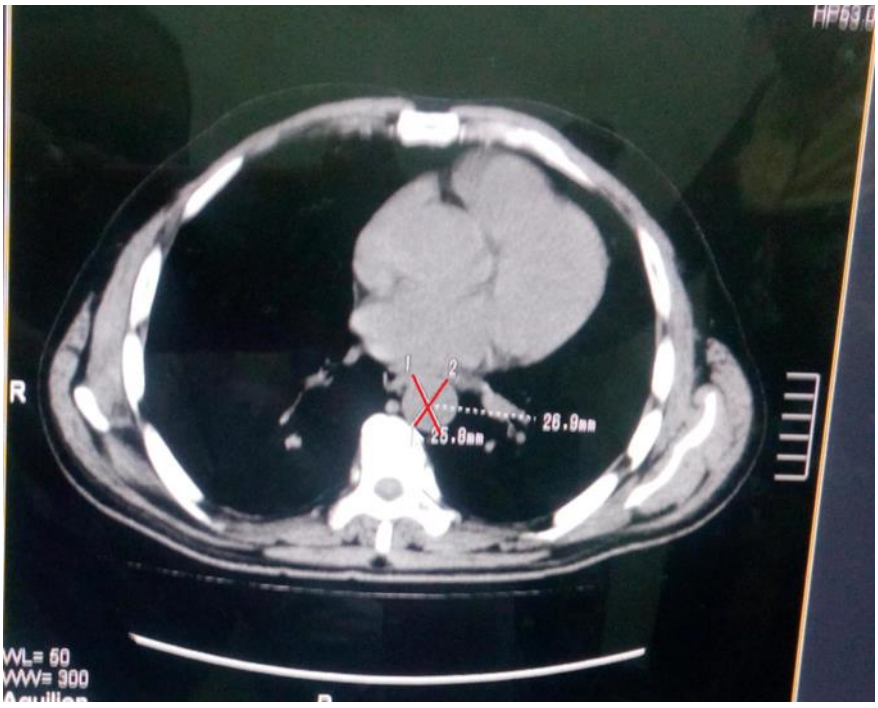

Figure show the middle width measurement of the descending thoracic aorta in CT axial plane

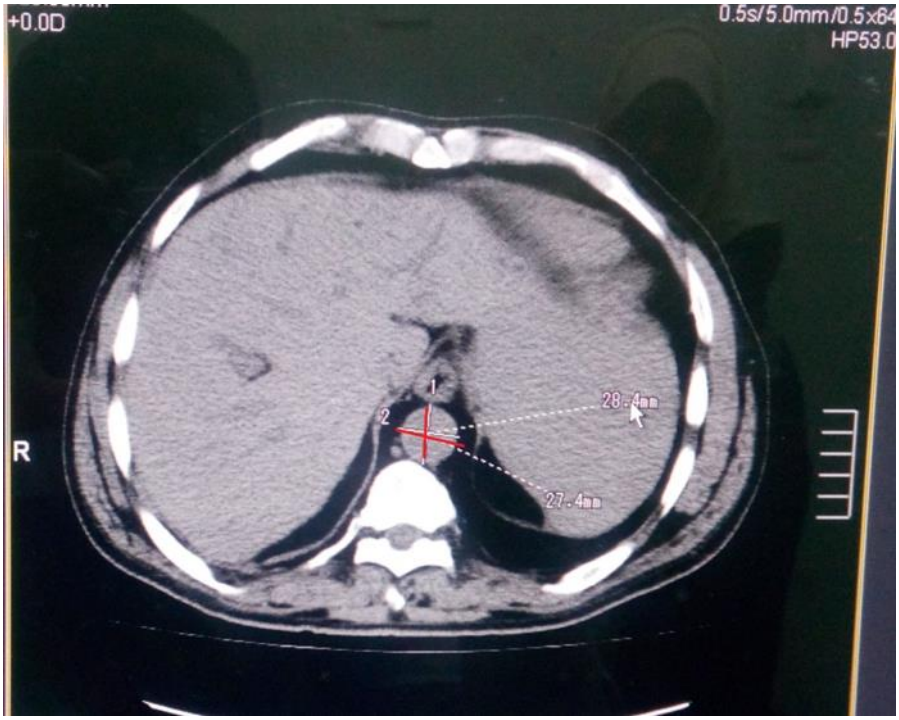

Figure show the distal width measurement of the descending thoracic aorta in CT axial plane

Appendix(2)

Ct machine 64 sclicse (alamal national hospital)

Appendix (3)

Data collection sheet

No.	Age	Sex	Height of the pt.	Weight of the pt.	Diameter of the descending thoracic aorta			Length of descending aorta.
					Proximal Level T5	Middle Level T6-T7	Distal Level T12	