Chapter One

Introduction

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Peripheral arterial disease (PAD)is an expression of atherosclerosis in the lower limb distal to the aortic bifurcation, which is a major problem in the population of 55 years and older.[1](PAD) is characterized by athermanous

Narrowing or occlusion of one or more of the arteries of the leg. Symptoms include intermittent claudication, ischemic rest pain, ulceration and gangrene[2]

Diagnostic imaging development is performed when PAD becomes life style limiting. Severity of stenosis how is significant variation that carries them medical decision-making [3,4].Digital subtraction angiography (DSA) has traditionally been used for anatomic assessment of PAD it provides a precise road map for planning treatment, but due to its invasiveness, DSA is associated with a risk of morbidity and mortality.

[5].Therefore, non-invasive imaging tests including duplex ultrasound (DUS), multi-detector computed tomographic angiography (CTA), and contrast-enhanced magnetic resonance angiography (MRA) are increasingly used for the initial evaluation of patients with PAD.

MRA became available for non-invasive imaging of the peripheral arteries in the early nineties 6,7]. Then, the introduction of contrast-enhanced MRA offered the wide spread usage for imaging peripheral arterial disease [8,9]. Disadvantages of MRA include the higher cost ,and

also contra indications like having a pacemaker and being claustrophobic[10].

More recently, in the late nineties multi-detector row CT scanners have been introduced for the noninvasive diagnostic imaging of PAD. The use of multi-detector row technology has resulted in shorter acquisition time, Increased volume coverage, lower dose of contrast medium, and improved spatial resolution [11].Results of several studies have shown that multi-detector row CTA is accurate for imaging peripheral arteries[12-15].The main disadvantages of CTA is the use of radiation,[16]the use of nephro- toxic iodinated contrast medium, the time-consuming reconstruction techniques, and the difficulty in assessing arterial luminal stenosis in the presence of vessel wall calcifications.[17,18] as well, several disadvantages compared with magnetic resonance angiography (MRA),including uncertainties in contrast bolus timing which may result in images obtained o early with poor arterial opacification or too late, poor opacification and venous contamination. For this reason, time-resolved MRA may be a better examination for evaluating peripheral arteries below-the-knee over flow [19].

This research was carried out to examine the evidence on effectiveness regarding the value of magnetic resonance angiography and computed tomographic angiography, as well to identify which technique is more acceptable to patients for the assessment of symptomatic peripheral arterial disease. The scientific base of diagnostic performance of CTA or MRA in diagnosing of peripheral artery disease were highlighted and the current study was intended to serve ready source

of information and to determine the protocols for physician about the most suitable method of diagnosing peripheral artery diseases.

1 . 2 : Material sand Methods:

In this study, cases were maintained at King Fahad Hospital regarding the Diagnostic of MRA magnetic resonance angiography for low erextremity peripheral arterial disease; in comparison to CT angiography. The purpose of the current study is to evaluate the diagnostic performance Magnetic Resonance Angiography at 1.5 T versus CT angiography for evaluation of lower extremity Peripheral Arterial Disease(PAD).

100 consecutive patients(52males, 48 were females, age range 34–83 years, average age 62.3years)with clinically suspected lower extremity PAD underwent MR and CTA. The diagnosis was compared in both modalities by two radiologists with10and8years'experience.

Main symptoms of the patients were limb pain and claudication with an average duration of 11.5months.Mean Creatinine level was from41to228μmol/ with an average of76.3 μmol/L. Main pertinent medical history

wassmoking(n = 30),diabetes(n = 45),hypertension(n = 25).Permissionwasob tainedfrom all patients before the examinations. MR and CTA examinations were performed on the same day.MRA was performed prior to CTAin70casesandafterCTAin30cases.

1 . 3: Magnetic Resonance Angiography –MRA)-: -

All MRA examinations were performed on a 1.5 T whole- body MRI system GE. Patients were placed on the scanner in feet-first supine position. A dedicated peripheral coil and two eight-element body array coils were used to cover the lower extremity and lower abdomen, and were combined

with the posterior integrated multi-channel spine coil. Electrocardiographic triggering was used to ensure proper synchronization between the arterial in flow even stand data sampling. Initially a scout image was performed of the whole lower extremity and abdomen for localization purposes using the following parameters: TR/TE, 2.56/1.44ms; FOV,

48 cm × 149cm; slice thickness, 5mm. MRA was performed in the transverse plane with the following

parameters: TR = 1 heart beat; TE = 1.68ms;flipangle, 90,orreduced according to SAR limitation ;band width,

700Hz;FOV,400

mm × 260mm;matrix,400 × 261;numberofslices,40;slicethickness,3mm.Th edata acquisition was performed inapproximately6.5min, given an average heart rate of 80/min. Coronal Maximum Intensity Projection (MIP) images of each station were generated by the scanner software, and all the MIP images were automatically spliced in to a composite image including then tire region of interest.

1 . 4: Computerized Angiogram (CTA):

All CTAexaminationswereperformedata128-row CT scanner

(DiscoveryHD750,GEmedical,

America),with the following parameters: tube voltage,100KVp; tubecurrent,150 mA; pitch, 0.98 4:1; table speed, 55mm/s; slice thickness, 0.625 mm; FOV, 50cm. Iodinated contrast agent (Ultravist, Bayer, Germany,

1.2 ml/kg bodyweight) was administered via an electronic power injector (Stellant, MEDRAD, America) through an18 gauge intravenous

1.3 line placed in the right cubital vein, at a rate of3 ml/s. The bolus-tracking technique was used whereby a region of interest (ROI) was

positioned at the aortic bifurcation. Image acquisition automatically started 5.5 safer the attenuation in the ROI reached the predefined threshold of 120 Hounsfield Units(HU).Post-processing procedures and measurement were performed on dedicated General Electric MRI machine. CTAMIP images were reconstructed with a window setting of 600/ 300 (window width/window level).

1. 5: Research Problem

1. The scientific base of accuracy of CTA or MRA in diagnosing of peripheral artery disease was not determined in investigating selection.
2. Angiographic radiography using cardiac catheter into any of the heart chambers, or any of main vessels is invasive and time consuming.

1 .6: Objectives:

1. To determine the diagnostic accuracy of magnetic resonance angiography and computed tomographic angiography, alone or in combination, for the assessment of lower limb peripheral arterial disease.
2. To maintain criteria and protocols to manage patient with peripheral arterial disease(PAD).
3. To evaluate the impact of these assessment methods on management of patients and outcomes.

1. 7: Thesis Overview:

The purpose of the current study was to evaluate the diagnostic value of MRA at1.5T versus CTA for evaluation of lower extremity peripheral arterial disease (PAD).

Accordingly, it is divided into the following chapters:

Chapter one is the introduction to this thesis. This chapter discusses the objectives and scope of work and introduces necessary background. It also provides an outline of the thesis.

Chapter two contains the background material for the thesis. Specifically it discusses the dose for all absorbed dose measurements and calculations. This chapter also includes a summary of previous work performed in this field.

Chapter three describes the materials and a method used to measure dose for CT machines and explains in details the methods used for dose calculation and optimization. Chapter four presents the results of this study. Chapter five presents the discussion, conclusion and recommendations of the thesis and presents suggestions for future work.

1. 8: Expected out comes

1. To enable physician and medical staff to determine which more efficiently and effectively method of investigation to be used in diagnosing peripheral artery disease and how severe the blockage is.
2. To evaluate and identify of aneurysms and cystic adventitial disease.
3. To Maintain precise assessment of atherosclerotic arterial disease using CTA & MRA.
4. Is intended to serve ready source of information about the most suitable method of diagnosing of Peripheral artery disease.
5. To determine protocols for physician to mange patient with (PAD) Peripheral arterial disease.

1. 9: Publications:

Two papers were published at IOSR Journal of dental and medical Sciences (IOSR-JDMS)

The first by the title: [Diagnostic Value Of CTA And MRA In Peripheral Artery Disease]. *e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 16, Issue 9 Ver. VI (Sep. 2017),* pp59-66 ,www.iosrjournals.org.

The second paper with title: [Diagnostic of peripheral arteries disease in Saudi Arabia population - CTA & MRA based Study].

Chapter Two

Literature Review

Chapter Two

Literature Review

2. 1:Anatomy:

Blood vascular tree is a circuit that conducts blood from the heart through arteries- large- diameter, low-resistance conducting vessels to small arteries and arterioles, capillaries are thin-walled a process that requires a very large area. The circuit back to the heart is completed by the veins, which are distensible and provide a volume buffer that acts as a capacitance for the vascular circuit. Walls of the blood vessel consist of three basic structures, Intima, media, and adventitia, which vary with the types of the vessels. Intima is composed of lining endothelial cells, separated from the media byinternal elastic lamina. Media is composed of smooth muscle cells. Outer limit of the media is separated from adventitia by external elastic lamina. Small arterioles (vasa vasorum) pass through the adventitia into the outer one-half to two-thirds of the media to perfuse the vessel wall. The circulation to the leg is derived from the femoral artery that is a continuation of the external iliac artery. A major branch from the femoral artery is the deep femoral artery. Distal to the deep femoral branch, the femoral artery (sometimes referred to as the superficial femoral artery at this point) continues down the leg and becomes the popliteal artery just above the knee. Two major arteries at the termination of the popliteal artery are the anterior and posterior tibial arteries, which supply blood flow to the lower leg and foot.

Femoral Artery:

The artery which supplies the greater part of the lower extremity is the direct continuation of the external iliac. It runs as a single trunk from the inguinal

ligament to the lower border of the popliteus, where it divides into two branches, the **anterior** and **posterior tibial.** The upper part of the main trunk is named the **femoral,** the lower part the **popliteal. See Fig. 1 –**which illustrates scheme of the femoral artery, common iliac bifurcates, internal iliac which courses anterior and adjacent to the sacroiliac joint. Posterior branches of the internal iliac artery: iliolumbar, superior-gluteal, and lateral sacral arteries. The anterior branches of internal iliac artery: Obturator, umbilical, vesical, pudendal, inferior gluteal, rectal and hemorrhoid arteries, external iliac artery passes obliquely down medial border of psoas& anterior and lateral to external iliac vein. The external iliac artery becomes the common femoral artery as it passes below the inguinal ligament.- Common femoral artery is approximately 4 cm in length and divides into superficial femoral and profunda femoral arteries. In upper thigh this artery lies between femoral vein and nerve in femoral triangle space roofed by fascia lata and bounded by inguinal ligament above, Sartorius muscle laterally, and adductor longus medially.

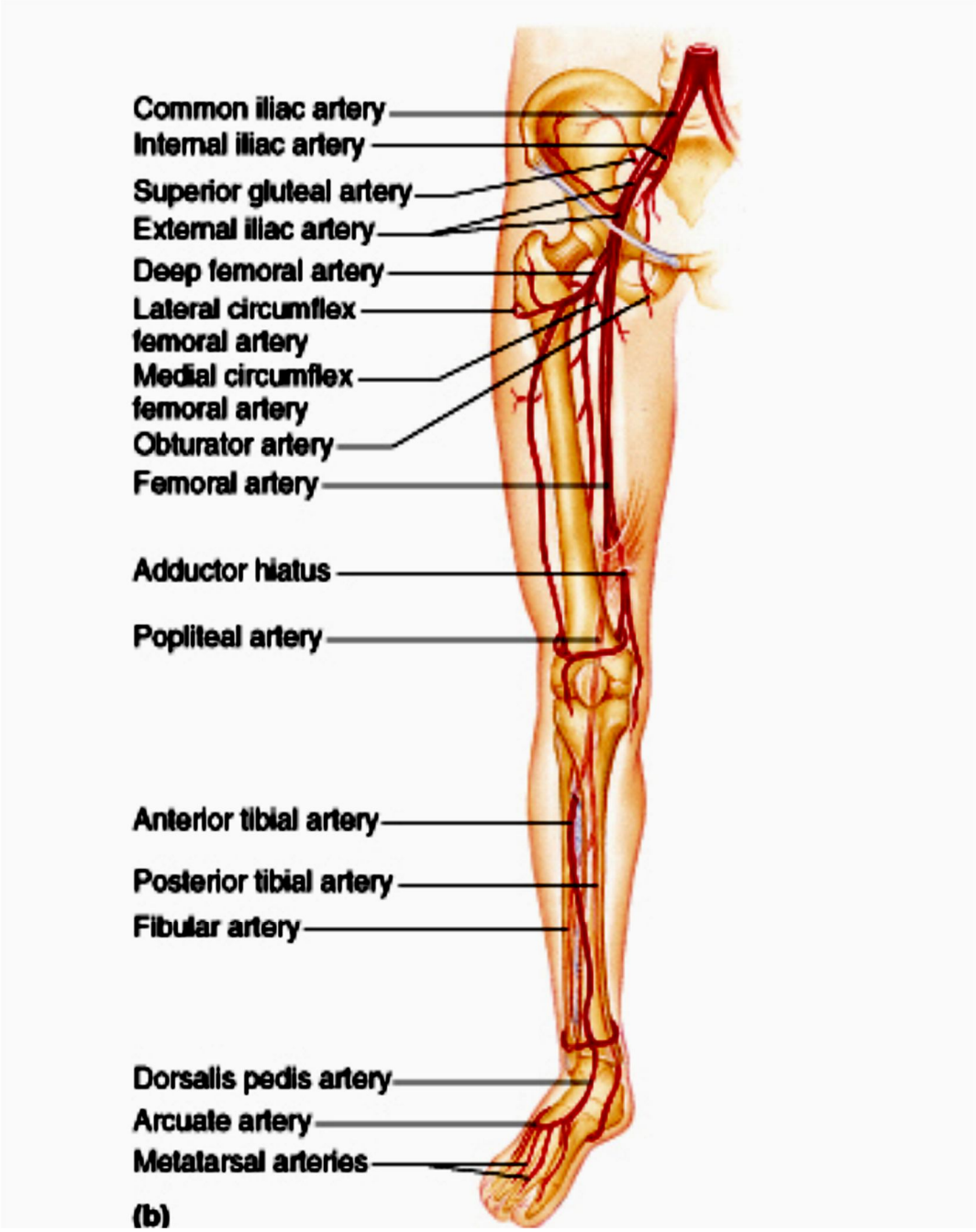

Fig. 2 . 1 :Scheme of the Femoral Artery.

Benjamin Cummings 2001

- Largest branch of the femoral artery in femoral triangle is profunda femoris, which arises on lateral side of the femoral artery, arches posteriorly, and continues downwards near the middle of the thigh; - Descending genicular artery arises from femoral artery; - at the distal apex of femoral triangle, above the knee, it passes through opening in adductor magnus to Enter popliteal space as popliteal artery.

- After providing genicular arteries at level of knee joint, it passes deep to soleus, where it transverses thru another fibrous tunnel; (hence, artery remains vulnerable during dislocation of knee because of tethering.

Popliteal artery then sends paired sural arteries to gastrocnemius & soleus ends by dividing into anterior & posterior tibial arteries.

Profunda Femoris: (deep femoral artery):

- largest branch of femoral artery in femoral triangle;
- arises on lateral side of femoral artery, 3-5 cm below inguinal leg;
- passes on surface of pectineus & adductor brevis;
- passes posterior, lying behind femoral artery& vein on medial side of femur, passing behind tendon of adductor longus;
- courses to lie directly on adductor magnus, perforating branches pass between edge of femur and tendinous insertion of add magnus **See Fig. 2**

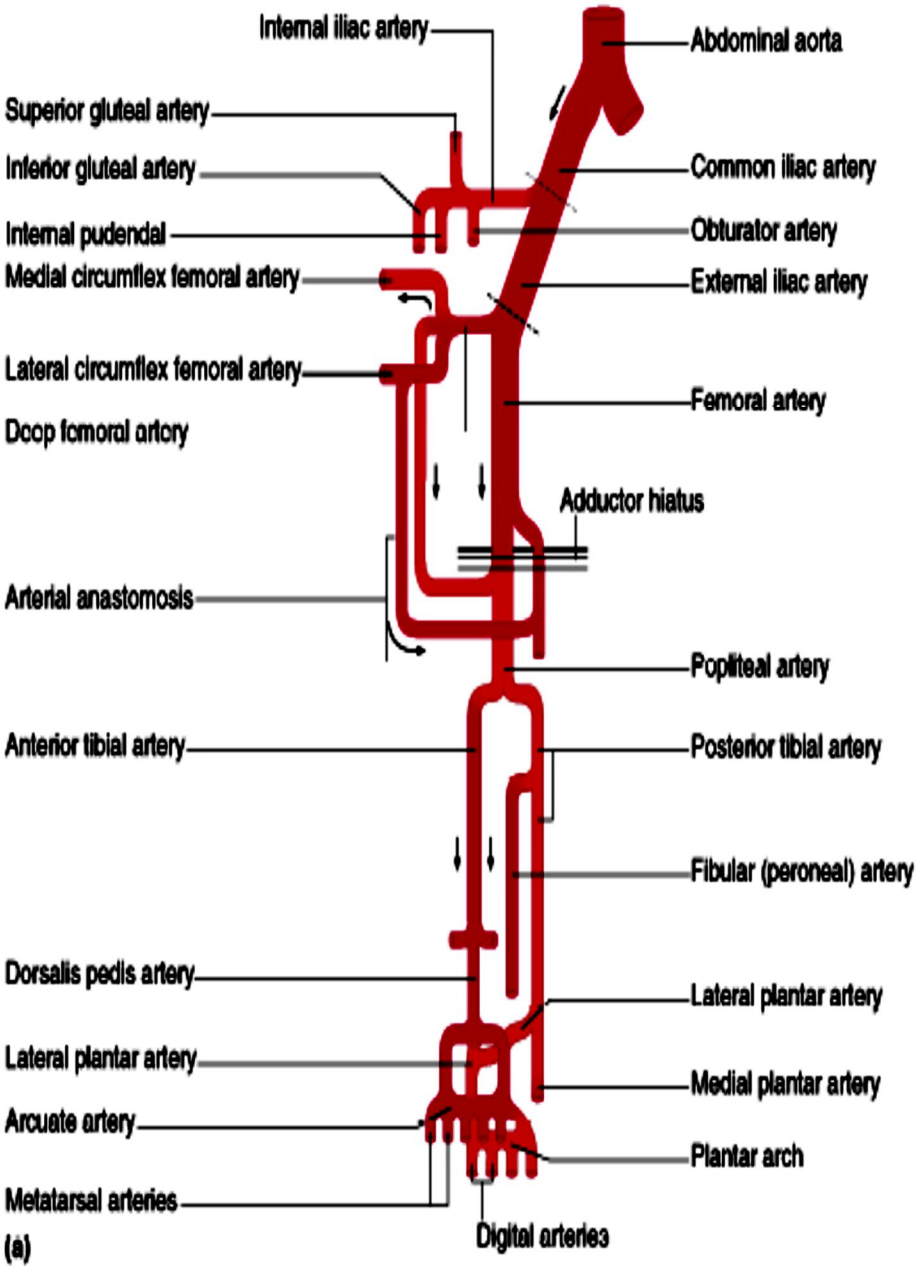

Fig. 2 . 2 : Scheme of the Lower limb blood supply.

Benjamin Cummings 2001

Popliteal Artery:

- Popliteal artery is the continuation of superficial femoral artery at hiatus of The adductor magnus muscle;
- Artery is anchored proximally by tendinous insertion of adductor magnus upon the medial femoral epicondyle.
- It runs posterior to the distal femur, behind the knee joint;
- At the level of the knee joint, the popliteal artery gives off the medial and lateral genicular arteries.
- Popliteal artery lies behind posterior horn of the lateral meniscus;
- Only thin layer of fat separates popliteal artery from thin posterior capsule behind posterior horn of lateral meniscus.
- Popliteal artery lies anterior to popliteal vein and 9 mm posterior to the posterior aspect of tibial plateau in 90 degrees of flexion.
- Before passing deep to fibrous arch over soleus muscle, it divides into anterior and posterior tibial arteries at distal aspect of popliteus muscle.
- Popliteal artery normally branches into anterior tibial arteryand tibioperoneal trunk at distal border of popliteus muscle.
- Anterior tibial artery passes from behind through gap above interosseous membrane to enter anterior compartment of leg and supply its muscles;
- As it crosses membrane, it gives off a recurrent branch;
- It continues on dorsum of foot as dorsalis pedis artery, which gives off medial and lateral tarsal branches, and ends by dividing into arcuate artery and the larger deep planter artery.

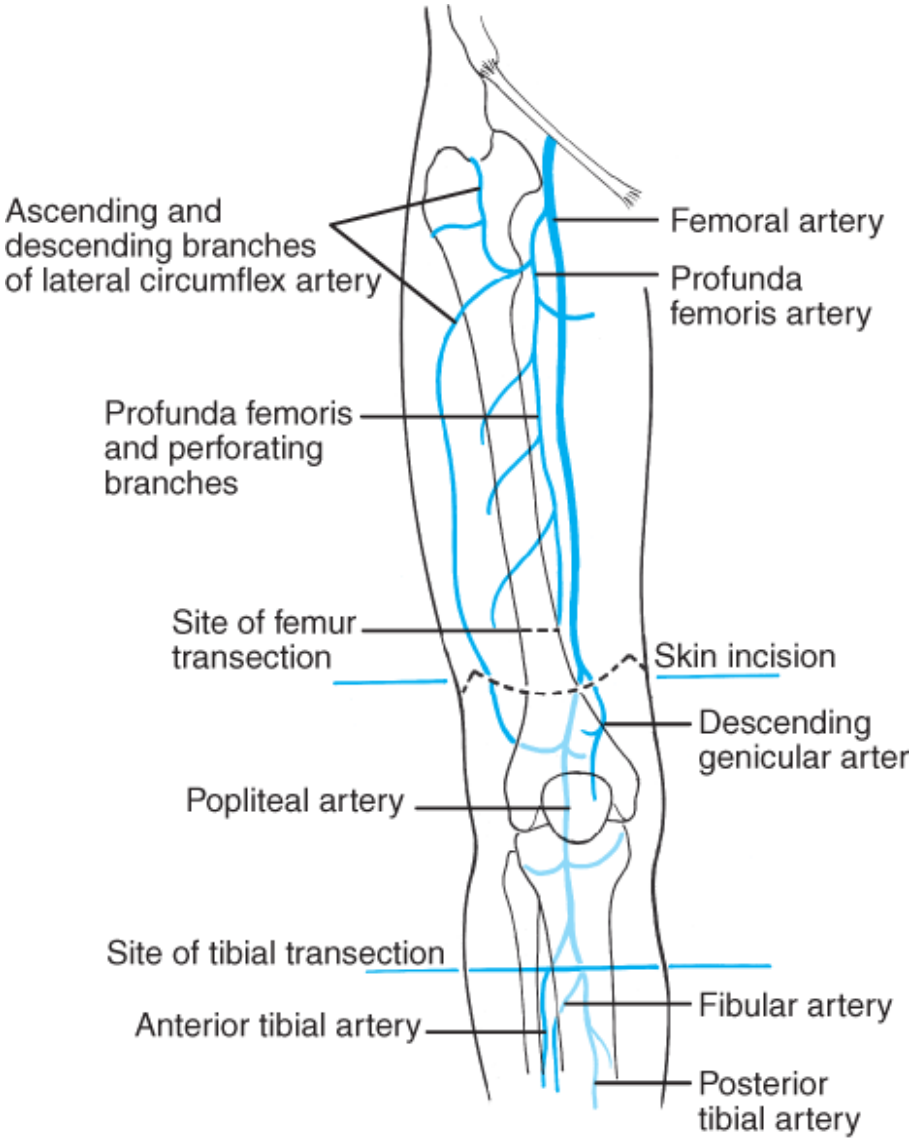

Fig. 2 . 3 : Scheme of the Femoral Artery.

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- Arcuate artery has three metatarsal branches that, in turn, divide into dorsal digital arteries.

- Deep plantar artery sends digital branches to great toe and second toe and passes between heads of the first dorsal interosseous muscle to the plantar surface;

Medial plantar artery:

- travels w/ medial plantar nerve supplies medial portion of plantar foot;
- three medial metatarsal arteries usually receive branches from the medial plantar artery;

lateral plantar artery:

- travels w/ lateral plantar nerve& passes across foot to form plantar arch, which joins w/ deep plantar artery from the dorsalis pedis.

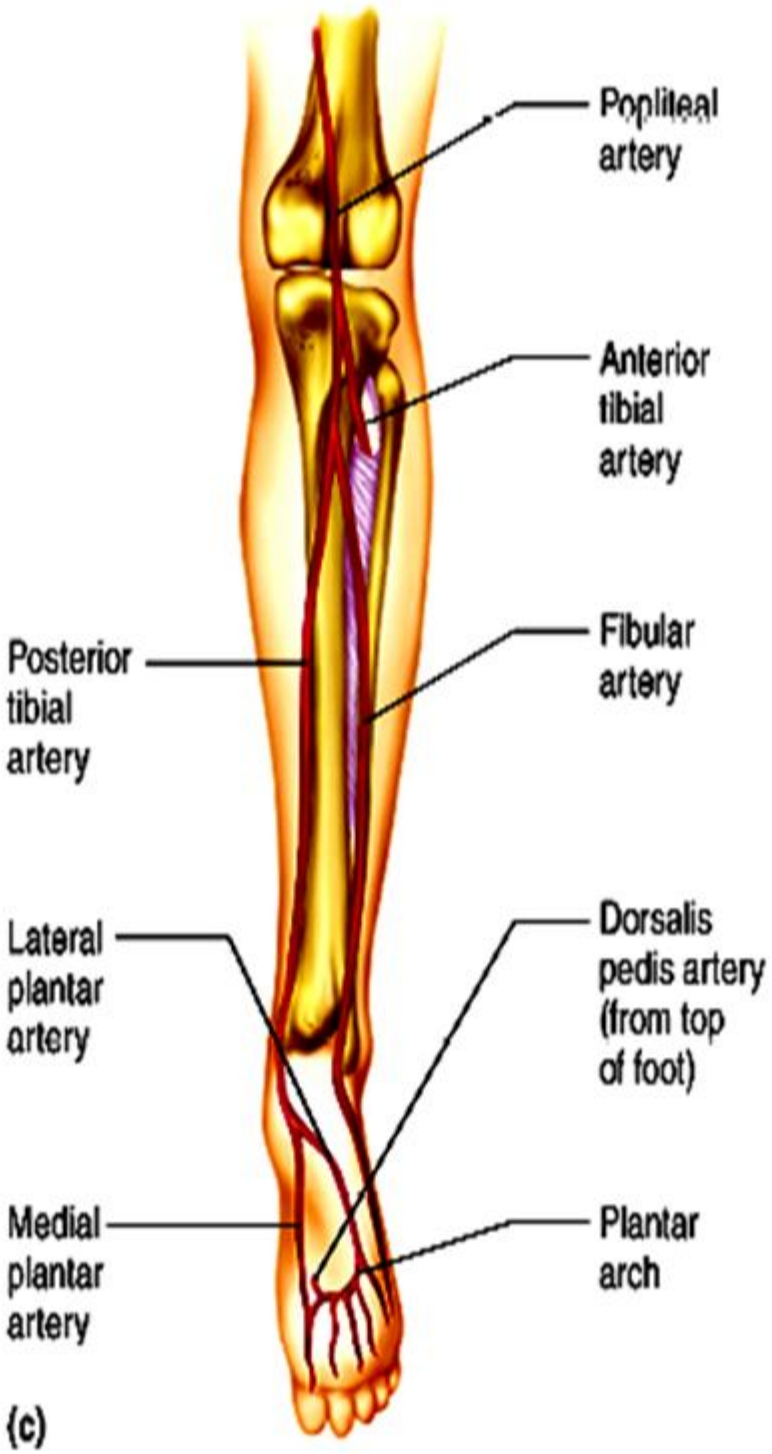

Fig. 2 . 4 : Scheme of the Leg Blood Supply.

Benjamin Cummings 2001

2.2:Physiology:

The circulatory system is the continuous system of tubes through which the blood is pumped around the body. It supplies the tissues with their requirements and removes waste products.

The Formation of Tissue Fluid and Lymph:

The thin walls of capillaries allow water, some white blood cells and many dissolved substances to diffuse through them. These form a clear fluid called **tissue fluid** (or **extracellular fluid** or **interstitial fluid**) that surrounds the cells of the tissues. The tissue fluid allows oxygen and nutrients to pass from the blood to the cells and carbon dioxide and other waste products to be removed from the tissues. Some tissue fluid finds its way back into the capillaries and some of it flows into the blind-ended lymphatic vessels that form a network in the tissues. Once the tissue fluid has entered the lymphatic it is called **lymph** although its composition remains the same. The lymph vessels have walls that are even thinner than the capillaries. This means that molecules and particles that are larger than those that can pass into the blood stream e.g. cancer cells and bacteria can enter the lymphatic system. These are then filtered out as the lymph passes through lymph nodes.

Arteries are blood vessels which carry blood away from the heart. All of which, with the exception of the pulmonary artery, carry oxygenated blood. The most widely known artery within the human body is the Aorta.

This is the largest of all blood vessels and transports blood away from the left ventricle of the heart where it then branches into smaller arteries.

As the arteries divide further they become smaller and smaller, until they are classed as arterioles. Arterioles continue to branch into smaller and smaller vessels which,

once they have decreased in size below 10 micrometers in diameter are known as **capillaries**. Small arteries and arterioles which lower blood pressure and protect the capillaries that allows the exchange of nutrients and waste products between tissue and blood. The pulmonary artery, is classed as an artery as it carries blood away from the heart, however it carries deoxygenated blood. The blood it carries has travelled around the body and back to the heart where it is pumped, via the pulmonary artery, to the lungs to release waste products and pick up more oxygen.

Smaller arteries and arterioles contain more smooth muscle tissue in order to control the changing pressure of the blood flow. This change in pressure is a direct effect of the pumping of the heart. During the diastolic phase blood pressure is low due to the rest period of the heart. In the systolic phase the heart contracts, forcing blood through the arteries and subsequently increasing the pressure. This change in pressure within an artery is what you can feel when you take a pulse

2. 3: Pathology:

Other Names for Peripheral Arterial Disease

- Atherosclerotic peripheral arterial disease
- Peripheral vascular disease
- Vascular disease
- Hardening of the arteries
- Claudication

Peripheral Artery Disease (PAD):*See Fig:(2 .5*) *&Fig (2. 6).*

PAD is a narrowing of the peripheral arteries, most common in the arteries of the pelvis and legs. Peripheral Artery Disease results from fatty deposits (plaque) that build up in the arteries outside the heart (peripheral arteries); mainly the arteries supplying the legs and feet. This buildup

narrows or blocks the arteries and reduces the amount of blood and oxygen delivered to the leg muscles and feet. The iliac, femoral, popliteal and tibial arteries are commonly affected PAD is similar to coronary artery disease (CAD) and carotid artery disease. All three of these conditions are caused by narrowed and blocked arteries in various critical regions of the body. Hardened arteries (or atherosclerosis) in the coronary artery region, restricts the blood supply to the heart muscle. Carotid artery disease refers to atherosclerosis in the arteries that supply blood to the brain.

The arteries carry blood rich in oxygen and nutrients from their heart to the rest of the body. When the arteries in the legs become blocked, the legs do not receive enough blood or oxygen, this condition called peripheral artery disease (PAD), sometimes called leg artery disease.

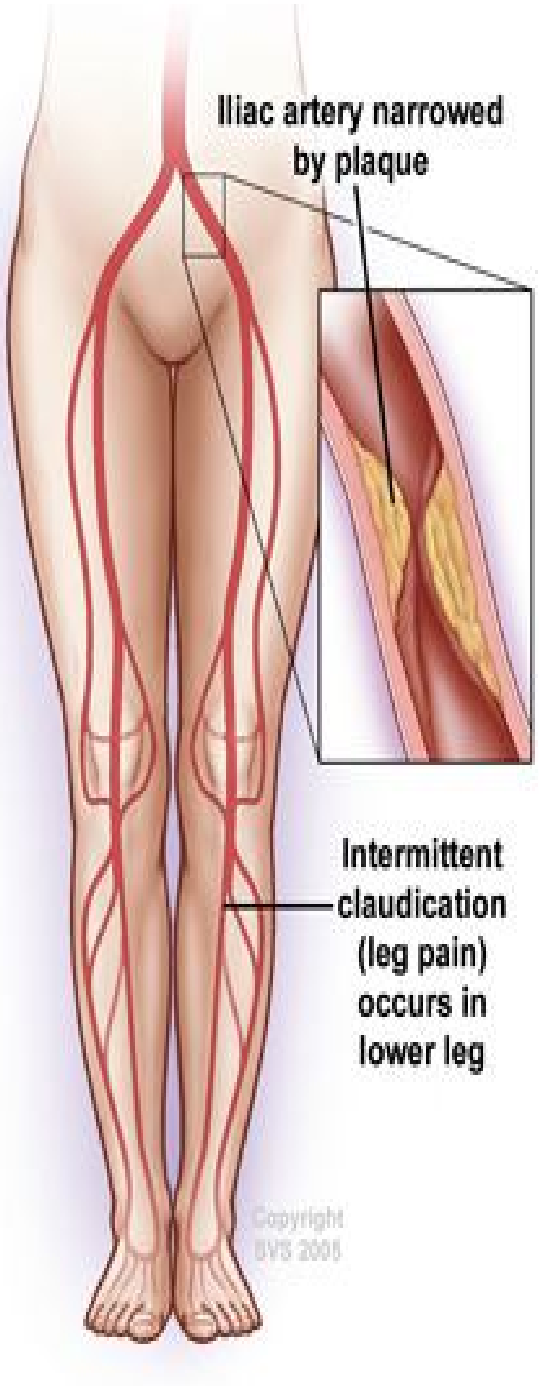

Figure :2. 5 : Peripheral Artery Disease (PAD)

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PAD can cause discomfort or pain during walking. The pain can occur in the hips, buttocks, thighs, knees, shins, or upper feet. One in 3 people age 70 or older has PAD. Smoking or having diabetes increases chances of developing the disease sooner.

The aorta is the largest artery in the body, and it carries blood pumped out of the heart to the rest of the body. Just beneath the belly button in the abdomen, the aorta splits into the two iliac arteries, which carry blood into each leg. When the iliac arteries reach the groin, they split again to become the femoral arteries. Many smaller arteries branch from the femoral arteries to take blood down to the toes.

The arteries are normally smooth and unobstructed on the inside but, with age, they can become blocked through a process called atherosclerosis, which means hardening of the arteries. With age, a sticky substance called plaque can build up in the walls of the arteries. Plaque is made up of cholesterol, calcium, and fibrous tissue. As more plaque builds up, the arteries narrow and stiffen. Eventually, enough plaque builds up to reduce blood flow to the leg arteries. When this happens, the leg does not receive the oxygen it needs. Physicians call this leg artery disease. Patient may feel well and still have leg artery disease or sometimes similar blockages in other arteries, such as those leading to the heart or brain. It is important to treat this disease not only because it may leads to a greater risk for limb loss but also for having a heart attack or stroke.

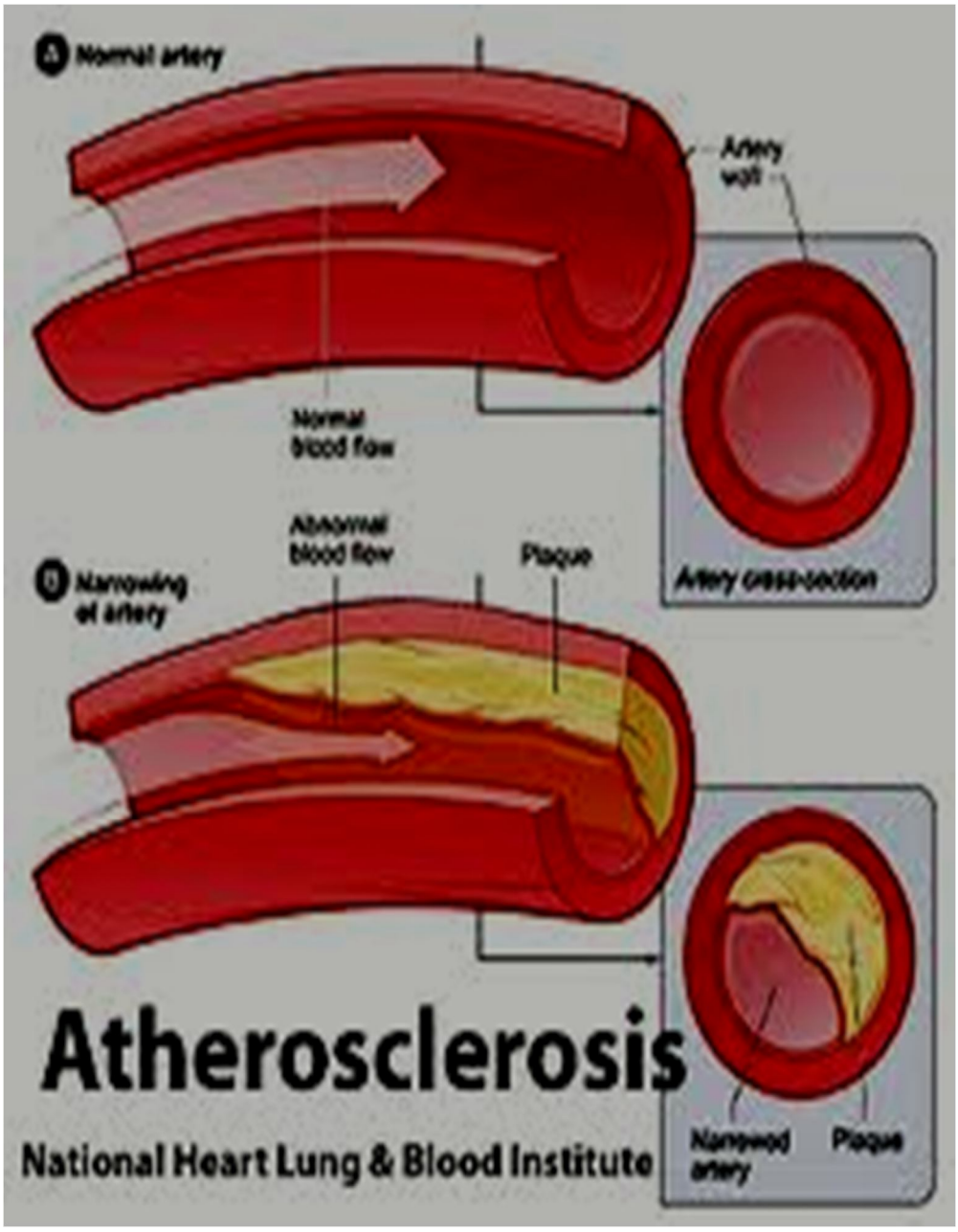

Fig 2.6:An illustration of peripheral artery disease

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The symptoms of peripheral artery disease:

Lower limb peripheral arterial disease (PAD) mischaracterized by athermanous narrowing or occlusion of one or more of the arteries of the leg. Narrowing (stenosis) of the arteries reduces blood flow through the affected artery and hence to distal tissues and may lead to the development of symptoms. Complete occlusion usually results from superimposed thrombosis within a narrowed artery.

The most common symptom of lower limb PAD is calf pain when walking or, if more proximal arteries such as the common/external iliac arteries or the aorta are narrowed, then pain may develop in the thighs or buttocks. This results in the patient needing to pause during walking, in order to relieve pain. The condition is known as intermittent claudication. Less specific symptoms of lower limb PAD include poor hair and toenail growth and cool feet. When lower limb blood flow is more severely compromised rest pain may develop. Any further deterioration in limb perfusion may result in ulceration or gangrene, both of which may be precipitated by minortrauma.1 the severity of lower limb PAD can be described using the classification developed by Leriche and Fontaine in the 1920s: stage I, asymptomatic; stage II, intermittent claudication; stage III, ischemic rest pain; stage IV, focal tissue necrosis with or without ischemic rest pain.

Risk factors for PAD include advanced age, smoking, hypertension, hyper lipidemia, diabetes, obesity, physical inactivity and family history. The most important of these risk factors is smoking. The relative risk for a person smoking more than15 cigarettes a day of developing PAD, compared with a non-smoker, is approximately 9.2 PAD is also common in diabetes, which is present in around 20% of PAD patients.

Patient may not feel any symptoms from peripheral artery disease at first. The most common early symptom is intermittent claudication which is discomfort or pain in the legs that happens when patient walk and goes away when patient rest. Patient may not always feel pain; instead he may feel tightness, heaviness, cramping, or weakness in the leg with activity, often occurs more quickly if he walk uphill or up a flight of stairs. Over time, he may begin to feel intermittent claudication at shorter walking distances.

Critical limb ischemia is a symptom that patient may experience if he have advanced peripheral artery disease. This occurs when the legs do not get enough oxygen even during resting. With critical limb ischemia, patient may experience pain in the feet or in the toes even when he is not walking.

Symptoms of severe PAD include:

- Leg pain that does not go away when stopped exercising.
- Foot or toe wounds that won't heal or heal very slowly.
- Gangrene.
- A marked decrease in the temperature of the lower leg or foot particularly compared to the other leg or to the rest of your body.

Other Signs and Symptoms

Other signs and symptoms of P.A.D. includes:

- Weak or absent pulses in the legs or feet.
- Sores or wounds on the toes, feet, or legs that heal slowly, or not at all.
- A pale or bluish color to the skin.
- A lower temperature in one leg compared to the other leg.
- Poor nail growth on the toes and decreased hair growth on the legs.
- Erectile dysfunction, especially among men who have diabetes.

Causes of peripheral artery disease (PAD):

Atherosclerosis causes peripheral artery disease. As person get older, risk of developing leg artery disease increases. People older than age 50 have an increased risk of developing the disease, and men have a greater risk than women.

Other factors that increase chances of developing the disease

includes:

- Smoking.
- Diabetes.
- High blood pressure.
- High cholesterol or triglycerides.
- High levels of homocysteine, an amino acid in your blood.
- Weighing over 30 percent more than your ideal weight.

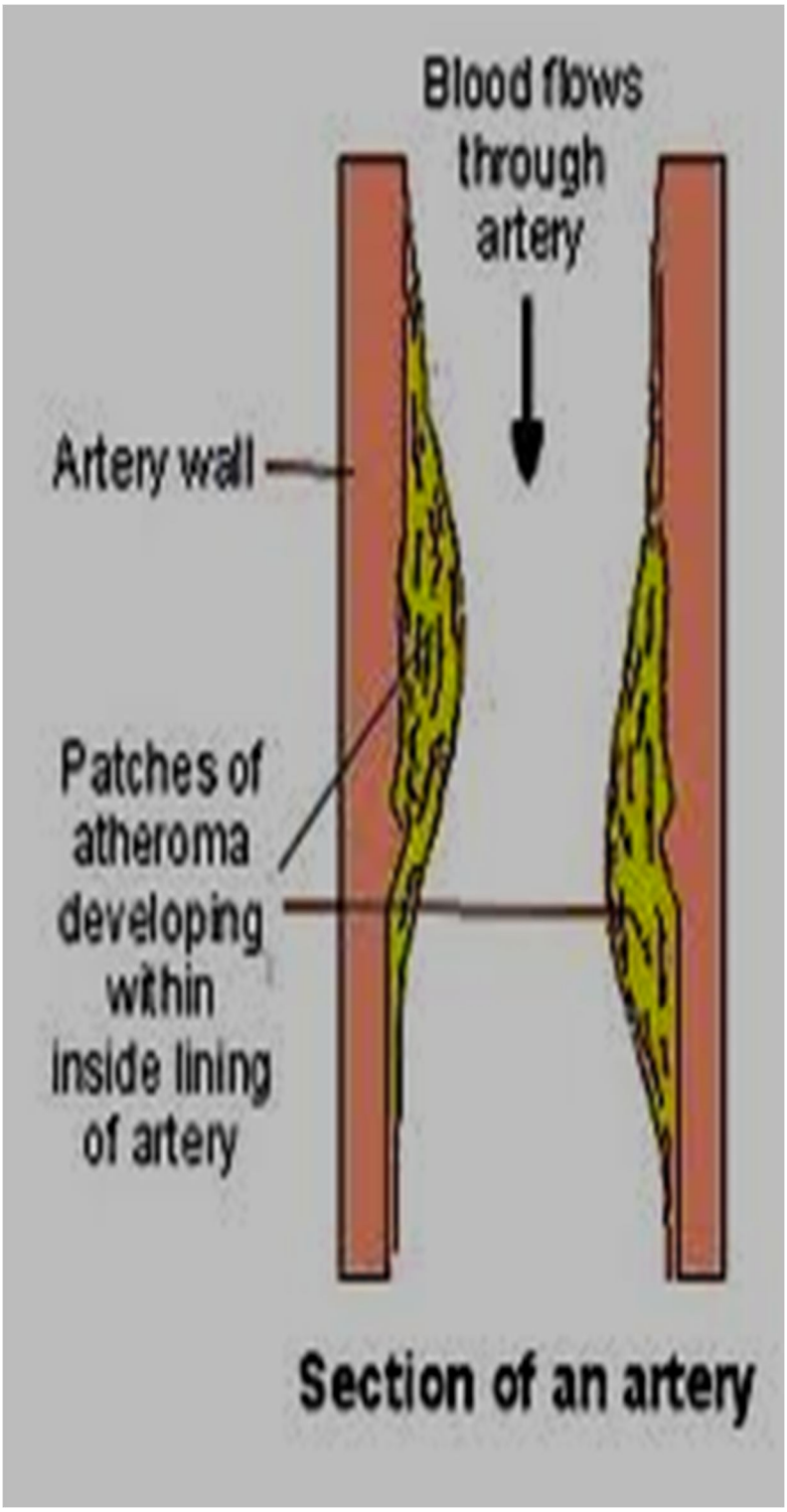

Fig. 2.7:An illustration of peripheral artery disease

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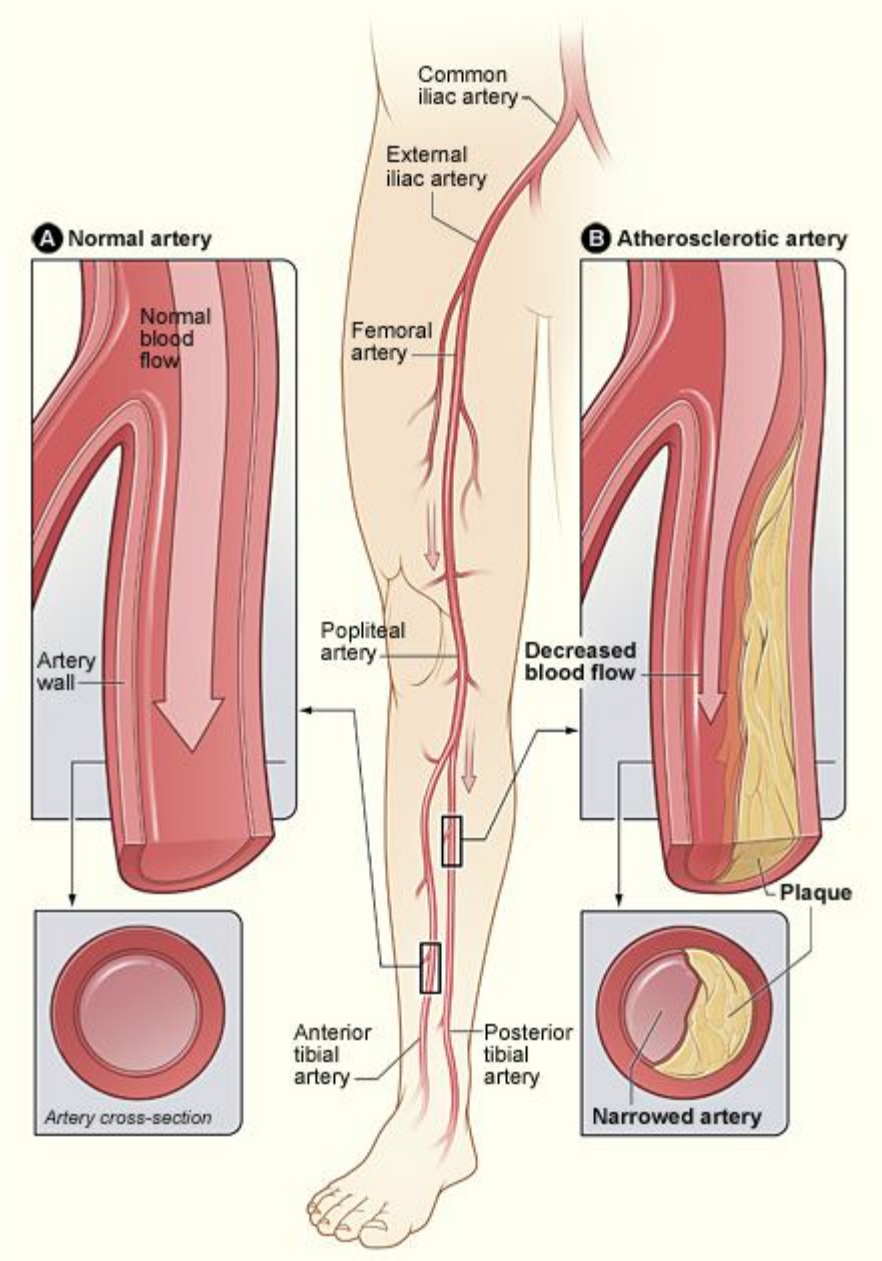

Fig [2.8]: The illustration shows how P.A.D. can affect arteries in the legs. Figure A shows a normal artery with normal blood flow. The inset image shows a cross-section of the normal artery. Figure B shows an artery with plaque buildup that's partially blocking blood flow. The inset image shows a cross-section of the narrowed artery.

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Atherosclerosis and PAD:

Atherosclerosis is a disease in which plaque builds up in the wall of an artery. PAD is usually caused by atherosclerosis in the peripheral arteries (or outer regions away from the heart). Plaque is made up of deposits of fats, cholesterol and other substances. Plaque formations can grow large enough to significantly reduce the blood's flow through an artery. When a plaque formation becomes brittle or inflamed, it may rupture, triggering a blood clot to form. A clot may either further narrow the artery, or completely block it.

If the blockage remains in the peripheral arteries, it can cause pain, changes in skin color, sores or ulcers and difficulty walking. Total loss of circulation to the legs and feet can cause gangrene and loss of a limb.

If the blockage occurs in a coronary artery, it can cause a heart attack. Heart attacks happen when an area of the heart tissue dies from lack of blood flow. When it occurs in a carotid artery, it can cause a stroke.

2.4: Previous studies:

Limited population-based data are available on the prevalence of and risk factors for PAD in Saudi Arabia.

A pilot cross-sectional study for patients who attended the primary health care center at King Khalid University Hospital between February 2006 and March 2006. A pre-designed questionnaire was used for each patient. Peripheral arterial disease was diagnosed, if the Ankle-Brachial index by Doppler were <0.90 and if the patient had signs or symptoms suggestively for PAD. Prevalence was estimated with 95% confidence intervals (CI),and

multivariable logistic regression analyses were performed to identify factors associated with PAD..Conducting such a study could act as prevalence of PAD in Saudi Arabia: A pilot study an impetus for establishing a broader picture on the widespread of PAD and the associated risk factors.

Results: A total of 471 patients were recruited. The mean age was 56 years and 32.3% were women. The prevalence of PAD was 11.7% (95% CI: 8.9-14.9%), and 92.7% of them were asymptomatic. Patients with PAD were slightly older than patients without PAD, suffered more often from diabetes, hypertension, lipid disorders, smoking, cerebro-vascular event, and coronary artery disease.

Conclusion: Prevalence of and risk factors for PAD in Saudi Arabia seem to be higher. A nationwide screening program is needed to confirm these results.

Such information may help in decision making for the provision of vascular services and improve the adverse outcomes in these patients. In addition, it may serve as a basis for a nationwide screening program to determine the prevalence of and risk factors for PAD in Saudi Arabia. (5)

Previous studies from other countries in other part of the world for PAD epidemiology is needed to provide a solid background for awareness programs and preventive efforts.

More than 200 million people worldwide were living with peripheral artery disease (PAD) in 2010, a new review suggests. More than two-thirds of these are living in low- and middle-income countries, including more than 55 million in Southeast Asia and 46 million in the western Pacific region.

According to **Dr. F Geral Fowkes** (University of Edinburgh, Scotland) and colleagues, the most alarming finding from their study is the rate at which the prevalence of PAD is increasing. In the past 10 years, the number of

people with PAD has risen by 23.5%. And strikingly, the rise in PAD has been twice as high in low-/middle-income countries (a 28.7% increase) as compared with the increase in high-income countries (13.1%).

"Little attention has been paid to this disease," Fowkes warned in a press statement accompanying the study, published online July 31, 2013 in the *Lancet*. This is despite the fact that PAD is the third leading cause of atherosclerotic cardiovascular morbidity, after coronary artery disease and stroke, the authors note.

Fowkes et al conducted a systematic literature review, looking at community-based studies since 1997. They used epidemiological modeling to define age-specific and sex-specific prevalence rates in high-income and low-/middle-income countries and calculated PAD prevalence using population numbers from 2000 and 2010.

Among the other findings of their review:

- The prevalence of PAD in high-income countries is similar between men and women, both at younger ages (45–49 years; approximately 5%) and older ages (85–89; approximately 18%).
    - In low-/middle-income countries, women have higher PAD rates than men, especially at younger ages.
    - Prevalence of PAD is lower in men but higher in women in low-/middle-income countries as compared with high-income countries at both younger and older ages.
    - Smoking was the most important risk factor for PAD, followed by diabetes, hypertension, and hypercholesterolemia.

"In view of the association of peripheral artery disease with loss of mobility, functional decline, and cardiovascular events, this dramatic increase in the number of people living with peripheral artery disease

represents a major public-health challenge," they write. "Interventions are urgently needed to reverse these trends in both [low-/middle-income countries] and [high-income countries]. The numbers are likely to grow substantially in the future, especially in [low-/middle-income countries], where much research is required on the social and economic burden as well as strategies for optimum treatment and prevention."

2.5:Investigations:

Peripheral arterial disease (P.A.D.) is diagnosed based on the medical and family histories, a physical exam, and results from tests. P.A.D. often is diagnosed after symptoms are reported. An accurate diagnosis is important, because people who have P.A.D. are at increased risk for coronary artery disease (CAD), heart attack, stroke, and transient ischemic attack ("mini-stroke"). If they have P.A.D., their doctor also may want to look for signs of these conditions. If the physician suspects peripheral artery disease, he or she may perform tests, such as:

- Ankle-brachial index (ABI), which compares the blood pressure in the arms and legs.
- Blood tests for cholesterol or other markers for artery disease
- To better understand the extent of the leg artery disease, the physician may also recommend duplex ultrasound, pulse volume recording, magnetic resonance angiography (MRA), or angiography.
- Duplex ultrasound uses high-frequency sound waves to measure real-time blood flow and detect blockages or other abnormalities in the structure of your blood vessels

- Pulse volume recording measures the volume of blood at various points in the legs using an arm blood pressure cuff and a Doppler probe.
- Magnetic resonance angiography (MRA) uses magnetic fields and radio waves to show blockages inside your arteries.
- Computed tomographic angiography (CTA) uses specialized CT scans and contrast dye to show blockages inside the arteries.
- Angiography, which produces X-ray images of the blood vessels in the legs using a contrast dye to highlight the arteries.

Physicians usually reserve angiography for people with more severe forms of leg artery disease. *See table No. 2.1: Imaging Tests for PAD.*

Table No. 2.1: Imaging Tests for PAD

	Ultrasound	CT Angiogram	MR Angiogram	Contrast Angiogram
Radiation?	No	Yes	No	Yes
Injected Dye?	No	Yes (iodine)	Yes gadolinium	Yes iodine
Magnetic Field?	No	No	Yes	No
Invasive?	No	No	No	Yes
Enclosed Space?	No	No	Yes	No
Time	Up to 2 hours	30 min or less	Up to 1 hour	30 to 45 min
Accuracy	Slightly less accurate than other tests, Less reliable in lower legs	More detailed than ultrasound and MRA, Less established than MRA	More detailed than ultrasound, Poses risk in women with metal implants (pacemaker, ICD)	Most accurate but carries risks

Physical Exam:

During the physical exam, signs and symptoms of P.A.D. were checked and may check the pulses in the leg arteries for an abnormal whooshing sound called a bruit using a stethoscope. A bruit may be a warning sign of a narrowed or blocked section of artery.

Blood pressure compared between the limbs to see whether the pressure is lower in the affected limb.

Also may check for poor wound healing or any changes in the hair, skin, or nails that may be signs of P.A.D.

Diagnostic Tests:

Ankle-Brachial Index: *See Fig [2 .9]:*

A simple test called an ankle-brachial index (ABI) is often used to diagnose P.A.D. The ABI compares blood pressure in the ankle to blood pressure in the arm. This test shows how well blood is flowing in the limbs. ABI can show whether P.A.D. is affecting the limbs, but it won't show which blood vessels are narrowed or blocked.

A normal ABI result is 1.0 or greater (with a range of 0.90 to 1.30). The test takes about 10 to 15 minutes to measure both arms and both ankles. This test may be done yearly to see whether P.A.D. is getting worse.

- **Ankle-brachial index (ABI):**

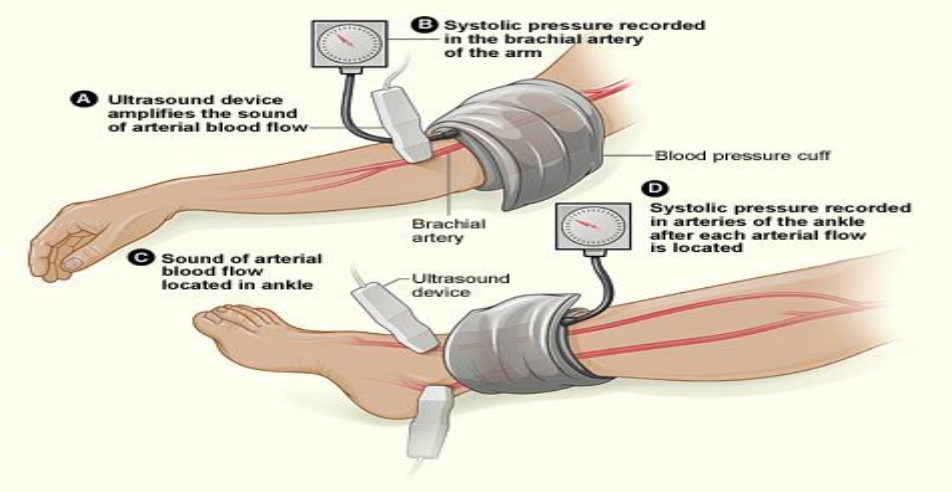

Fig [2.9]

The Illustration shows the ABI test.

The ABI compares blood pressure in the ankle to blood pressure in the arm. As the cuff deflates, the blood pressure in the arteries is recorded.

A painless exam that compares the blood pressure in feet to the blood pressure in arms to determine how well blood is flowing. This inexpensive test takes only a few minutes and can be performed by the healthcare professional as part of a routine exam. Normally, the ankle pressure is at least 90 percent of the arm pressure, but with severe narrowing it may be less than 50 percent.

See figure [2.9] which is an illustration of ankle-brachial index testing watch a video about ankle-brachial index testing if an ABI reveals an abnormal ratio between the blood pressure of the ankle and arm, you may need more testing. The doctor may recommend one of these other tests.

Doppler and Ultrasound (Duplex) imaging:

A non-invasive method that visualizes the artery with sound waves and measures the blood flow in an artery to indicate the presence of a blockage. This test uses a blood pressure cuff and special device to measure blood flow in the veins and arteries of the limbs. A Doppler ultrasound can help find out how severe P.A.D. is.

Computed Tomographic Angiography (CT): a non-invasive test that can show the arteries in your abdomen, pelvis and legs. This test is particularly useful in patients with pacemakers or stents. View an illustration of CT imaging.

Magnetic Resonance Angiography (MRA): a non-invasive test that gives information similar to that of a CT without using X-rays. Non-invasive imaging, with either MR angiography (MRA) or CT angiography (CTA), is now the first choice technique having supplanted invasive diagnostic arteriography for the initial evaluation of peripheral arterial disease in many situations.

Angiography: (generally reserved for use in conjunction with vascular treatment procedures) during an angiogram, a contrast agent is injected into the artery and X-rays are taken to show blood flow, arteries in the legs and to pinpoint any blockages that may be present. View an illustration of a peripheral angiogram.

- For both CTA and MRA the interpretation of source images at workstation is essential along with more advanced visualization tools.
- CTA is particularly useful for assessment of abdominal aneurysm morphology and in the emergency setting.
- Accurate assessment of stenosis may be difficult with CTA in the presence of calcified plaque, particularly in smaller vessels.
- Gadolinium contrast-enhanced MRA has the most evidence for lower limb arterial assessment, particularly in critical ischemia.
- Optimal MRA of the tibial arteries is best performed with dedicated station including time-resolved techniques, especially in critical ischemia.
- MRA blood pool techniques can further improve visualization and afford the opportunity for concomitant venous imaging for added value.

The technologies of CTA and MRA are at the forefront in diagnosis and treatment planning of cardiac and peripheral vascular diseases. During this course imaging faculty will emphasize image acquisition, post processing and interpretative review strategies. Clinical faculty will emphasize clinical indications, key imaging features, therapeutic options and management in vascular disease. Several interactive workstation reviews have also been added to further enhance the clinical presentations.

Optional Cardiac and Peripheral CTA Case Review Sessions are scheduled at the end of the main lecture program on Friday and Sunday. These are designed to meet both ACR and ACC interpreting guidelines for Cardiac and Peripheral CTA. Approximately 20 non-direct performance contrasts enhanced cardiac CTA cases and 20 peripheral CTA cases will be presented during the Case Review Sessions.

CT angiography:

Peripheral MD-CT angiographies were performed using a 16-row, multi-slice CT scanner (Somatom Sensation 16 Siemens Medical Systems, Erlangen, Germany). Automated contrast injections were performed with a programmable power injector (Angiomat CT, Digital Injection System, Liebel-Flarsheim Company, Cincinnati, OH). Iomeprol, a non-ionic iodinated contrast medium, was used at a concentration of 400 mg iodine/ml for all CT studies (Iomeron 400, Bracco, Italy).

Care bolus technique

In all patients, a care bolus technique was used. A reference scan above the aortic bifurcation was initiated 8 seconds after starting the contrast injection. Reference scans were acquired every second until the enhancement within the aorta exceeded 150 HU.

CT angiography contrast injection parameters:

A standardized contrast injection protocol was used for all patients. This protocol consisted of a biphasic contrast injection followed by a saline flush. The advantages of a biphasic contrast injection for large scanning volumes such as the peripheral arteries were described previously. In a first phase of 5.5 s, 25 ml of contrast medium was injected at a flow rate of 4.5 ml/s. The second bolus was injected at a flow rate of 2.3 ml/s. The volume of the second phase injection was calculated based on the remaining scanning time. The mean remaining scanning time was 27.4 s, resulting in a mean contrast medium volume of 63.0 ml in the second phase. The injection was finalized by a saline flush of 17.4 s (40 ml injected at a flow rate of 2.3 ml/s) to utilize all contrast material.

CT angiography scanning parameters:

All patients underwent CT angiography from the level of the renal arteries to the mid-foot. A detector configuration of 16×0.75 mm was combined with a table increment (table translation per 360° gantry rotation) of 14 mm, contributing to a table speed of 28 mm/s. This protocol allowed coverage of 1,200 mm in about 40 to 45 second.

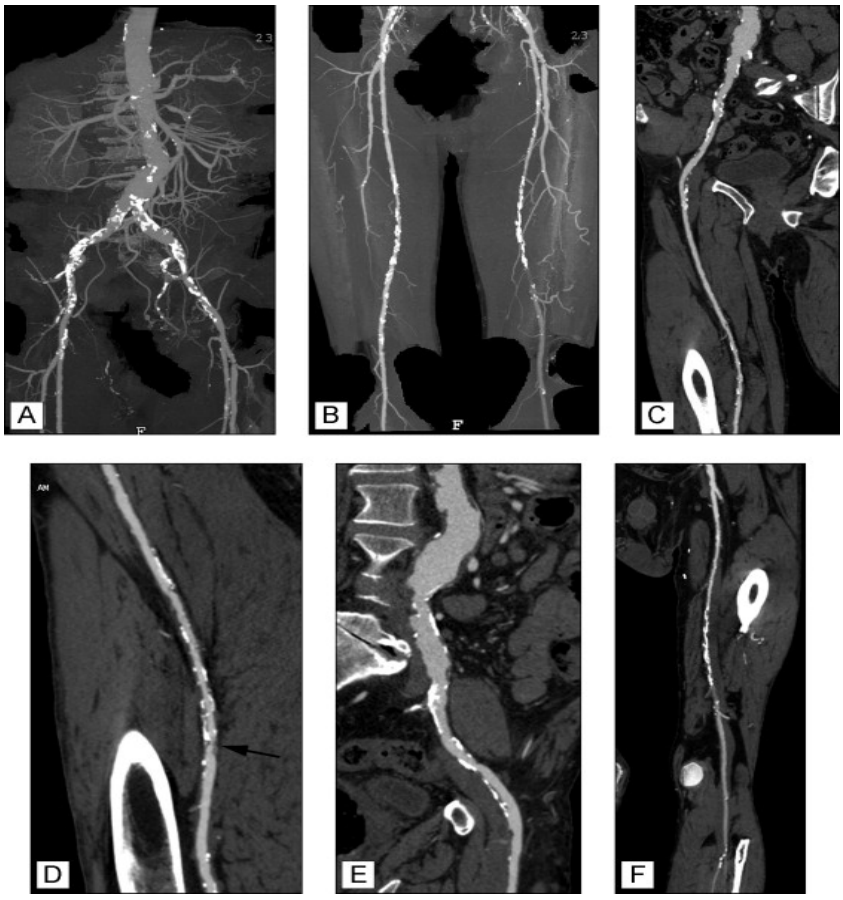

Fig: [2. 10] :CTA examination in a 75-year-old man

a: MIP reformation of the aorta and iliac artery. Presence of extensive calcification impairing lumen patency evaluation; b: MIP reformation of the femoro-popliteal arteries. Extensive calcifications are seen on both side with multiple luminal stenoses on the right side and chronic occlusion on the left side; c, d: curved MPR reformations on the iliac and femoral arteries on the right side showing several moderate stenoses on the iliac artery and one severe stenosis on the distal superficial femoral artery (arrow); e, f: curved MPR reformation on the left side showing a moderate stenosis on the left common iliac and a long chronic occlusion of the mid and distal superficial femoral artery

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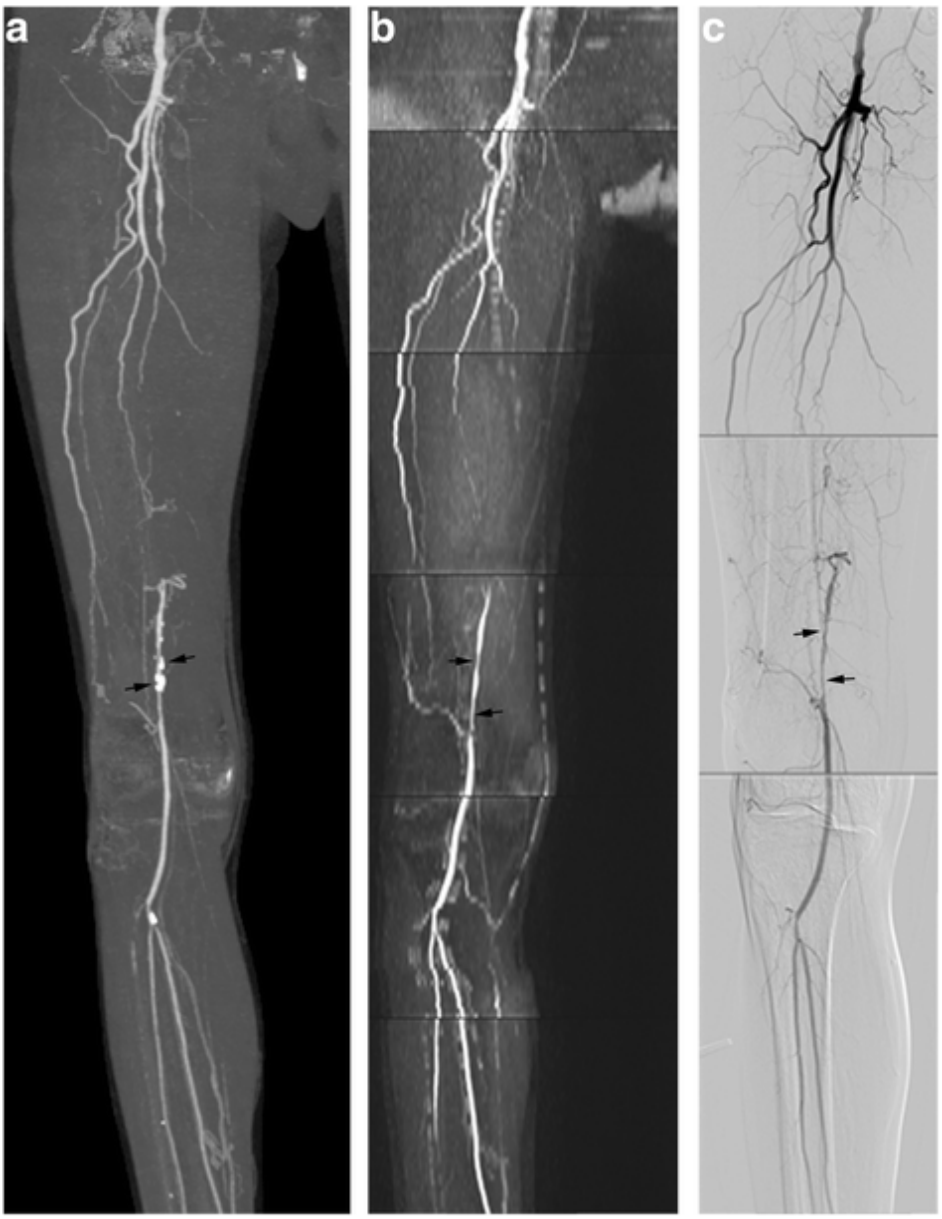

Fig: [2.11]:Occlusion of right femoral artery was seen at CTA (a) and MRA (b), and was proved by DSA (c). Stenosis degree is difficult to determine duo to calcified plaques overlapping at CTA MIP image (arrows). Significant stenosis (arrows) were well seen at MRA MIP image (b) and DSA (c)

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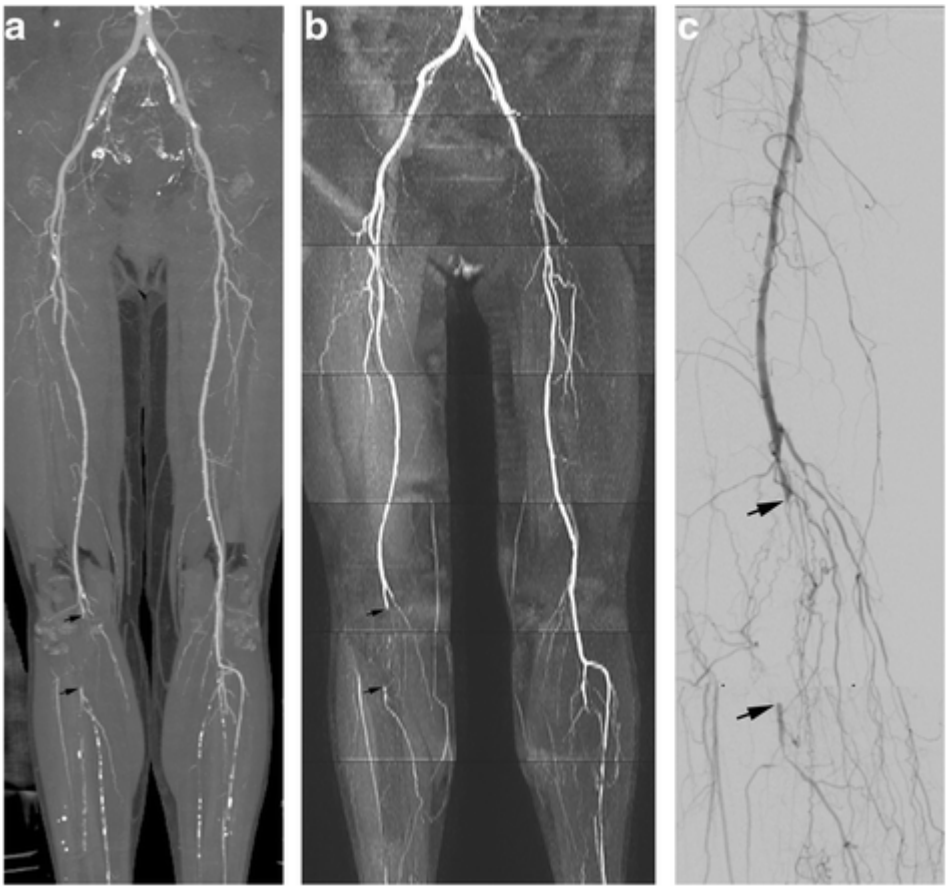

Fig: [2 .12]

a. Multiple stenosis at right femoral artery and occlusion (arrows) of right popliteal artery were shown with CTA image; however, occlusions at bilateral lower leg were difficult to identify duo to multiple calcified plaques. b. Occlusion of the right popliteal artery was also shown with MRA (arrows). Calcified plaques were not problematic with MRA, with occlusions easily identified at calf. c Occlusion of the right popliteal artery was proved by DSA (arrows). More collateral circulation vessels were shown with DSA

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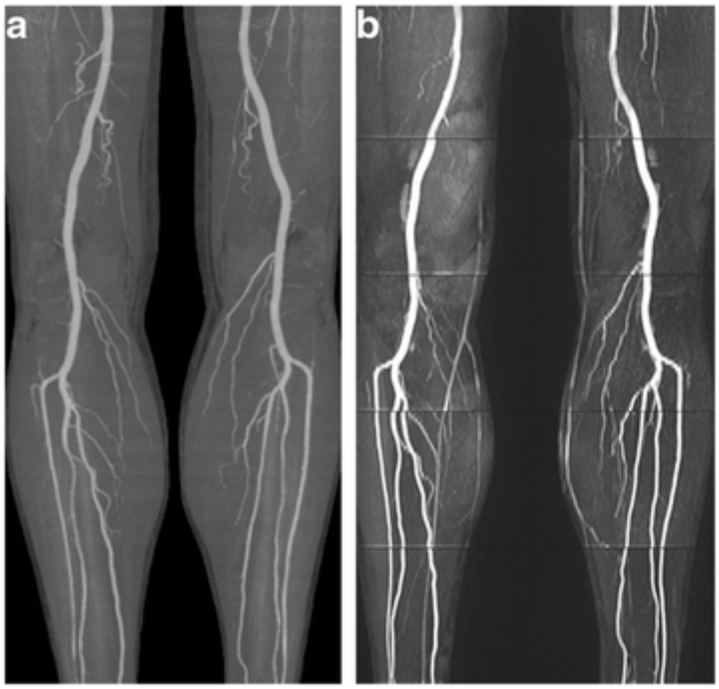

Fig: [2 .13]

a. Segments including popliteal artery, anterior tibial artery, posterior tibial artery and peroneal artery were rated as excellent in quality with CTA. b These segments were rated as excellent in quality with MRA

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What is CT angiography?

Angiography is a minimally invasive medical test that helps physicians diagnose and treat medical conditions. Angiography uses one of three imaging technologies and, in some cases, a contrast material to produce images of major blood vessels throughout the body.

Angiography is performed using:

- X-rays with catheters.
- Computed tomography (CT).
- Magnetic resonance imaging (MRI).

CT imaging uses special x-ray equipment to produce multiple images and a computer to join them together in multidimensional views. In CT angiography (CTA), a contrast material (also known as "dye") is injected into a vein to produce detailed images of both blood vessels and tissues.

What are some common uses of the procedure?

CT angiography is used to examine blood vessels in key areas of the body, including the:

- brain
- abdomen (such as the kidneys and liver)
- pelvis
- legs
- lungs
- heart
- neck

Indication of the procedure to:

- Identify abnormalities, such as aneurysms, in the aorta, both in the chest and abdomen, or in other arteries.
- Detect atherosclerosis disease in the carotid artery of the neck, which may limit blood flow to the brain and cause a stroke.
- Identify a small aneurysm or arterio-venous malformation inside the brain.
- Detect atherosclerotic disease that has narrowed the arteries to the legs and help prepare for endovascular intervention or surgery.
- Detect disease in the arteries to the kidneys or visualize blood flow to help prepare for a kidney transplant.
- Guide interventional radiologists and surgeons making repairs to diseased blood vessels, such as implanting stents or evaluating a stent after implantation.
- Detect injury to one or more arteries in the neck, chest, abdomen, pelvis or extremities in trauma patients.
- Evaluate arteries feeding a tumor prior to surgery or other procedures such as chemo-embolization or selective internal radiation therapy.
- Identify dissection or splitting in the aorta in the chest or abdomen or its major branches.
- Show the extent and severity of atherosclerosis in the coronary arteries and plan for a surgical operation, such as a coronary bypass and stetting.
- Sample blood from specific veins in the body to detect any endocrine disease.

- Examine pulmonary arteries in the lungs to detect pulmonary embolism (blood clots from leg veins).
- Look at congenital abnormalities in blood vessels, especially arteries in children (e.g., malformations in the heart due to birth defects).
- Evaluate obstructions of vessels (e.g., blood clots in the lungs).

What does the equipment look like? *See Fig: [2 - 14]*

Fig [2.14]:Computerized Tomography Machine

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What are the benefits versus risks?

Benefits;

- Angiography may eliminate the need for surgery. If surgery remains necessary, it can be performed more accurately.
- CT angiography is able to detect narrowing or obstruction of blood vessels in time for corrective therapy to be done.
- CT angiography may give more precise anatomical detail than magnetic resonance imaging (MRI), particularly in small blood vessels.
- Many patients can undergo CT angiography instead of a conventional catheter angiogram (catheterization).
- Compared to catheter angiography, which involves placing a catheter (plastic tube) and injecting contrast material into a large artery or vein, and may require sedation or general anesthesia, CT angiography is a much less invasive and more patient-friendly procedure.
- This procedure is a useful way of screening for arterial and venous disease, as well as structural abnormalities of the heart 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 catheter inserted into a large artery or vein in the groin.
- No radiation remains in a patient's body after a CT examination.
- X-rays used in CT scans usually have no immediate side effects.

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.

- If you have a history of allergy to x-ray contrast material, your radiologist may advise that you take special medication, such as a steroid, for 24 hours before CT angiography to lessen the risk of allergic reaction. Another option is to undergo a different exam that does not call for contrast material injection.
  - If a large amount of X-ray contrast material leaks out from the vessel being injected and spreads under the skin where the IV is placed, skin damage or damage to blood vessels and nerves, though unlikely, can result. If you feel any pain in this area during contrast material injection, you should immediately inform the technologist.
  - Women should always inform their physician and x-ray or CT technologist if there is any possibility that they are pregnant.
  - Nursing mothers should wait for 24 hours after contrast material injection before resuming breast-feeding.

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.

CTA limitations?

CT angiography should be avoided in patients with a previous reaction to contrast material, advanced kidney disease or severe diabetes, because X-ray contrast material can further harm kidney function.

Magnetic Resonance Imaging: See *Fig [2.8] MRI Machine.*

Definition: An MRI is a device used for medical Imaging which, unlike X-ray sand CT scans, uses Magnets and radio waves to take diagnostic image of the body.

Fig [2.15]: MRI Machine

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The Magnetic Resonance Imaging technology works on the principal, where a radio frequency & magnetic field is created to detect and create images of particular part of the body. Specific coils used to detect the energy given off by magnetic induction from the processing of the atoms. A computer interprets the data, and creates images that display the different resonance characteristics of different tissue types.

What kinds of nuclei can be used for NMR?

- Nucleus needs to have 2 properties:
  - Spin
  - charge
- Nuclei are made of protons and neutrons
  - Both have spin ½
  - Protons have charge
- Pairs of spins tend to cancel, so only atoms with an odd number of protons or neutrons have spin
  - Good MR nuclei are ^{1}H, ^{13}C, ^{19}F, ^{23}Na, ^{31}P

Hydrogen atoms are best for MRI

- Biological tissues are predominantly ^{12}C, ^{16}O, ^{1}H, and ^{14}N
- Hydrogen atom is the only major species that is MR sensitive
- Hydrogen is the most abundant atom in the body
- The majority of hydrogen is in water (H_2O)
- Essentially all MRI is hydrogen (proton) imaging

To start, let's look at the parts of the MRI machine. The three basic Components of the MRI machine are:

1. **The primary magnet**: the largest part of the MRI is the **primary magnet**. Developing a magnetic field of adequate strength to create MRI

images was an early hurdle to overcome in the development of this technology.

2. **The gradient magnets**

   The **gradient magnets** are the 'fine-tuning' part of the MRI machine. They allow the MRI to focus on a specific part of the body. The gradient magnets are also responsible for the 'clanging' noise in a MRI.

3. **The coil**

   Next to the part of the body being imaged is **the coil**. There are coils made for shoulders, knees, and other body parts. The coil will emit a radiofrequency that makes a MRI possible.

4. Another component of the MRI machine that determines what it looks like is a series of **shims**. To prevent signal dropout and fill in the gaps caused by distortions in the magnetic field, the machine require the implementation of these shims.

Chapter Three

Material & Methodology

Chapter Three

Methodology

In this chapter there are 100 cases maintained at King Fahad Hospital regarding the diagnostic of MRA magnetic resonance angiography for lower extremity peripheral arterial disease, in comparison to CT angiography.

The purpose of the current study is to compare image quality and diagnostic performance Magnetic Resonance Angiography at 1.5 T versus CT angiography for evaluation of lower extremity Peripheral Arterial Disease (PAD).

100 consecutive patients (52 male, 48female, age range 34–83 years, average age 62.3 years) with clinically suspected lower extremity PAD underwent MRA and CTA. Image quality of MRA was compared with CTA by two radiologists with 10 and 8 years' experience.

[3.1]: Patients:

Main symptoms of the patients were limb pain and claudication, with an average duration of 11.5 months. Creatinine level was from 41 to 228 μmol/ with an average of 76.3 μmol/L. Main pertinent medical history was smoking ($n = 30$), diabetes ($n = 45$), hypertension ($n = 25$). Written informed consent was obtained from all patients before the examinations. MRA and CTA examinations were performed on the same day. MRA was performed prior to CTA in 70 cases and after CTA in 30 cases.

[3.2]: Magnetic Resonance Angiography-(MRA)-:

All non-contrast enhanced MRA examinations were performed on a 1.5 T whole-body MR system GE Patients were placed on the scanner in feet-first supine position. A dedicated peripheral coil and two eight-element body array coils were used to cover the lower extremity and lower abdomen,

and were combined with the posterior integrated multi-channel spine coil. Electrocardiographic triggering was used to ensure proper synchronization between the arterial inflow events and data sampling. Initially a scout image was performed of the whole lower extremity and abdomen for localization purposes using the following parameters: TR/TE, 2.56/1.44 ms; FOV, 48 cm × 149 cm; slice thickness, 5 mm. MRA was performed in the transverse plane with the following parameters: TR = 1 heart beat; TE = 1.68 ms; flip angle, 90, or reduced according to SAR limitation; bandwidth, 700Hz; FOV, 400 mm × 260 mm; matrix, 400 × 261; number of slices, 40; slice thickness, 3 mm. The data acquisition was performed in approximately 6.5 min, given an average heart rate of 80/min. Coronal Maximum Intensity Projection (MIP) images of each station were generated by the scanner software, and all the MIP images were automatically spliced into a composite image including the entire region of interest.

[3.3]: Computerized Angiography- (CTA)-:

All CTA examinations were performed at a 128-row CT scanner (Discovery HD 750, GE medical, America), with the following parameters: tube voltage, 100 KVp; tube current, 150 mA; pitch, 0.984:1; table speed, 55 mm/s; slice thickness, 0.625 mm; FOV, 50 cm. Iodinated contrast agent (Ultravist, Bayer, Germany, 1.2 ml/kg body weight) was administered via an electronic power injector (Stellant, MEDRAD, America) through an 18 gauge intravenous line placed in the right cubital vein, at a rate of 3 ml/s. The bolus-tracking technique was used whereby a region of interest (ROI) was positioned at the aortic bifurcation. Image acquisition automatically started 5.5 s after the attenuation in the ROI reached the predefined threshold of 120 Hounsfield Units (HU).

[3.4]: Data analysis:

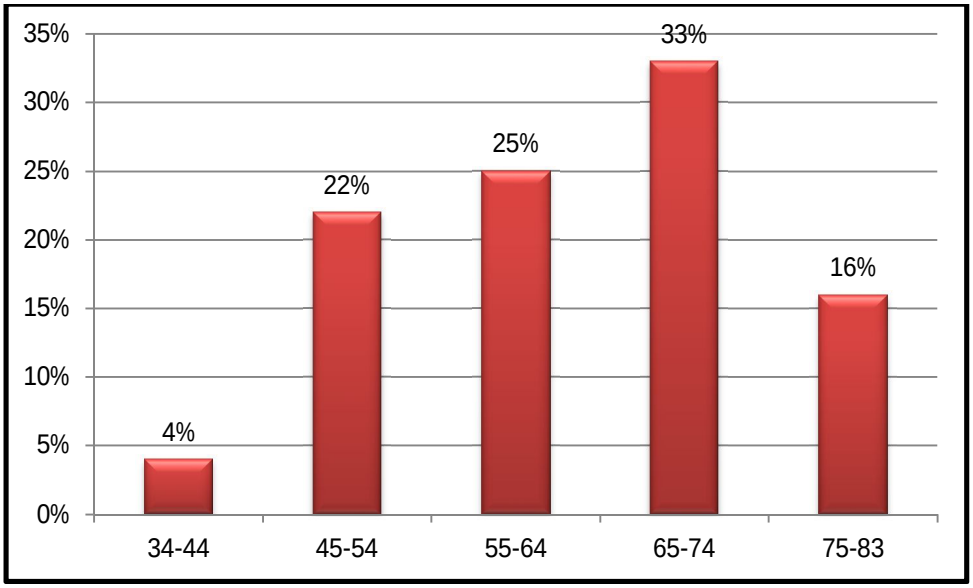
Post-processing procedures and measurement were performed on a dedicated General Electric MRI machine. CTA MIP images were reconstructed with a window setting of 600/300 (window width/window level). Two readers with 10 and 8 years' experience graded the image quality for each segment using source images as well as reconstructed images (MIP, and multi-planar reconstruction).

The arterial stenosis severity was rated by two readers with 11 years' and 9 years' experience respectively. Blinded readers were allowed to use both source images and reconstructed images (including MIP, and multi-planar reconstruction) for stenosis evaluation. 0, normal; 1, minimal stenosis is less than 50 %; 2, one lesion with 50 % or greater stenosis; 3, more than one lesion with 50 % or greater stenosis; 4, occlusion. Each segment at MRA was assigned a score. Evaluation with CTA was performed using the same criteria as with MRA. Inter modality agreement and inter observer agreement for stenosis rating was determined on a per segment basis.

Table No. (3.1) Distribution of study sample according to Participant's age

.	Frequency	Percent (%)
34-44	4	4.0
45-54	22	22.0
55-64	25	25.0
65-74	33	33.0
75-83	16	16.0
Total	100	100.0 (%)

Figure No. (3. 2) Distribution of study sample according to Participant's age



Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Age	100	34.00	83.00	62.3000	11.34002

Table No. (3.3) Distribution of study sample according to Participant's gender

Gender	Frequency	Percent (%)
Male	52	52.0
Female	48	48.0
Total	100	100.0 (%)

Figure No. (3.4) Distribution of study sample according to Participant's gender

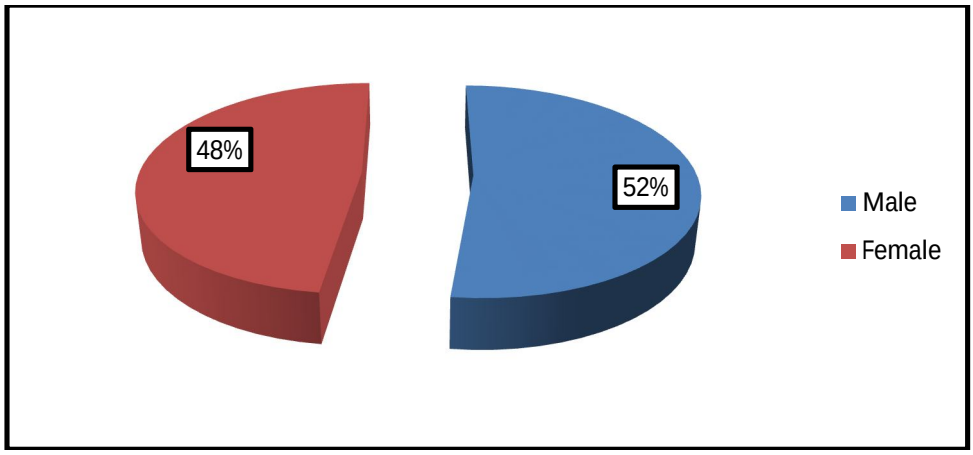


Table No. (3.5) Frequency of pathological results of CTA & MRA of Peripheral arteries

	CTA-Common iliac artery	MRA -Common iliac artery
	Frequency(%)	Frequency (%)
Normal	96(96)	96(96)
Aneurysm	2(2)	2(2)
Stenosis	2(2)	1(1)
Blockage	0(0)	1(1)
	CTA-External iliac artery	MRA -External iliac artery
Normal	95(95)	95(95)
Aneurysm	2(2)	2(2)
Stenosis	3(3)	1(1)
Blockage	0(0)	2(1)
	CTA-Internal iliac artery	MRA -Internal iliac artery
Normal	94(94)	94(94)
Aneurysm	4(4)	4(4)
Stenosis	2(2)	2(2)
Blockage	0(0)	0(0)
	CTA-Femoral artery	MRA -Femoral artery
Normal	89(89)	89(89)
Aneurysm	5(5)	5(5)
Stenosis	6(6)	3(3)
Blockage	0(0)	3(3)
	CTA-Femoral profound artery	MRA -Femoral profound artery
Normal	90(90)	90(90)
Aneurysm	2(2)	2(2)
Stenosis	8(8)	3(3)
Blockage	0(0)	5(5)
	CTA-Popliteal artery	MRA -Popliteal artery
Normal	86(86)	86(86)
Aneurysm	3(3)	3(3)
Stenosis	11(11)	5(5)
Blockage	0(0)	6()
	CTA-Anterior tibial artery	MRA -Anterior tibial artery
Normal	96(96)	84(84)
Aneurysm	4(4)	3(3)
Stenosis	0(0)	10(10)

Blockage	0(0)	3(3)

	Frequency(%)	Frequency (%)
	CT**A-Posterior tibial artery**	**MRA -Posterior tibial artery**
Normal	97(97)	82(82)
Aneurysm	3(3)	4(4)
Stenosis	0(0)	10(10)
Blockage	0(0)	4(4)
	CT**A-Peroneal artery**	**MRA -Peroneal artery**
Normal	92(92)	79(79)
Aneurysm	8(8)	3(3)
Stenosis	0(0)	10(10)
Blockage	0(0)	8(8)
	CT**A-Distal abdominal aorta**	**MRA -Distal abdominal aorta**
Normal	100(100)	100(100)
Aneurysm	0(0)	0(0)
Stenosis	0(0)	0(0)
Blockage	0(0)	0(0)

Table No. (3 . 6)
Common iliac artery * MRA -Common iliac artery CTA Cross tabulation

Common iliac artery * MRA -Common iliac artery CTA Cross tabulation							
P-value = 0.000			MRA -Common iliac artery				Total
			Normal	Aneurysm	Stenosis	Blockage	
Common iliac artery	Normal	Count	96	0	0	0	96
		% of Total	96.0%	0.0%	0.0%	0.0%	96.0%
	Aneurysm	Count	0	2	0	0	2
		% of Total	0.0%	2.0%	0.0%	0.0%	2.0%
	Stenosis	Count	0	0	1	1	2
		% of Total	0.0%	0.0%	1.0%	1.0%	2.0%
Total		Count	96	2	1	1	100
		% of Total	96.0%	2.0%	1.0%	1.0%	100.0%

Table No. (3 - 7)
External iliac artery * MRA -External iliac artery Cross tabulation

External iliac artery * MRA -External iliac artery Cross tabulation							
P-value = 0.000			MRA -External iliac artery				Total
			Normal	Aneurysm	Stenosis	Blockage	
External iliac artery	Normal	Count	95	0	0	0	95
		% of Total	95.0%	0.0%	0.0%	0.0%	95.0%
	Aneurysm	Count	0	2	0	0	2
		% of Total	0.0%	2.0%	0.0%	0.0%	2.0%
	Stenosis	Count	0	0	1	2	3
		% of Total	0.0%	0.0%	1.0%	2.0%	3.0%
Total		Count	95	2	1	2	100
		% of Total	95.0%	2.0%	1.0%	2.0%	100.0 %

Table No. (3. 8)
Internal iliac artery * MRA -Internal iliac artery Cross tabulation

Internal iliac artery * MRA -Internal iliac artery Cross tabulation						
P-value = 0.000			MRA -Internal iliac artery			Total
			Normal	Aneurysm	Stenosis	
Internal iliac artery	Normal	Count	94	0	0	94
		% of Total	94.0%	0.0%	0.0%	94.0%
	Aneurysm	Count	0	4	0	4
		% of Total	0.0%	4.0%	0.0%	4.0%
	Stenosis	Count	0	0	2	2
		% of Total	0.0%	0.0%	2.0%	2.0%
Total		Count	94	4	2	100
		% of Total	94.0%	4.0%	2.0%	100.0%

Table No (3 . 9)
Femoral artery * MRA -Femoral artery Cross tabulation

Femoral artery * MRA -Femoral artery Cross tabulation							
P-value = 0.000			MRA -Femoral artery				Total
			Normal	Aneurysm	Stenosis	Blockage	
Femoral artery	Normal	Count	89	0	0	0	89
		% of Total	89.0%	0.0%	0.0%	0.0%	89.0%
	Aneurysm	Count	0	5	0	0	5
		% of Total	0.0%	5.0%	0.0%	0.0%	5.0%
	Stenosis	Count	0	0	3	3	6
		% of Total	0.0%	0.0%	3.0%	3.0%	6.0%
Total		Count	89	5	3	3	100
		% of Total	89.0%	5.0%	3.0%	3.0%	100.0%

Table No. (3 . 10)
Femoral profound artery * MRA -Femoral profound artery Cross tabulation

Femoral profound artery * MRA -Femoral profound artery Cross tabulation							
P-value = 0.000			MRA -Femoral profound artery				Total
			Normal	Aneurysm	Stenosis	Blockage	
Femoral profound artery	Normal	Count	90	0	0	0	90
		% of Total	90.0%	0.0%	0.0%	0.0%	90.0%
	Aneurysm	Count	0	2	0	0	2
		% of Total	0.0%	2.0%	0.0%	0.0%	2.0%
	Stenosis	Count	0	0	3	5	8
		% of Total	0.0%	0.0%	3.0%	5.0%	8.0%
Total		Count	90	2	3	5	100
		% of Total	90.0%	2.0%	3.0%	5.0%	100.0%

Table No. (3 . 11)

Popliteal artery * MRA -Popliteal artery Cross tabulation

Popliteal artery * MRA -Popliteal artery Cross tabulation							
P-value = 0.000			MRA -Popliteal artery				Total
			Normal	Aneurysm	Stenosis	Blockage	
Popliteal artery	Normal	Count	86	0	0	0	86
		% of Total	86.0%	0.0%	0.0%	0.0%	86.0%
	Aneurysm	Count	0	3	0	0	3
		% of Total	0.0%	3.0%	0.0%	0.0%	3.0%
	Stenosis	Count	0	0	5	6	11
		% of Total	0.0%	0.0%	5.0%	6.0%	11.0%
Total		Count	86	3	5	6	100
		% of Total	86.0%	3.0%	5.0%	6.0%	100.0%

Table No. (3 -12)

Anterior tibial artery * MRA -Anterior tibial artery Cross tabulation

Anterior tibial artery * MRA -Anterior tibial artery Cross tabulation							
P-value = 0.000			MRA -Anterior tibial artery				Total
			Normal	Aneurysm	Stenosis	Blockage	
Anterior tibial artery	Normal	Count	84	3	9	0	96
		% of Total	84.0%	3.0%	9.0%	0.0%	96.0%
	Stenosis	Count	0	0	1	3	4
		% of Total	0.0%	0.0%	1.0%	3.0%	4.0%
Total		Count	84	3	10	3	100
		% of Total	84.0%	3.0%	10.0%	3.0%	100.0%

Table No. (3 -13)

Posterior tibial artery * MRA -Posterior tibial artery Cross tabulation

Posterior tibial artery * MRA -Posterior tibial artery Cross tabulation							
P-value = 0.000			MRA -Posterior tibial artery				Total
			Normal	Aneurysm	Stenosis	Blockage	
Posterior tibial artery	Normal	Count	82	4	10	1	97
		% of Total	82.0%	4.0%	10.0%	1.0%	97.0%
	Stenosis	Count	0	0	0	3	3
		% of Total	0.0%	0.0%	0.0%	3.0%	3.0%
Total		Count	82	4	10	4	100
		% of Total	82.0%	4.0%	10.0%	4.0%	100.0%

Table No. (3 -14)

Peroneal artery * MRA -Peroneal artery Cross tabulation

Peroneal artery * MRA -Peroneal artery Cross tabulation							
P-value = 0.000			MRA -Peroneal artery				Total
			Normal	Aneurysm	Stenosis	Blockage	
Peroneal artery	Normal	Count	79	3	10	0	92
		% of Total	79.0%	3.0%	10.0%	0.0%	92.0%
	Stenosis	Count	0	0	0	8	8
		% of Total	0.0%	0.0%	0.0%	8.0%	8.0%
Total		Count	79	3	10	8	100
		% of Total	79.0%	3.0%	10.0%	8.0%	100.0%

Table No. (3 -15)

Distal abdominal aorta * MRA -Distal abdominal aorta Cross tabulation

Distal abdominal aorta * MRA -Distal abdominal aorta Cross tabulation				
			MRA -Distal abdominal aorta	Total
			Normal	
Distal abdominal aorta	Normal	Count	100	100
		% of Total	100.0%	100.0%
Total		Count	100	100
		% of Total	100.0%	100.0%

Chapter Four

Discussion Conclusion and Recommendations

Chapter Four

Discussion Conclusion and Recommendations

[4.1]: Discussion:

Lower extremity peripheral CTA and MRA are increasingly used as non invasive technique.

evaluatepatientswithperipheralarterialdisease.MRA have gained wide spread use for imaging peripheral arterial disease [20,21,22].Disadvantages of MRA include the limited spatial resolution [23]. The recently introduced multi-detector row CT scanners has resulted in shorter acquisition time, increased volume coverage, and improved spatial resolution [24,25].Results of several studies have shown that multi-detector row CTA is accurate for imaging peripheral arteries [26-31].It is therefore increasingly important or all vascular specialists to become familiar with the strengths and limitations of these technique and which one is suitable in diagnosis of each artery. In the evaluation of those diagnostic tests the study of agreement or their results were obtained. The selected arteries to be evaluated were: common iliac artery, external iliac, internal iliac, femoral, femoral profound, popliteal, anterior tibial, posterior tibial, peroneal artery and distal abdominal aorta.

Table No. (3 . 6)cross tabulated the diagnosis / findings of common iliac artery in both MRAandCTA,96out of100 were found to be normal in both techniques and 2 cases as aneurysm. On negative case was detected, it was diagnosed as stenosis in CTA but was found to be totally occludedinMRA.In2cases; the external iliac arteries were diagnosed better in

MRA to be occluded while it was diagnosed as stenosis in the CTA examination, as presented in Table No. (3 - 7).

Stenosis and aneurysm of the internal iliac artery, Table No. (3 - 7),based on MRA showed significant agreementwithCTA.4%ofthecaseswerefoundtohaveaneurysm and2%werewithstenosisindicating that MRA can potentially be used for stenosis assessment and aneurysm diagnosis at the internal iliac arteries, similar results was mentionedbyAkosVarga-Szemesetal2017[32].

In 6 cases, the femoral arteries were diagnosed as stenosis by CTA while MRAshowedthatonly3 arteries were with stenosis and there is have totally occluded Table No. (3 - 9).The mismatch noticed in the diagnosis of such cases to be confused between stenosis or totally occluded because the presence of the vessel wall calcifications appearsonCTA[32].Thisjustificationhavealsobeenexposedtoaffectimageint erpretation in several studies [33,34,]. In our experience, extensive arterial wall calcifications found in common iliac artery, externaliliacarteries,internaliliacarteryandfemoralarteries,arefrequently seen in patients with peripheral arterial disease and interfered with the imageinterpretation/diagnosis.Thevesseldiametercombinedwithvessel wall calcifications may have contributed to the lowest harmony between the two modalities occurring in those arteries.

Femoral profound artery showed similar results as normal and aneurysm in 90 and 2 patients in respectively in both MRA and CTA, while 8 patients were diagnosed as stenosis, however 5 of them were found to be completely occluded when they are investigated by MRA.As well 6 cases were found to have total occlusion in the popliteal artery and also were

Diagnosed by MRA, Table No. (3 - 10)&Table No. (3 - 11).

Popliteal aneurysm is the most common peripheral arterial aneurysm and 50% of aneurysms are bilateral, [35] how ever in our cases we found it unilateral. Studies have mentioned that80%ofthepopliteal aneurysm are associated with aneurysm elsewhere [35] as well we diagnosed it in common iliac artery, external iliac, internal iliac, femoral, femoral profound, popliteal, were fared the findings to the atherosclerotic disease

.Anterior tibial artery was also been evaluated in both imaging methods, 96caseswere diagnosed as normal in CTA however MRAshowed3outof96haveaneurysm and9havestenosis, aswell4werediagnosedtohave stenosisbuttheMRIshowed3casesaretotallyoccluded,aswellthe posteriortibialartery in both MRA and CTA was also been evaluated, 97caseswerediagnosedtobeasnormal but15caseswerefoundtohave aneurysm(4;4%)stenosis(10;10%)andtotalocclusion(1;1%).3caseswerediagnosedtohavestenosisbyCTA but total occlusion was found in all of those cases when were examined by MRA, table (7,8)

In peroneal artery the aneurysm and stenosis were found in 15 cases which were diagnosed as normal in the CTA examination as well 8 cases were diagnosed to be totally occluded in MRA and were diagnosed as stenosis in the CTA, Table No. (3 - 14). The distal abdominal aorta was found to be normal in all the cases and are equally diagnosed in MRA and CTA, Table No. (3 - 15).

Statistically; the study showed that there are no significant difference in the results found in the CTA and MRA in the diagnosis of the common iliac artery, external iliac, internal iliac, , femoral profound, popliteal, anterior tibial, posterior tibial, peroneal artery and distal abdominal aorta. All the occlude cases were well diagnosed by MRA, The literature have mentioned that MRA is a widely used modality for imaging of peripheral artery occlusion diseases[36-40]. It is non invasive and low-risk and can image the entire vascular system, including tibial arteries [41-43]. Moreover, in a patient with total occlusion, MRA more reliably defines there constituted vessels. [44] When comparing the two modalities; both MRA and CTA assume a greater role in patientevaluation.MRAisexcellentinabettervisualizationofvascular system[45] on the other hand CTA used the ionizing radiation, potentially nephrotoxic iodinated contrast medium, and it was difficult to assess the arterial luminal stenosis in the presence of vessel wall calcifications [18] which made it to give false positive results about stenosis or whether the vessels were totally occluded.

Several studies have demonstrated the excellent diagnostic value of CTA in evaluating or to iliac and peripheralarteries.[46,47,48-50]CTAisparticularlyusefulforevaluatingthevasculardisease however; CTA is still somewhat limited in its ability to grade the severity of stenosis lesions accurately when the volume of calcified plaque in a vessel is high with respect to the diameter of the vessel which is an important limitation when using CTA in the calf. [51, 52,53]Those findings were also been noticed in our results that there were cases diagnosed as stenosis and were found to be totally occluded.

[4. 2]: Conclusion

Interpretation of MRA and CTA for peripheral arterial disease has an excellent agreement, with significant correlation between the two modalities at p=0.000in the diagnosis the normal and aneurysm ,stenosis and occlusion in the peripheral arteries including common iliac artery, external iliac, internal iliac, femoral, femoral profound, popliteal, anterior tibial, posterior tibial, peroneal artery and distal abdominal aorta. The results support the increasing use of both MRA and CTA in the diagnostic imaging work-up of patients with peripheral arterial disease.

1. The image slices have 3-D properties that determine spatial resolution (CT better than MRI), and contrast sensitivities that allow tissue characterization (MRI better than CT).
2. CTA used the ionizing radiation, potentially nephrotoxic iodinated contrast medium, and it was difficult to assess the arterial luminal stenosis in the presence of vessel wall calcifications [18]which made it to give false positive results about stenosis or when the the vessels were totally occluded. CTA's role will be for strictly anatomic coronary information; MRA's role will be for function, perfusion and viability.
3. Down the line, we can anticipate perfusion information and lower radiation from CTA and better spatial resolution and plaque characterization from MRA.
4. The results of the review suggest that MRA has a better overall diagnostic accuracy than CTA and that CE MRA is generally preferred by patients over CTA.
5. Magnetic resonance angiography (MRA) is a less invasive alternative to CTA.

6. The overall diagnostic performance of CTA in detecting stenosis & aneurysm or more was inferior to MRA especially below the knee.
7. Both MRA and CTA assume a greater role in patientevaluation.MRA is excellent in a better visualization of vascular system.

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