Sudan University of Science and Technology

College of Graduate Studies

Measurement of Common Carotid Artery Intima- Media Thickness in Sudanese using Ultrasound

قياس سمك بطانة الشريان السباتي الرئيسي في السودانيين باستخدام التصوير بالموجات فوق الصوتية

A thesis submitted for partial fulfillment of M.Sc. degree in diagnostic medical ultrasound

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الاستهــلال

قال تعالى:

(وَقُلِ اعْمَلُوا فَسَيَرَى اللَّهُ عَمَلَكُمْ وَرَسُولُهُ وَالْمُؤْمِنُونَ وَسَتُرَدُّونَ إِلَى عَالِمِ الْغَيْبِ وَالشَّهَادَةِ فَيُنَبِّئُكُمْ بِمَا كُنْتُمْ تَعْمَلُونَ)

صدق الله العظيم

سورة التوبة (الآية 105)

Abstract

This was descriptive study concluded in Khartoum state- Sudan in different ultrasound departments from May 2016 to July 2016, the study was done to measure the common carotid artery intima-media thickness in Sudanese adult population using B-mode ultrasound. The problem was the association of CIMT with numerous of risk factors so accurate value should be detected. The data f this study collected from 50 volunteers using master data sheet, classified ad analyzed using SPSS. The result of this study reveals that the mean value of Rt IMT is thicker than the Lt IMT and they equal 0.06 cm and 0.05cm respectively. The study shows correlation and direct linear relationship between age and IMT, were Rt IMT increased by 0.0002cm per year ad Lt IMT increased by 0.0003cm per year. Study also shows that IMT have no significant difference with gender, weight, height and BMI.

ملخص البحث

الاعتراف بأهمية الشريان السباتي جعلت التقييم السريري لأي تغييرات بسبب الأمراض أمرا بالغ الدقة والأهمية. الهدف الرئيسي من هذه الدراسة هو قياس سمك بطانةالشريان السباتي في البالغين السودانيين في ولاية الخرطوم باستخدام الموجات فوق الصوتية. بيانات هذه الدراسة تم جمعها من 50 متطوعا باستخدام ورقة البيانات الرئيسية من أجل تحليلها وحساب القيمة المتوسطة لسمك بطانة الشريان السباتي. نتيجة هذه الدراسة تكشف أن القيمة المتوسطة لسمك بطانة الشريان السباتي الأيمن أعلى من سمك بطانة الشريان السباتي الأيسر والتي تساوي 0.06 سم و 0.05 سم على التوالي. وتشير الدراسة إلى ارتباط وعلاقة خطية مباشرة بين العمر وسمك بطانة الشريان السباتي التي تزيد بمعدل 0.0002 سم للشريان السباتي الأيمن و 0.0003 سم للشريان السباتي الأيسر سنويا. يظهر الدراسة أيضا أنسمك بطانة الشريان السباتي ليس لديها اختلاف كبير مع الجنس والوزن والطول ومؤشر كتلة الجسم.

DEDICATION

To my wonderful parents how have raised me to be the person I am today, they have been with me in every step on the way and always give me tenderness and love.

To my husband who has inspired and encouraged me all the way and whose encouragement has made sure that I give it all it takes to finish that which I have started.

To my sweet daughter how always give me joy and drown smile on my face.

To my lovely three brothers and my little sister.

To my dear frinds.

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Prayers are to Allah Almighty my creator, my strong pillar, my source of inspiration, wisdom, knowledge and understanding.

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Finally I pay much gratitude to Sudan University of Science and Technology for being knowledge home.

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Abbreviation:

IMT	Intima-media thickness
BMI	Body mass index
CCA	Common carotid artery
HDL	High-density lipoprotein
LDL	Low-density lipoprotein
DC	Dispensability coefficient
CWS	Circumferential wall stress
M. IMT	Mean intima-media thickness
MM IMT	Maximum mea of intima-media thickness
FIMT	Femoral intima-media thickness

Chapter one

Chapter one

Introduction

1-1 Introduction:

Intima-media thickness (IMT), also called intimal medial thickness, is a measurement of the thickness of tunica intima and tunica media, the innermost two layers of the wall of an artery. The measurement usually made by external ultrasound and occasionally by internal, invasive ultrasound catheters; see intravascular ultrasound. Measurements of the wall thickness of blood vessels can also done using other imaging modalities.

IMT is used to detect the presence of atherosclerotic disease in humans and, more contentiously, to track the regression, arrest or progression of atherosclerosis.

Carotid artery scanning by ultrasound is one of the most common requested vascular ultrasound examinations. Carotid IMT has measured in numerous epidemiological and clinical studies. These have shown associations with numerous risk factors, including type 2 diabetes and impaired glucose tolerance, familial hypercholesterolemia, high-density lipoprotein cholesterol (HDL-C) and triglycerides, rheumatoid arthritis, non-alcoholic fatty liver disease, and air pollution, due to this associations and this results the measurement of the carotid IMT in different population and ages is important to correlate it with this risk factors.

Intima-medial thickening is a complex process, depending on a variety of factors, including local hemodynamics, blood pressure, shear stress and circumferential tensile stress.

Variations in IMT between different locations, such as the inflow side of branches, the inner curvature at bends and opposite the flow, divider at bifurcations may reflect differences in local hemodynamic forces. However, an IMT greater than 0.9-1mm is highly likely to be indicative of atherosclerosis and increased risk of cardiovascular disease. Often, the value of the IMT measured in three locations: in the common carotid (typically at one cm proximal to the flow divider), at the bifurcation, and in the internal carotid artery. IMT measurements of the far (deeper) wall, by ultrasound, are generally considered more reliable than measurements performed on the near (more superficial) wall, although measurement of both near and far wall IMT has also been advocated.

1-2 Problem of the study:

Because ultrasound is lower cost compared with most other method and relative comfort and convenience for the patient being examined, it’s the most uses modality for carotid artery imaging, and due to the importance of the carotid IMT and its association with Numerous of risk factors according to different studies the accurate measurement of the carotid IMT in Sudanese population mast be studied and detected.

1-3 General objectives:

The main purpose of this study is to measure the carotid IMT in Sudanese population.

1-3-1 Specific objectives:

- To compeer male and female carotid IMT.

-To describe different in IMD according to age.

-To verify weather body mass index has an influence on IMD value.

1-3-2 Significance of the study:

This study will determined the normal value of CIMT which lay the foundation for easer and more accurate diagnosing of any changes or alteration that may affect CIMT and connected to pathologies as atherosclerosis, hypercholesterolemia, high-density lipoprotein cholesterol (HDL-C) and triglycerides, rheumatoid arthritis, non-alcoholic fatty liver disease.

1-4 Ethical issue:

Permission of the department at area of the study should be taken as well as the volunteers permission to use the collected data for scientific purpose.

1-5 Over view of the study:

This study consist of five chapters, where chapter one is an introduction of the study and give a view about chapter two include the previous study talking about the same subject, chapter three mentioned the study area and time and study sample and data collection method and analysis, chapter four including the result of the analyzing the data and lastly chapter five is the discussion of the results and the recommendations given for the further studies made

Chapter two

Chapter two

Literature review and previous studies

2-1 Literature review

2-1-1 Anatomy of common carotid artery:

The principal arteries of supply to the head and neck are the two common carotids; they ascend in the neck and each divides into two branches, the external carotid, supplying the exterior of the head, the face, and the greater part of the neck; the internal carotid, supplying to a great extent the parts within the cranial and orbital cavities. (Gray H.1918)

The Common Carotid Artery (A. Carotis Communis)—The common carotid arteries differ in length and in their mode of origin. The right begins at the bifurcation of the innominate artery behind the sternoclavicular joint and is confined to the neck. The left springs from the highest part of the arch of the aorta to the left of, and on a plane posterior to the innominate artery, and therefore consists of a thoracic and a cervical portion

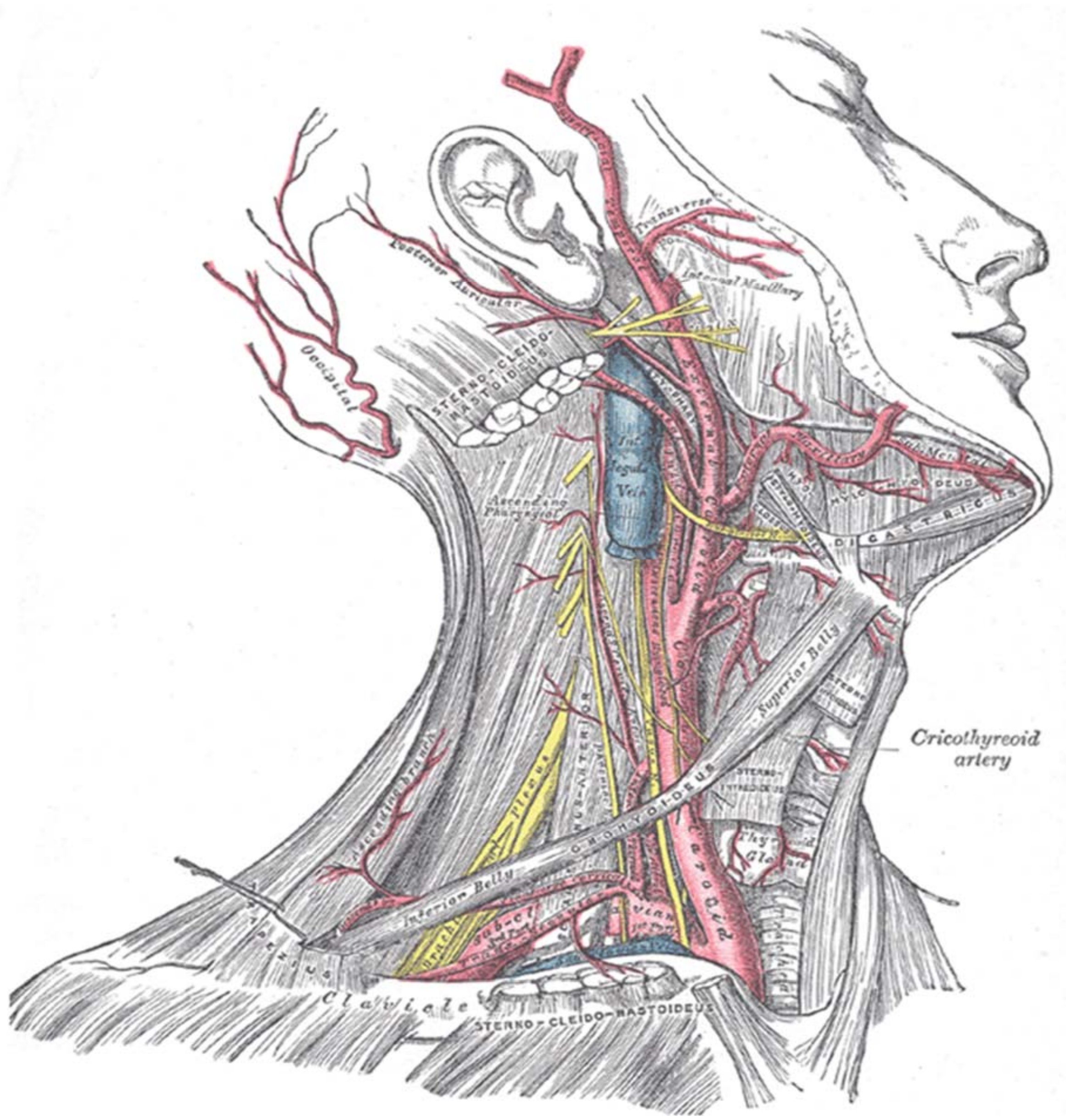


Fig (1.1) Superficial dissection of the right side of the neck, showing the carotid and subclavian arteries

(Gray H. 1918)

The thoracic portion of the left common carotid artery ascends from the arch of the aorta through the superior mediastinum to the level of the left sternoclavicular joint, where it is continuous with the cervical portion.

Relations: In front, it is separated from the manubrium sterni by the Sternohyoideus and Sternothyreoideus, the anterior portions of the left pleura and lung, the left innominate vein, and the remains of the thymus; behind, it lies on the trachea, esophagus, left recurrent nerve, and thoracic duct. To its right side below is the innominate artery, and above, the trachea, the inferior thyroid veins, and the remains of the thymus; to its left side are the left vagus and phrenic nerves, left pleura, and lung. The left subclavian artery is posterior and slightly lateral to it.
The cervical portions of the common carotids resemble each other so closely that one description will apply to both. Each vessel passes obliquely upward, from behind the sternoclavicular articulation, to the level of the upper border of the thyroid cartilage, where it divides into the external and internal carotid arteries.

At the lower part of the neck the two common carotid arteries are separated from each other by a very narrow interval which contains the trachea; but at the upper part, the thyroid gland, the larynx and pharynx project forward between the two vessels. The common carotid artery is contained in a sheath, which is derived from the deep cervical fascia and encloses also the internal jugular vein and vagus nerve, the vein lying lateral to the artery, and the nerve between the artery and vein, on a plane posterior to both. On opening the sheath, each of these three structures is seen to have a separate fibrous investment.

At the lower part of the neck the common carotid artery is very deeply seated, being covered by the integument, superficial fascia, Platysma, and deep cervical fascia, the Sternocleidomastoideus, Sternohyoideus, Sternothyreoideus, and Omohyoideus; in the upper part of its course it is more superficial, being covered merely by the integument, the superficial fascia, Platysma, deep cervical fascia, and medial margin of the Sternocleidomastoideus. When the latter muscle is drawn backward, the artery is seen to be contained in a triangular space, the carotid triangle, bounded behind by the Sternocleidomastoideus, above by the Stylohyoideus and posterior belly of the Digastricus, and below by the superior belly of the Omohyoideus. This part of the artery is crossed obliquely, from its medial to its lateral side, by the sternocleidomastoid branch of the superior thyroid artery; it is also crossed by the superior and middle thyroid veins which end in the internal jugular; descending in front of its sheath is the descending branch of the hypoglossal nerve, this filament being joined by one or two branches from the cervical nerves, which cross the vessel obliquely. Sometimes the descending branch of the hypoglossal nerve is contained within the sheath. The superior thyroid vein crosses the artery near its termination, and the middle thyroid vein a little below the level of the cricoid cartilage; the anterior jugular vein crosses the artery just above the clavicle, but is separated from it by the Sternohyoideus and Sternothyreoideus. Behind, the artery is separated from the transverse processes of the cervical vertebræ by the Longus colli and Longus capitis, the sympathetic trunk being interposed between it and the muscles. The inferior thyroid artery crosses behind the lower part of the vessel. Medially, it is in relation with the esophagus, trachea, and thyroid gland (which overlaps it), the inferior thyroid artery and recurrent nerve being interposed; higher up, with the larynx and pharynx. Lateral to the artery are the internal jugular vein and vagus nerve.

At the lower part of the neck, the right recurrent nerve crosses obliquely behind the artery; the right internal jugular vein diverges from the artery, but the left approaches and often overlaps the lower part of the artery.
Behind the angle of bifurcation of the common carotid artery is a reddish-brown oval body, known as the glomus caroticum (carotid body). It is similar in structure to the glomus coccygeum (coccygeal body) which is situated on the middle sacral artery.

Peculiarities as to Origin.—The right common carotid may arise above the level of the upper border of the sternoclavicular articulation; this variation occurs in about 12 per cent. of cases. In other cases the artery may arise as a separate branch from the arch of the aorta, or in conjunction with the left carotid. The left common carotid varies in its origin more than the right. In the majority of abnormal cases it arises with the innominate artery; if that artery is absent, the two carotids arise usually by a single trunk. It is rarely joined with the left subclavian, except in cases of transposition of the aortic arch.

Peculiarities as to Point of Division.—In the majority of abnormal cases this occurs higher than usual, the artery dividing opposite or even above the hyoid bone; more rarely, it occurs below, opposite the middle of the larynx, or the lower border of the cricoid cartilage; one case is related by Morgagni, where the artery was only 4 cm. in length and divided at the root of the neck. Very rarely, the common carotid ascends in the neck without any subdivision, either the external or the internal carotid being wanting; and in a few cases the common carotid has been found to be absent, the external and internal carotids arising directly from the arch of the aorta. This peculiarity existed on both sides in some instances, on one side in others.

Occasional Branches.—The common carotid usually gives off no branch previous to its bifurcation, but it occasionally gives origin to the superior thyroid or its laryngeal branch, the ascending pharyngeal, the inferior thyroid, or, more rarely, the vertebral artery.

Collateral Circulation.—After ligature of the common carotid, the collateral circulation can be perfectly established, by the free communication which exists between the carotid arteries of opposite sides, both without and within the cranium, and by enlargement of the branches of the subclavian artery on the side corresponding to that on which the vessel has been tied. The chief communications outside the skull take place between the superior and inferior thyroid arteries, and the profunda cervicis and ramus descendens of the occipital; the vertebral takes the place of the internal carotid within the cranium.

Carotid artery as other arteries consist of three layers:

- Tunica-intima/interna
- Tunica-media
- Tunica adventitia

The tunica intima or intima for short, is the innermost tunica (layer) of an artery or vein. It is made up of one layer of endothelial cells and is supported by an internal elastic lamina. The endothelial cells are in direct contact with the blood flow.

In dissection, the inner coat (tunica intima) can be separated from the middle (tunica media) by a little maceration, or it may be stripped off in small pieces; but, because of its friability, it cannot be separated as a complete membrane. It is a fine, transparent, colorless structure which is highly elastic, and, after death, is commonly corrugated into longitudinal wrinkles.

The inner coat consists of:

1. A layer of pavement endothelium, the cells of which are polygonal, oval, or fusiform, and have very distinct round or oval nuclei. This endothelium is brought into view most distinctly by staining with silver nitrate.
2. A subendothelial layer, consisting of delicate connective tissue with branched cells lying in the interspaces of the tissue; in arteries of less than 2 mm in diameter the subendothelial layer consists of a single stratum of stellate cells, and the connective tissue is only largely developed in vessels of a considerable size.
3. An elastic or fenestrated layer, which consists of a membrane containing a net-work of elastic fibers, having principally a longitudinal direction, and in which, under the microscope, small elongated apertures or perforations may be seen, giving it a fenestrated appearance. It was therefore called by Henle the fenestrated membrane. This membrane forms the chief thickness of the inner coat, and can be separated into several layers, some of which present the appearance of a network of longitudinal elastic fibers, and others a more membranous character, marked by pale lines having a longitudinal direction. In minute arteries the fenestrated membrane is a very thin layer; but in the larger arteries, and especially in the aorta, it has a considerable thickness.

Tunica media is made up of smooth muscle cells and elastic tissue. It lies between the tunica intima on the inside and the tunica externa on the outside.

The middle coat (tunica media) is distinguished from the inner (tunica intima) by its color and by the transverse arrangement of its fibers.

- In the smaller arteries it consists principally of plain muscle fibers in fine bundles, arranged in lamellæ and disposed circularly around the vessel. These lamellæ vary in number according to the size of the vessel; the smallest arteries having only a single layer,[2] and those slightly larger three or four layers. It is to this coat that the thickness of the wall of the artery is mainly due.
- In the larger arteries, as the iliac, femoral, and carotid, elastic fibers unite to form lamellæ which alternate with the layers of muscular fibers; these lamellæ are united to one another by elastic fibers which pass between the muscular bundles, and are connected with the fenestrated membrane of the inner coat.
- In the largest arteries, as the aorta[3] and brachiocephalic, the amount of elastic tissue is very considerable; in these vessels a few bundles of white connective tissue also have been found in the middle coat. The muscle fiber cells are arranged in 5 to 7 layers of circular and longitudinal smooth muscle with about 50µ in length and contain well-marked, rod-shaped nuclei, which are often slightly curved.

The tunica externa also known as the tunica adventitia (or adventitia for short), is the outermost tunica (layer) of a blood vessel, surrounding the tunica media. It is mainly composed of collagen and, in arteries, is supported by external elastic lamina. The collagen serves to anchor the blood vessel to nearby organs, giving it stability.

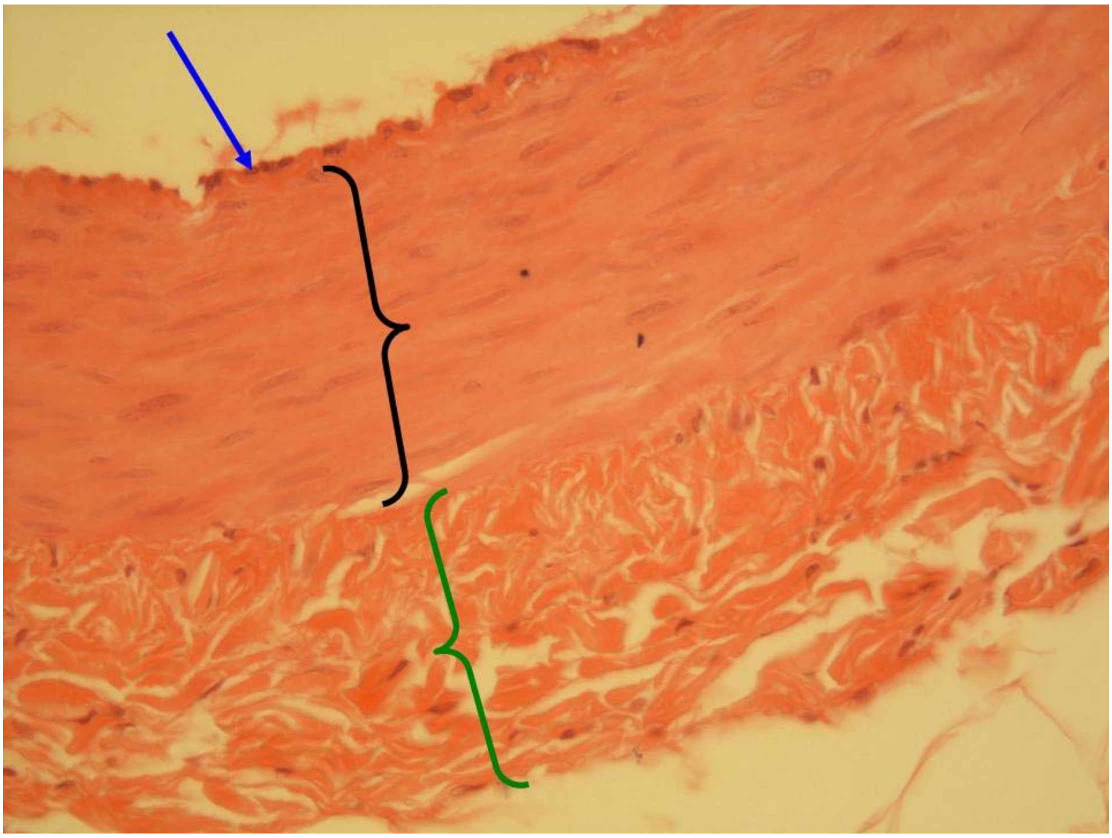


Fig (1.2) The blue arrow is indicates the tunica intima. The black bracket represents the tunica media and the green bracket is the tunica adventitia. This is the wall of an artery at 400x. (Bell J.)

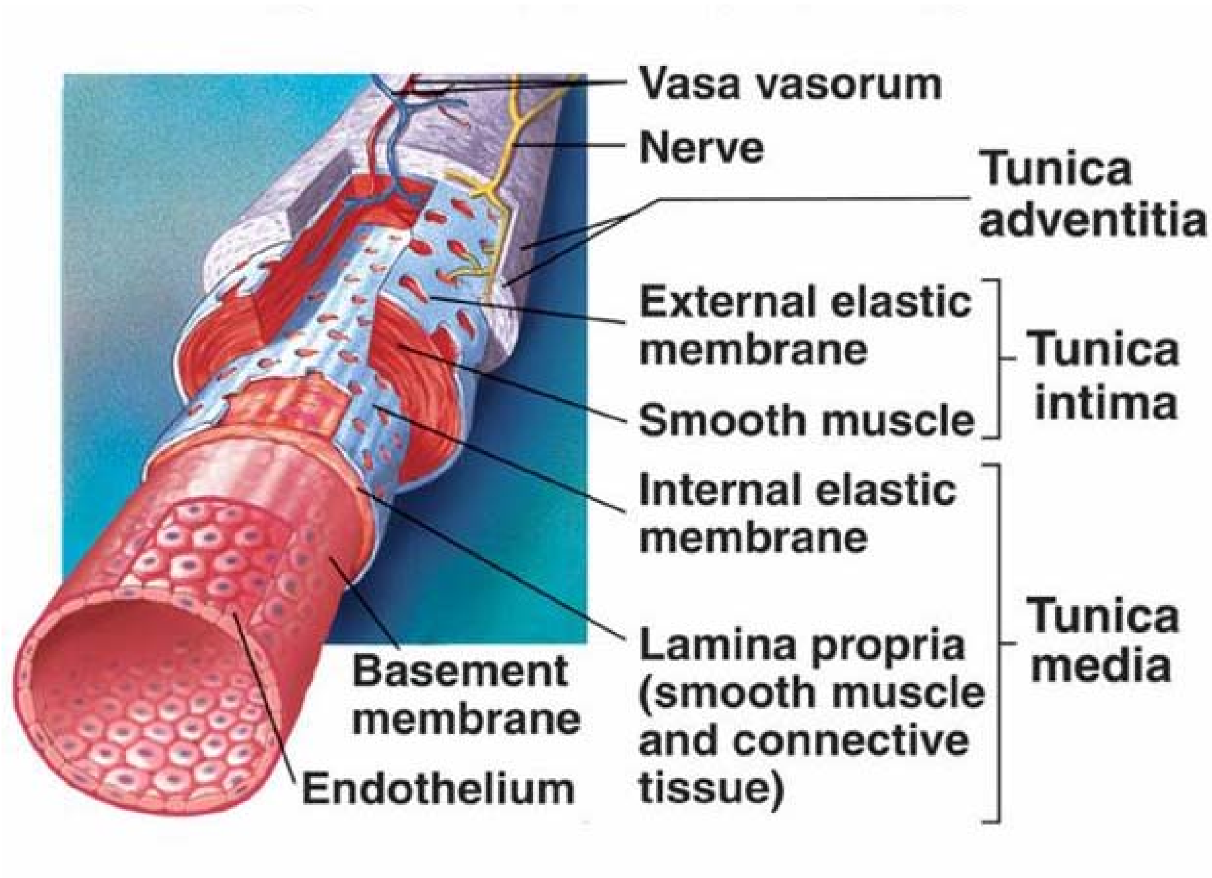


Fig (1.3) Cross sectional image showing the layers of the common carotid artery

2-2 Previous studies:

Baldassarre D. et al. (2012) stated that ultrasonographic measurements of carotid artery in routine clinical practice can yield the same results as those obtained with quantitative methods, in their study they scanned CCA in different projects to obtained MM.IMT in 487 male and 478 female, in their result the male were younger than female and with higher BMI, M.IMT values were greater in male than female and IMT values correlated highly with age in total population.

Toing k.et. al. (2007) studied Asymptomatic men and women aged 35 to 75 years, without evidence of clinical atherosclerosis, underwent B-mode carotid duplex. Mean carotid IMT at the far wall of both left and right CCA were quantitatively determined. Healthy population was defined as participants with no cardiovascular disease and no evidence of diabetes mellitus or hypertension with a body mass index less than 30 kg/m2, serum cholesterol less than 6 mmol/L, and absence of carotid plaque on ultrasound. In Result of the 453 participants, 137 were found to be healthy. IMT measured at the bifurcation was significantly higher compared with that at the CCA. Carotid IMT in both CCA and its bifurcation increased significantly with age. The upper limits (97.5 percentile) of IMT at CCA for participants age 35 to 39, 40 to 49, 50 to 59, and 60 years or older were 0.60, 0.64, 0.71, and 0.81 mm, respectively, whereas for that at bifurcation were 0.83, 0.77, 0.85, and 1.05 mm, respectively.

Jarauta E. et.al (2008) studied Carotid Intima-Media Thickness in Subjects With no Cardiovascular Risk Factors, The carotid intima-media thickness was assessed in 138 subjects (64 men and 74 women) aged 20-79 years whose age and sex were homogeneously distributed. The upper limit of normal for the mean carotid intima-media thickness ranged from 0.59-0.95 mm in men and from 0.52-0.93 mm in women. The upper limit for the maximum thickness varied from 0.81-1.11 mm in men and from 0.66-1.13 mm in women. The main parameters determining the intima-media thickness were age, male sex, systolic blood pressure and low-density lipoprotein cholesterol level.

Homma S. et.al.(2001) studied Carotid Plaque and Intima-Media Thickness by B-Mode Ultrasonography in Subjects Ranging From Young Adults to Centenarians, they examined ultrasonographically carotid arteries of subjects who had no major atherosclerotic risk factors, study population was 319 healthy subjects (154 men, 165 women; age range, 21 to 105 years) with no history of hypertension, diabetes mellitus, or atherosclerotic disease. Mean intima-media wall thickness (IMT) of common carotid arteries at plaque-free sites and prevalence of plaques were evaluated by B-mode ultrasound. *In Results* Mean common carotid IMT increased in a linear manner with age for all decades of life, including centenarians [IMT=(0.009×Age)+0.116] (r=0.83). In centenarians (n=30), intima-media complexes were diffusely thickened (mean IMT, 1.01 mm). Plaque prevalence increased up to the tenth decade of life (83.3%, n=30) but decreased in centenarians (60.0%). IMT and plaque prevalence were closely associated in the seventh and eighth decades of life but not at older ages. Conclusions The study indicates that increased IMT is a physiological effect of aging that corresponds to diffuse intimal thickening, especially in very elderly persons, and that IMT is distinct from pathological plaque formation

Jourdan et.al (2005) sonographicly evaluated Normative values for intima–media thickness and distensibility of large arteries in healthy adolescent, they assessed the IMT of the common carotid (cIMT) and femoral arteries (fIMT), carotid elasticity indices and interacting anthropometric factors in 247 healthy subjects aged 10–20 years.. in Results: cIMT, fIMT, incremental elastic modulus (Einc) and circumferential wall stress (CWS) were positively, and distensibility coefficient (DC) inversely, correlated with age, height, body mass index (BMI), systolic blood pressure (BP) and brachial pulse pressure ($r = 0.56$ to -0.45, $P < 0.05$ to 0.0001). DC ($r = -0.29$, $P < 0.0001$) and stiffness index β ($r = 0.25$, $P < 0.0001$), but not Einc, were significantly associated with cIMT independently of age. All vascular parameters showed non-Gaussian distributions. Excessively high IMT was associated with BMI and pulse pressure above the 90th percentile, and elevated Einc with high-normal BMI. Multivariate analysis identified independent positive effects of standardized BMI and brachial pulse pressure on normalized cIMT, negative effects of systolic BP and cIMT on DC, a positive effect of cIMT on stiffness, and positive effects of systolic BP and BMI on Einc and CWS. Conclusions: Morphological and functional measures of large arteries should be normalized to take account of changes during adolescence and skewed distributions. Relative body mass, systolic blood pressure and/or pulse pressure are determinants of IMT and elasticity.

Elaine M. et. al (2002)examined relation and impact of multiple coronary risk factors on the intima-media thickness of different segments of carotid artery in healthy young adults, a sample of 518 black and white subjects (mean age 32 years; 71% white, 39% male) were scanned. IMT was thicker and more skewed in the bulb compared with other carotid segments. Race differences (blacks more than whites) were noted for the common carotid ($p < 0.001$) and carotid bulb (bifurcation) IMT (women only, $p < 0.001$). Men had a greater IMT in the common carotid ($p < 0.05$), internal carotid ($p < 0.05$), and carotid bulb (whites only, $p < 0.001$). In a multivariate analysis, systolic blood pressure, race, age, low-density lipoprotein (LDL) cholesterol, and high-density lipoprotein (HDL) cholesterol were entered into a model in that order and accounted for the 16.7% variance in the common carotid IMT; age, systolic blood pressure, HDL cholesterol, LDL cholesterol, race, and insulin levels explained the 19.4% variance in the carotid bulb IMT. Gender and body mass index (BMI) accounted for the 4.7% variance in the internal carotid IMT. Increases in IMT with increasing number of risk factors (cigarette smoking, higher total cholesterol to HDL cholesterol ratio, higher systolic blood pressure, greater waist circumference, and higher insulin level) were noted for the common carotid and carotid bulb segments (p for trend <0.001 for both). The observed deleterious trend of increasing IMT at different carotid segments with increasing number of risk factors in free-living, asymptomatic young subjects underscores the importance of profiling multiple risk factors early in life. Ultrasonography of carotid arteries, especially at the bifurcation, may be helpful along with measurements of risk factors for evaluation of asymptomatic atherosclerotic disease.

Paul L. et, Al. (1997) studied Relationship Between Carotid Intima-Media Thickness and Symptomatic and Asymptomatic Peripheral Arterial Disease, their study described the distribution of IMT within the general population and was one of the first to investigate its association with noninvasively assessed symptomatic and asymptomatic peripheral arterial disease. Valid readings of IMT were recorded in 1106 subjects aged 60 to 80 years, and the maximum from the right and left sides of the neck was used in the analysis. In *Results* IMT increased continuously with age ($P \leq .01$), and its distribution was positively skewed in both sexes. The results suggested that levels of atherosclerotic development in the common carotid artery are 5 to 10 years more advanced in men than in women. In this population, the overall prevalence of moderate to severe disease was very low (only 1.2% of study participants had IMT values >2 mm). The presence of symptomatic (intermittent claudication) or asymptomatic (ankle brachial pressure index ≤ 0.9)

peripheral arterial disease was significantly associated with increased IMT ($P \leq .05$). *Conclusions:* Although the prevalence of advanced atherosclerosis was very low, small changes in IMT were associated with clinically significant development of atherosclerosis in the peripheral arteries.

Matteo M. et,al. (2010) evaluated Carotid artery intima-media thickness: normal and percentile values in the Italian population, The aim of thier research was to develop an epidemiological study of the normal mean values of IMT of the common carotid artery, adjusted for age and sex, in the Italian population. a total of 1017 patients (596 males, mean age: 58.5 + 13.2 years) were enrolled at four different Italian centers. Inclusion criteria were the absence of cardiovascular risk factors or presence of not more than one. Patients underwent two-dimensional echo-color Doppler scanning of the carotid arteries, adopting a high-definition vascular echographic apparatus and a 11–3 MHz linear electronic probe. The arithmetical mean of the IMT value was calculated. Data obtained from this study showed the carotid IMT changes in relation to age and sex. In particular, it grows higher with increasing age, and is always higher in men than in women. Conclusion: In relation to the percentile distribution of the values in the population analyzed, the normal range of m-IMT could be established just on the basis of the patient’s age and sex. In this way, the ultrasound scan operator can rely on a simple reference scheme. This will help to refine the use of carotid ultrasound as an excellent tool for detecting asymptomatic carotid alterations and patients at high risk for cerebral and cardiovascular disease.

Chapter Three

Chapter Three

Methodology

3-1 Design of the study:

This is a descriptive study designed to measure the IMT of common carotid artery in Sudanese population using B-mode ultrasonography.

3-2 Population of the Study:

The study included adult volunteers in ages of 22-75 years of both genders, while excluded data is from patients with Atherosclerosis, Heart disease, Diabetes mellitus, Hypertensive patients and smokers.

3-3 Sample size and type:

The sample of this study consist of 50 Sudanese adults (20 male and 30 female).

3-4 Study area and Duration:

This study have been carried out in Khartoum state in different hospitals and medical centres including Bashaeir Teaching Hospital, Academic teaching hospital, and Sudan Heart Centres during period from May 2016 to July 2016.

3-5 Material:

The data collected by using Medison Ultrasound machine model AccuvixXG, Mindray, and General Electric machines, using linear transducers, frequencies of 10-15 MHz was carried out.

3-6 Method of data collection:

Each volunteer scanned twice, in an international scanning guidelines and protocols, firstly by the researcher and then by a qualified sinologist to confirm the findings. Ultrasound technique was performed with patient lying in supine position, were an adequate amount of ultrasound coupling gel had been placed on the patient's neck, longitudinal section of common carotid artery has been taken at 1 cm before bifurcation, the double echogenic line at far wall has been measured, Then the collected findings inserted in to the master data sheet.

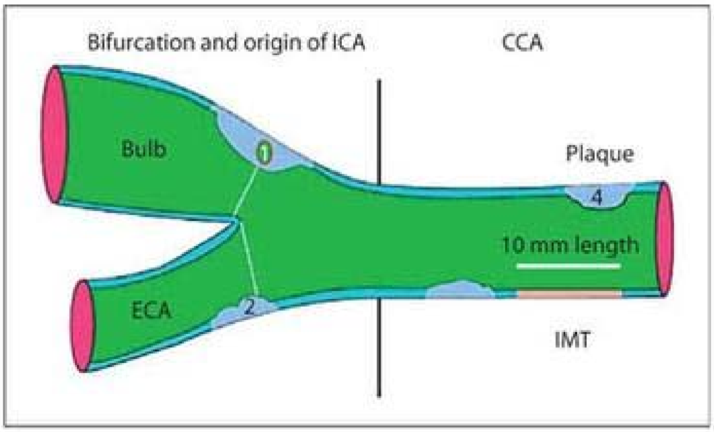


Figure 3-1 :Proper location for IMT measurement

3-7 Study Variables:

The variables of the study consist of the following: age, gender, height and weight to calculate BMI and wright and left common carotid arteries IMT.

3-8 Method of data analysis:

The data analyzed using SPSS and EXIL under windows, by finding the correlation, liner association and significant differences between IMT and age, gender and BMI.

3-9 Ethical Clearance:

Permission of departments at the area of the study granted as well as volunteers' permission to use the collected data for scientific purposes; volunteers' details will not be disclosed.

Chapter four

Chapter Four

Result

The result of this study obtained from following figures and tables presented the data obtained from 50 subject scanned by B-mode ultrasound machine with 10-15 MHZ linear transducer and the relation between different variables are presented by using scatter plot, bar graph and t.test.

Table 4-1: frequency and percentage of each gender in the collected sample.

Gender	Frequency	Percent
Male	20	40.0
Female	30	60.0
Total	50	100.0

Table 4-2: frequency table shows ages in the collected data.

Age	Frequency	Percent
22-30	18	36.0
31-39	7	14.0
40-48	9	18.0
49-57	7	14.0
58-66	5	10.0
67-75	4	8.0
Total	50	100.0

Table 4-3: frequency table shows heights among the data collected.

Height	Frequency	Percent
1.55-1.60	12	24.0
1.61-1.66	15	30.0
1.67-1.72	16	32.0
1.73-1.78	6	12.0
1.79-1.84	1	2.0
Total	50	100.0

Table 4-4: frequency table shows weight in the collected data.

Weight	Frequency	Percent
50-57	4	8.0
58-65	13	26.0
66-73	9	18.0
74-81	10	20.0
82-89	9	18.0
90-97	5	10.0
Total	50	100.0

Table 4-5: frequency table shows BMI .

BMI	Frequency	Percent
18.9-20.9	4	8.0
21.9-23.9	8	16.0
24.9-26.9	16	32.0
27.9-29.9	11	22.0
30.9-32.9	5	10.0
33.9-35.9	6	12.0
Total	50	100.0

Table 4-6: mean and standard deviation of Rt and Lt carotid artery IMT in male and female.

Gander		Mean	Std. Deviation
Rt Carotid IMT	Male	0.0615	.007
	Female	0.0620	.010
Lt Carotid IMT	Male	0.0545	.009
	Female	0.0540	.014

Table 4-7: describe the significant difference of independent variable (gender) by using 2-tailed (t-test) at p= 0.05.

Independent Samples Test for gender		
	t-test for Equality of Means	
	t	Sig. (2-tailed)
Rt Carotid IMT	-.182	0.856
Lt Carotid IMT	.139	0.890

Means: there is no significant difference between male and female concerning Carotid IMT for Rt and Lt at p = 0.05 using t-test

Table 4-8: mean and std. Deviation of Rt and Lt carotid IMT.

Average of IMT between Rt and Lt

Paired Samples Statistics		
Carotid	Mean	Std. Deviation
Rt IMT	.0618	.00941
Lt IMT	.0542	.01230

Table 4-9: Paired t-test showed significant difference between Rt and Lt IMT where the Rt IMT in average were larger than the Lt one.

Paired Samples Test		
Carotid	t	Sig. (2-tailed)
Rt IMT and Lt IMT	4.735	.000

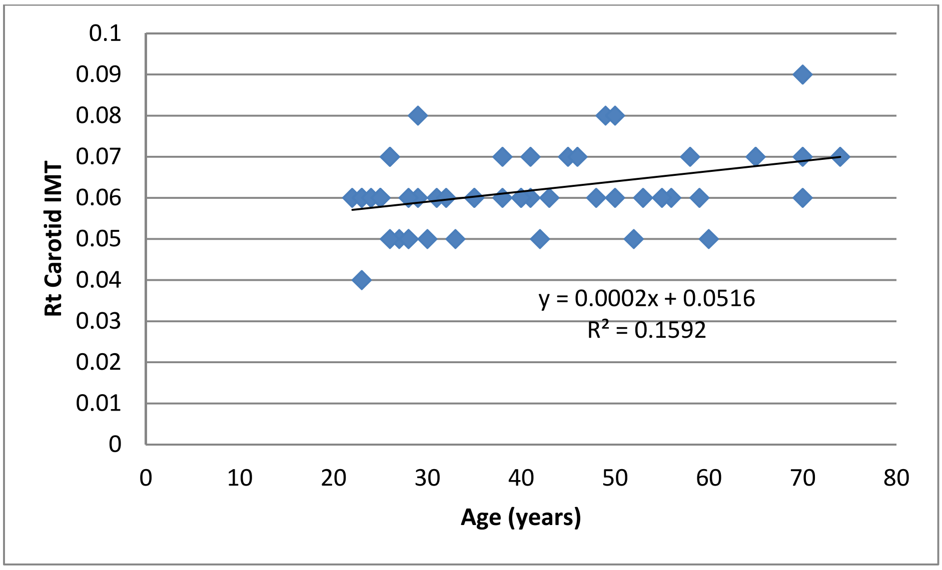


Diagram 4-1: scatter plot diagram for age and Rt Carotid IMT.

Diagram 4-1 is a scatter plot use to show linear relationship between age and Rt Carotid IMT. A regression equation and correlation squared were calculated, the regression equation was as following: Rt IMT= 0.0002age+0.0516
The correlation was: R2=0.1592

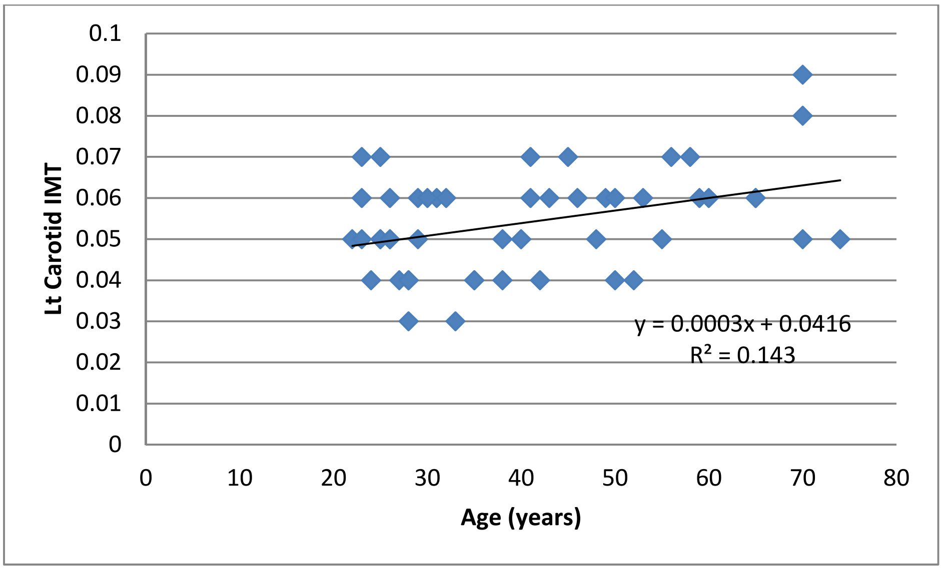


Diagram 4-2: scatter plot diagram for age and Lt Carotid IMT.

Diagram 4-2 is a scatter plot use to show linear relationship between age and Lt Carotid IMT. A regression equation and correlation squared were calculated, the regression equation was as following: Lt IMT= 0.0003age+0.0416
The correlation was: R^2=0.143

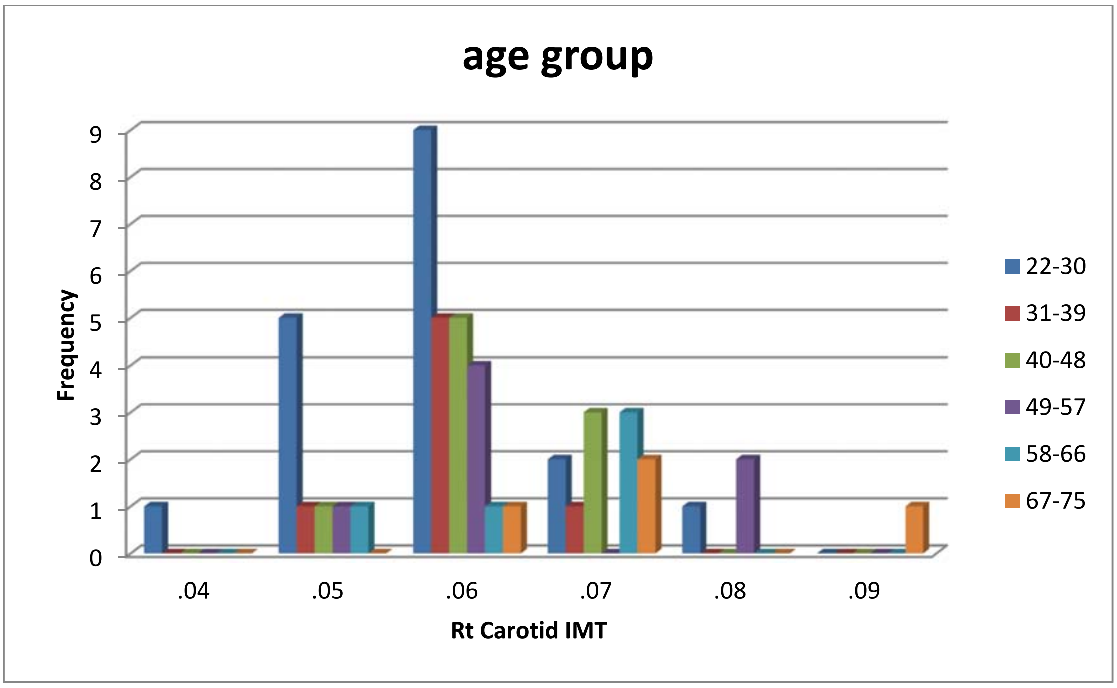


Figure 4-1: a bar graph shows relation between Rt carotid IMT and age.

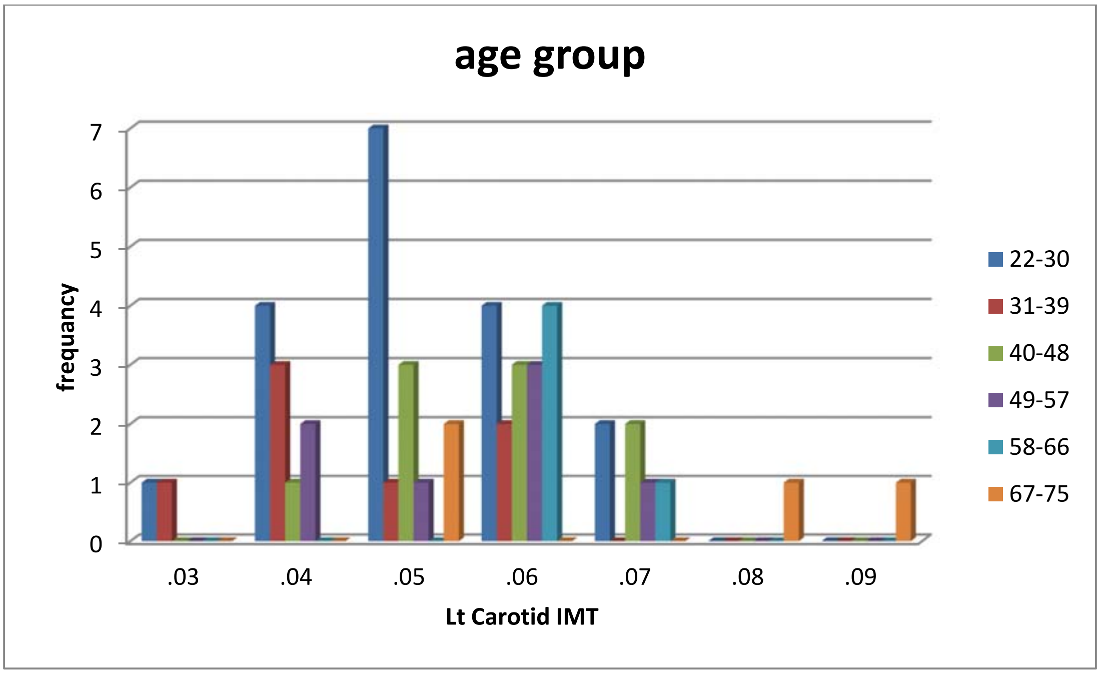


Figure 4-2: a bar graph shows relation between Lt carotid IMT and age.

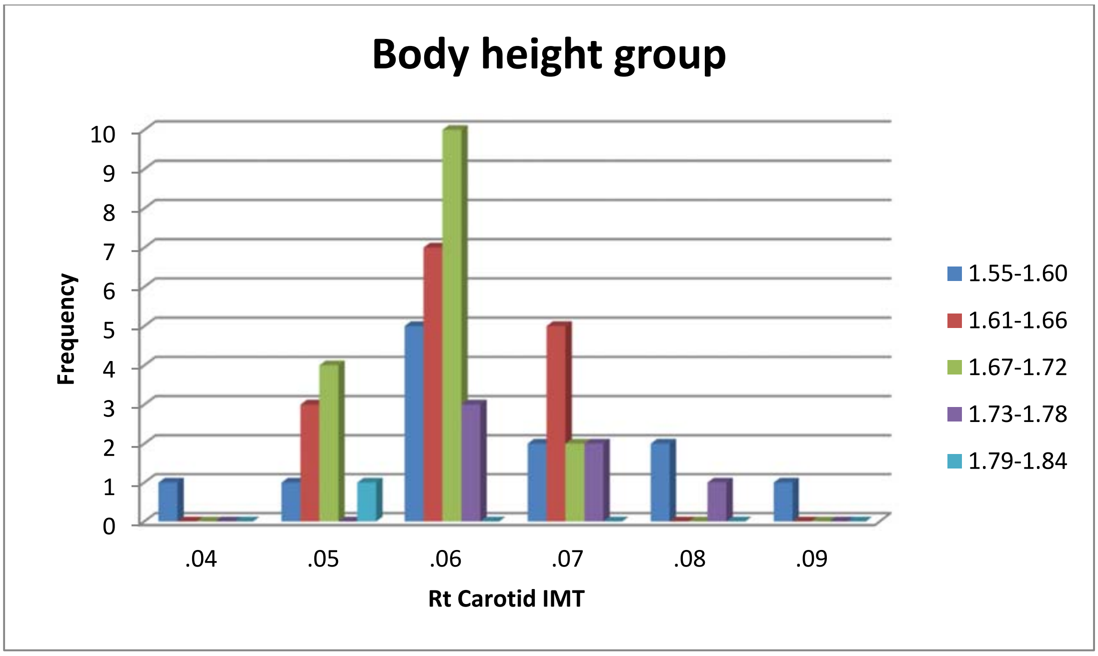
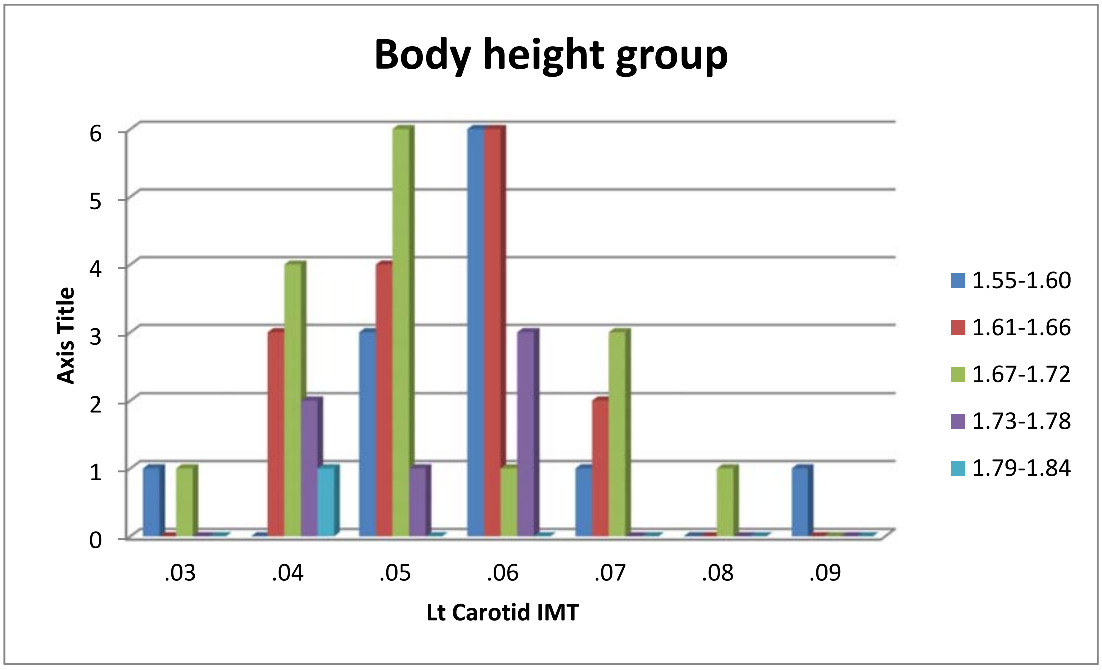


Figure 4-3: a bar graph shows relation between Rt carotid IMT and body height.



Figure, 4-4: a bar graph shows relation between Lt carotid IMT and body height.

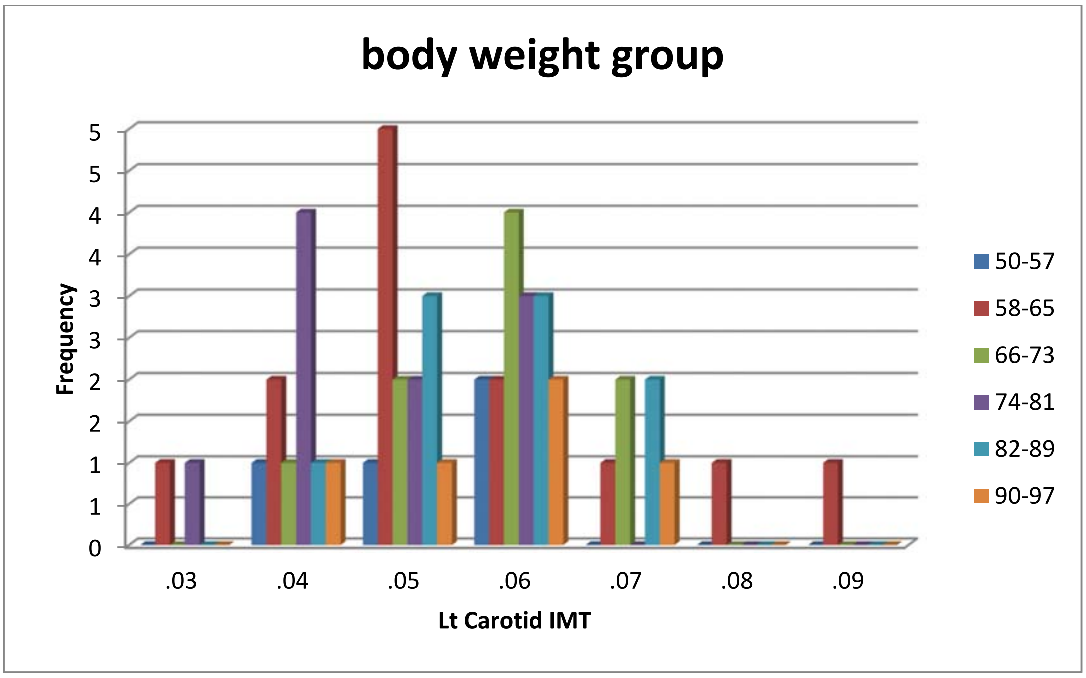


Figure 4-5: a bar graph shows relation between Lt carotid IMT and body weight.

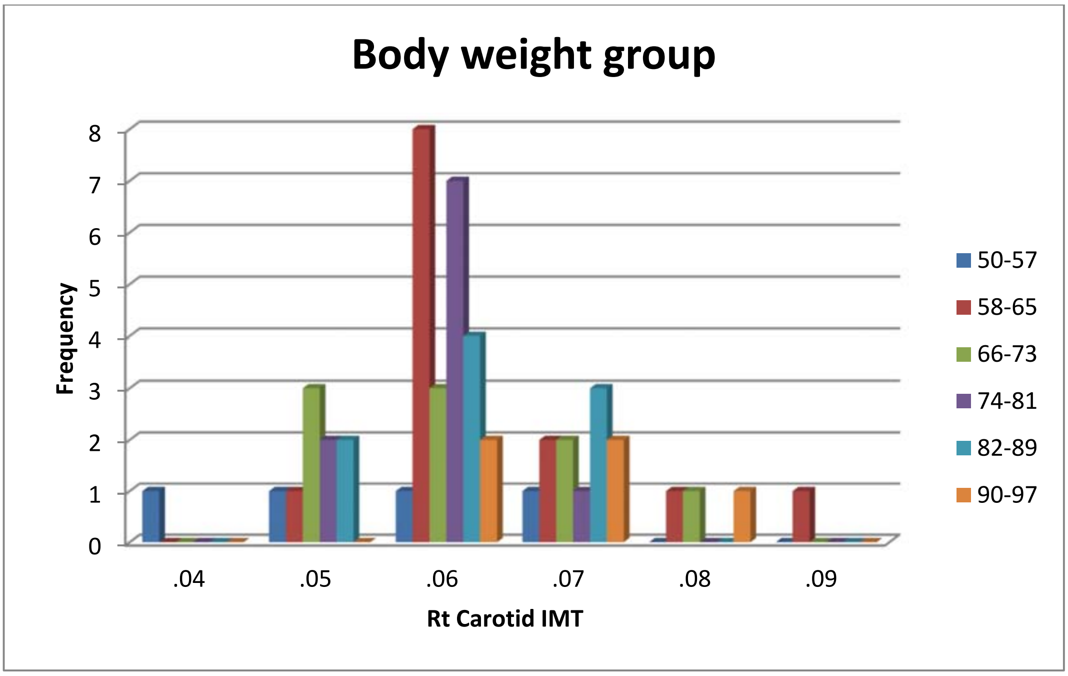


Figure 4-6: a bar graph shows relation between Rt carotid IMT and body weight.

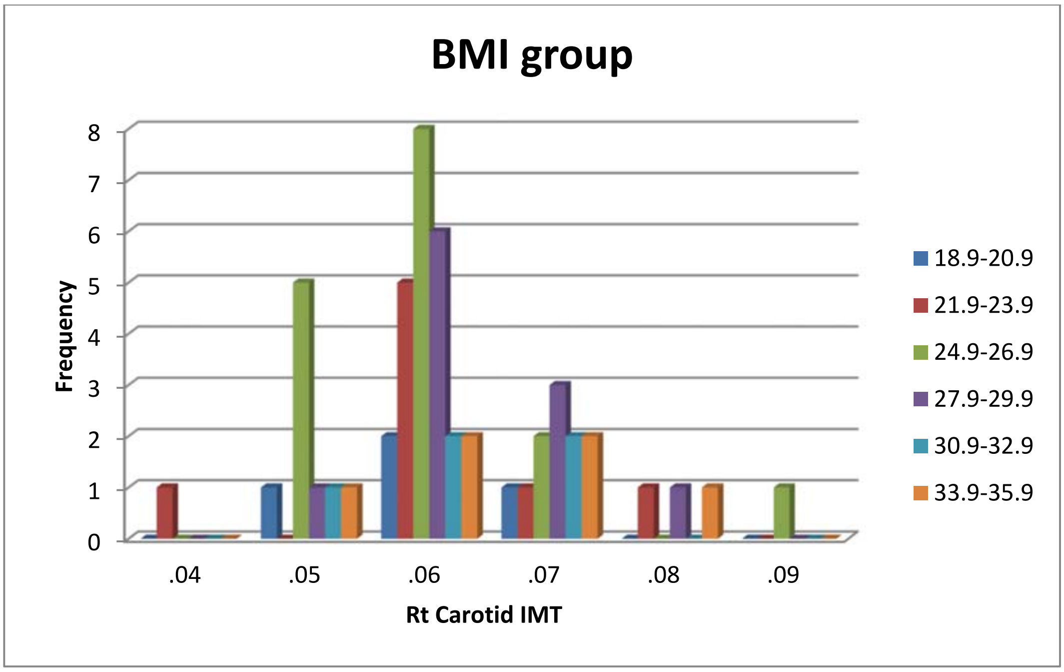


Figure 4-7: a bar graph shows relation between Rt carotid IMT and BMI

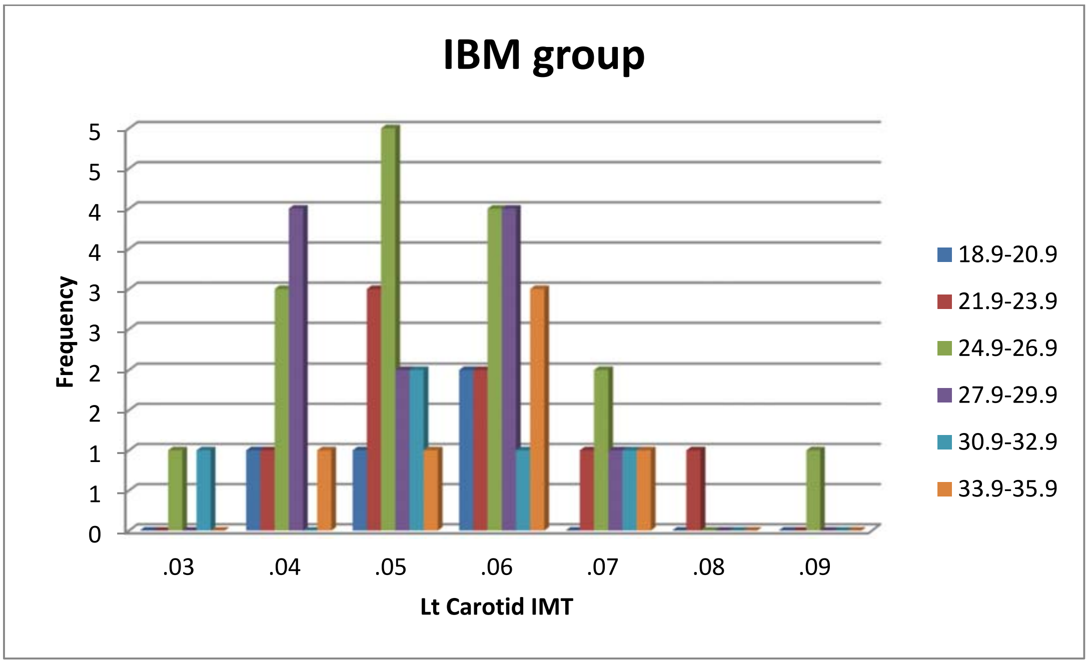


Figure 4-8: a bar graph shows relation between Lt carotid IMT and BMI.

Chapter five

Chapter five

Discussion, conclusion and recommendation

5-1 discussion:

The main objective of this study was to measure the value of common carotid artery IMT in Sudanese population using B-mode Ultrasound; the study included adult volunteers with no history of hypertension, diabetes, heart disease or smokers. The data collected in different medical centers in Khartoum state, the data collected from both genders were 40% are male and the majority were female representing 60% of the data.

The ages ranged from 22 years old up to 75 years old, the higher were the age group ranged from 22-30 years representing 36% off all population, while the lower frequency ranged from 67-75 years representing only 8%. The height of volunteers ranged from 1.55m up to 1.84m with 32% of population ranged between 1.677- 1.72 m and only 2% measured 1.79-1.84 m in height. In weight distribution the majority of data ranged between 58-65 kg and this represented 26% of data collected. The most frequent BMI ranged between 24.9-26.9 representing 32% f collected data followed by BMI ranged betwee 27.9-29.9 that representing 22%, this was expected because female were the majority in population.

The mean and standard deviation of Rt and Lt common carotid IMT or both genders were calculated by t-test at p=o.o5 (4-7) and no significant difference were found between the two groups that’s why all other independent variable were analyzed as one group, Baldassarre D. et.al (2012),Elaine M. etal. (2002) and Metteo M. etal.(2010) are disagreed and stated that male has higher mean IMT value than female, otherwise Paul L. etal. (2001) stated that IMT increased with age by factor equal 0.0009cm.

In this study age were divided In to 6 groups, 36% of study population ranged from 22-30 years old with Rt IMT measured 0.06cm while the Lt IMT measured 0.05cm as figure (4-1) and (4-2) showed.

The figure (4-3) and (4-4) showed relation of Rt and Lt IMT in respect to height were the Rt IMT measured 0.06cm for the higher frequency height group ranged from 1.67-1.72m. The Lt IMT values for the higher frequency groups (height ranged from 1.61-1.66 m and 1.55-1.60m) measured 0.06cm and 0.05cm for height group ranged from 1.67-1.72m.

The higher weight frequency in this result were 58-65kg with Rt IMT measured 0.06cm ad Lt IMT measured 0.05cm, the same IMT values is measured for the higher frequency BMI group that ranged between 24.9-26.9.

5-2 Conclusion:

Carotid artery is one of the vital vessels that need an early detection for any wall thickness change due to pathology, IMT is important parameter in diagnosing and early detection of disorders like atherosclerosis, knowing value of IMT in Sudanese population safe time in diagnosis process. This study aimed to measure this value among Sudanese sample consist of 50 volunteer scanned at different medical centers in Khartoum state and the data collected in master data sheet.

The result of this study showed that the mean diameter of Rt common carotid IMT measured 0.618mm and the Lt common carotid IMT measured 0.542mm, were the Rt IMT value is higher than the Lt IMT value.

This study also showed that there is no effect of weight, height and BMI in IMT value. Gender was also with no significant difference with IMT value.

The study found linear relationship between age and IMT value were Rt IMT and Lt IMT increased by 0.0002cm and 0.0003cm per year respectively.

5-3 Limitation:

The main limitation of this study is the small sample size, also the difficulty of reproducibility of scan technique and subject or volunteer position.

5-4 Recommendation:

- This study highly recommended further studies with increasing variables, and adding systolic blood pressure variable.
- This study also recommended further studies were life style and geographic area are take into account.
- Due to importance of detecting and following changes in carotid IMT, routine scan should done for ages above 50years.

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Appendix:

Data collecting sheet

No.	gander	Age	height	Weight	BMI	C.IMT	
						Rt	Lt
1.	F	22	1.70	70	24	.06	.05
2.	F	23	1.76	60	19	.06	.05
3.	F	23	1.58	55	22	.04	.06
4.	M	45	1.75	88	28.7	.07	.07
5.	F	70	1.60	60	23	.06	.08
6.	F	27	1.58	50	20	.05	.04
7.	F	25	1.68	58	20.5	.06	.05
8.	F	26	1.63	62	23	.07	.05
9.	F	70	1.58	60	24	.09	.09
10.	M	25	1.70	68	23.5	06	.07

No.	gander	Age	height	weight	BMI	C.IMT	
						Rt	Lt
11.	F	28	1.63	80	30	.05	.03
12.	M	41	1.65	95	34.9	.07	.06
13.	F	23	1.65	85	31	.06	.07
14.	F	41	1.60	58	22.7	.06	.07
15.	M	24	1.63	65	24.5	.06	.04
16.	F	29	1.62	54	20.6	.06	.05
17.	F	38	1.60	82	32	.07	.05
18.	M	25	1.63	63	23.7	.06	.05
19.	F	28	1.65	58	21	.06	.04
20.	M	43	1.72	70	23.7	.06	.06
No.	gander	Age	height	Weight	BMI	C.IMT	

						Rt	Lt
21.	F	31	1.70	58	20	.06	.06
22.	F	35	1.67	78	28	.06	.04
23.	F	29	1.70	60	20.8	.08	.06
24.	M	26	1.65	70	25.7	.05	.05
25.	M	40	1.70	76	26.3	.06	.05
26.	F	26	1.72	56	18.9	.07	.06
27.	F	30	1.67	68	24.4	.05	.06
28.	M	28	1.72	75	25.4	.05	.04
29.	F	74	1.65	90	33	.07	.05
30.	M	40	1.76	83	26.8	.06	.05
No.	gander	Age	height	weight	BMI	C.IMT	
						Rt	Lt

31.	M	38	1.66	96	34.8	.06	.04
32.	F	50	1.60	75	29.3	.06	.04
33.	M	49	1.67	92	33	.08	.06
34.	F	42	1.63	70	26.3	.05	.04
35.	F	33	1.61	65	25	.05	.03
36.	F	65	1.56	72	29.6	.07	.06
37.	M	32	1.75	77	25.1	.06	.06
38.	M	52	1.80	89	27.5	.05	.04
39.	F	56	1.66	90	32.7	.06	.07
40.	M	65	1.69	76	26.6	.07	.06
No.	gander	Age	height	weight	BMI	C.IMT	
						Rt	Lt
41.	M	58	1.57	73	23.8	.07	.07

42.	F	70	1.55	60	25	.07	.05
43.	M	48	1.70	77	26.6	.06	.05
44.	F	35	1.73	80	26.7	.06	.04
45.	F	46	1.70	85	29.4	.07	.06
46.	M	55	1.65	88	32.3	.06	.05
47.	M	59	1.70	85	29.4	.06	.06
48.	F	50	1.55	66	27.5	.08	.06
49.	F	60	1.57	83	33.7	.05	.06
50.	M	53	1.75	80	26.1	.06	.06

Age * Rt_C_IMT Crosstabulation

Count

		Rt_C_IMT						Total
		.04	.05	.06	.07	.08	.09	
Age	22-30	1	5	9	2	1	0	18
	31-39	0	1	5	1	0	0	7
	40-48	0	1	5	3	0	0	9
	49-57	0	1	4	0	2	0	7
	58-66	0	1	1	3	0	0	5
	67-75	0	0	1	2	0	1	4
Total		1	9	25	11	3	1	50

Age * Lt_C_IMT Crosstabulation

Count

		Lt_C_IMT							Total
		.03	.04	.05	.06	.07	.08	.09	
Age	22-30	1	4	7	4	2	0	0	18
	31-39	1	3	1	2	0	0	0	7
	40-48	0	1	3	3	2	0	0	9
	49-57	0	2	1	3	1	0	0	7
	58-66	0	0	0	4	1	0	0	5
	67-75	0	0	2	0	0	1	1	4
Total		2	10	14	16	6	1	1	50

height * Rt_C_IMT Crosstabulation

Count

		Rt_C_IMT						Total
		.04	.05	.06	.07	.08	.09	
height	1.55-1.60	1	1	5	2	2	1	12
	1.61-1.66	0	3	7	5	0	0	15
	1.67-1.72	0	4	10	2	0	0	16
	1.73-1.78	0	0	3	2	1	0	6
	1.79-1.84	0	1	0	0	0	0	1
Total		1	9	25	11	3	1	50

height * Lt_C_IMT Crosstabulation

Count

		Lt_C_IMT							Total
		.03	.04	.05	.06	.07	.08	.09	
height	1.55-1.60	1	0	3	6	1	0	1	12
	1.61-1.66	0	3	4	6	2	0	0	15
	1.67-1.72	1	4	6	1	3	1	0	16
	1.73-1.78	0	2	1	3	0	0	0	6
	1.79-1.84	0	1	0	0	0	0	0	1
Total		2	10	14	16	6	1	1	50

weight * Rt_C_IMT Crosstabulation

Count

		Rt_C_IMT						Total
		.04	.05	.06	.07	.08	.09	
weight	50-57	1	1	1	1	0	0	4
	58-65	0	1	8	2	1	1	13
	66-73	0	3	3	2	1	0	9
	74-81	0	2	7	1	0	0	10
	82-89	0	2	4	3	0	0	9
	90-97	0	0	2	2	1	0	5
Total		1	9	25	11	3	1	50

weight * Lt_C_IMT Crosstabulation

Count

		Lt_C_IMT							Total
		.03	.04	.05	.06	.07	.08	.09	
weight	50-57	0	1	1	2	0	0	0	4
	58-65	1	2	5	2	1	1	1	13
	66-73	0	1	2	4	2	0	0	9
	74-81	1	4	2	3	0	0	0	10
	82-89	0	1	3	3	2	0	0	9
	90-97	0	1	1	2	1	0	0	5
Total		2	10	14	16	6	1	1	50

BMI * Rt_C_IMT Crosstabulation

Count

		Rt_C_IMT						Total
		.04	.05	.06	.07	.08	.09	
BMI	18.9-20.9	0	1	2	1	0	0	4
	21.9-23.9	1	0	5	1	1	0	8
	24.9-26.9	0	5	8	2	0	1	16
	27.9-29.9	0	1	6	3	1	0	11
	30.9-32.9	0	1	2	2	0	0	5
	33.9-35.9	0	1	2	2	1	0	6
Total		1	9	25	11	3	1	50

BMI * Lt_C_IMT Crosstabulation

Count

		Lt_C_IMT							Total
		.03	.04	.05	.06	.07	.08	.09	
BMI	18.9-20.9	0	1	1	2	0	0	0	4
	21.9-23.9	0	1	3	2	1	1	0	8
	24.9-26.9	1	3	5	4	2	0	1	16
	27.9-29.9	0	4	2	4	1	0	0	11
	30.9-32.9	1	0	2	1	1	0	0	5
	33.9-35.9	0	1	1	3	1	0	0	6
Total		2	10	14	16	6	1	1	50

Table 4-10: Paired t-test showed significant difference between Rt IMT and age, p=0.05

Dependent Variable: Rt Carotid IMT			
Coefficient	B	t	Sig.
(Constant)	.052	14.391	.000
Age	.0002	3.014	.004

Table 4-11: Paired t-test showed significant difference between Lt IMT and age, p=0.05

Dependent Variable: Lt Carotid IMT			
Coefficient	B	t	Sig.
(Constant)	.042	8.783	.000
Age	.0003	2.830	.007