THE PATTERN OF VASCULAR PATHOLOGY ON MULTIDETECTOR COMPUTERISED TOMOGRAPHY ANGIOGRAPHY IN KENYATTA NATIONAL HOSPITAL

A dissertation submitted in part fulfilment for the degree of Master of Medicine (Diagnostic Imaging), University of Nairobi

2009

DR. KAGUTHI J. NYOKABI

ACKNOWLEDGEMENT

I would like to express the deepest appreciation to my supervisor Dr. M. N. Wambugu who continually conveyed a spirit of guidance in regard to my research and an excitement in regard to Vascular Pathology. Without her guidance and persistent help this dissertation would not have been possible.

I would like to thank KNH Staff and in particular Mrs. Margaret Njue who mastered the technique of CTA and propelled the research to international standards. I also appreciate the patients who willingly volunteered in this important research.

In addition, this acknowledgement would not be complete without a thank you to my colleagues, whose advice and intellect offered me with various insights that added value to my research

I thank the management of Kenyatta National Hospital for providing an enabling environment for this research that will go a long way into management of Vascular Pathology not only in this country but in this region.

Last but not least, I thank my husband Michael, our son, siblings and my parents for the support they offered during the time I was writing this research.

DECLARATION

Candidate:

This dissertation is my original work and has not been presented for a degree in any other university

Signed: _____

DR. KAGUTHI J. NYOKABI, M.B.Ch.B.

This dissertation has been submitted for examination with my approval as a university supervisor

Signed: _____

DR M.N WAMBUGU, M.B.Ch.B. (Makerere University), M.MED. (U.O.N), Senior Lecturer. Department of Diagnostic Imaging and Radiation Medicine, University of Nairobi

ABBREVIATIONS USED

AAA	Abdominal Aortic Aneurysm
AVM	ArterioVenous Malformation
CBT	Carotid Body Tumour
CCF	Congestive Cardiac Failure
CFA	Common Femoral Artery
CT	Computer Tomography
CTA	Computerised Tomography Angiography
DM	Diabetes Mellitus
DSA	Digital Subtraction Angiography
DVT	Deep Venous Thrombosis
2D	Two- Dimensional
3 D	Three- Dimensional
FMD	Fibromuscular Dysplasia
IV	Intravenous
KNH	Kenyatta National Hospital
MDCTA	Multidetector Computerised Tomography Angiography
MIP	Maximum Intensity Projection
MPA	Main PulmonaryArtery
MRA	Magnetic Resonance Angiography
MRI	Magnetic Resonance Imaging
PE	Pulmonary Embolism
PAA	Popliteal Artery Aneurysm
PVD	Peripheral Vascular Disease
RAS	Renal Artery Stenosis
SAH	Subarachnoid Haemorrhage
Se	Standard error

CONTENTS

List of Tables and figures

ABSTRACT

Introduction

The development of multidetector Computer Tomography (MDCT) has revolutionized CT angiography (CTA). New techniques and software are currently being developed and modified to improve CTA. The advantage of MDCT relevant to CTA is the ability to acquire high resolution, near isotropic data sets in a shorter acquisition time. Also important is the ability to achieve a longer scanning range in the arterial phase, which has led to the introduction of CTA of the peripheral arterial system. Image processing techniques have also progressed rapidly, with simplification of a previously cumbersome process. The high spatial resolution and relatively non-invasive nature of MDCT angiography are favourable factors against established vascular imaging techniques. The implication of this is that traditional diagnostic pathways for evaluation of the vascular system will become less relevant, as the value of MDCT angiography becomes fully established.

Objective

The purpose of the study was to evaluate the pattern of findings of vascular pathology on CTA as seen at the national referral and teaching hospital, KNH.

Methodology

This was a six month descriptive prospective study of CTA findings from September 2008 to February 2009.

Results

A total of 73 patients were evaluated with CTA during the study period. The male to female ratio was 1:1.2. The mean age was 48.8 years, the median was 49.0 years and the range was 4 to 100 years. Pathology was identified in 94.4% of the study subjects. The vascular territories analysed were peripheral (both upper and lower limbs) 46.6%, renal 3.5%, thoracic aorta 9.6%, abdominal aorta 16.4%, pulmonary vessels 8.2% and the carotid system 13.7%. Those patients who smoked were 20 (25.6%) and those who did not were 53 (75.4%). The lower limb was evaluated in 85.7% of the peripheral vascular requests while the upper limb was in 14.3%. There were 24.6% of patients with diabetes mellitus and 29.2% had hypertension.

Conclusion

CT angiography is an accurate and reliable method of non-invasively assessing vascular diseases. The noninvasive nature of this diagnostic test allows for detection that is time efficient for both the patient and health care providers.

LITERATURE REVIEW

In spite of the improvement in living standards, many conditions influence the human health as age advances; these include cigarette smoking, diabetes mellitus (DM), hypertension and possibly dietary changes. This has led to many more patients presenting with vascular pathologies. The arterial disease is mostly due to atheromatous degeneration of the arterial wall.

A few vascular conditions are described:-

1. Atherosclerosis

The term is derived from the Greek word *sclerosis*, which refers to the thickening of the arterial intima and *athere*, the accumulation of lipid along the intima that characterizes the typical lesion. These lesions affect large and medium-sized arteries.

Development of an atherosclerotic lesion can be divided into 3 stages:

1. Fatty-streak stage. This involves the formation of lipid-filled smooth muscle cells in the tunica intima. This is believed to be reversible. No obstruction is present in the affected vessel.
2. Stage of fibrous plaque formation. Lipid-laden smooth muscle cells are surrounded by collagen, elastic fibers, and mucoprotein matrix. The lesion protrudes into the lumen of the artery and causes obstruction proportional to the vessel size. Frequently, the lesion is located at arterial bifurcations. This is possibly because of reflected pressure waves which cause arterial wall vibration and weaken the vessel wall.
3. Stage of fibrous plaque hardening. A complicated lesion ensues when fibrous plaques are altered over time by hemorrhage, calcification, and mural thrombus. The intimal surface may become ulcerated as the lipid-laden plaque enlarges and hardens, and this can lead to embolism. The complicated lesion is often a cause of vessel and blood flow obstruction.

No racial predilection exists for the development of atherosclerosis. Males and females have an equal risk of atherosclerosis; however, atherosclerosis of the lower extremities is seen most frequently in elderly men [1]. The highest incidence occurs in those aged 50-70 years, commencing in association with entry of diabetes mellitus (DM), hypertension and dyslipidaemias. The most common presenting symptom in patients with peripheral vascular disease is intermittent claudication [2]. The patient complains of pain, cramping, or

muscle fatigue, which occurs during exercise and is relieved by rest. The site of claudication is distal to the location of the narrowed (stenotic) segment. With progression of the disease, resting pain develops. At this stage, patients complain of pain or numbness of the foot, which frequently occurs at night while the foot is nondependent. Atherosclerotic plaques also contribute to vessel narrowing like carotid artery stenosis that could result in ischaemic or haemmorhagic cerebral infarcts [3]. Multidetector CT—enables scanning of long segments of the vascular tree, with a single contrast injection and thin sections, usually from 3 to 4 mm [4-6]. This gives the multidetector CT the potential to cover the whole length of the peripheral vascular tree and reveal peripheral vascular disease.

2. Takayasu's disease

This is a chronic inflammatory arteriopathy occurring the world over but most commonly in oriental women. The cause of Takayasu's disease remains unknown. An autoimmune mechanism is possible given the clinical and laboratory findings in early stages of the disease and systemic lupus erythromatosis [7]. The lesions in Takayasu's show a panarteritis involving the aorta and its main branches and the pulmonary vessels. The lesions of the arterial wall begin with mesoperiarteritis and fibrosis and are followed by fibrotic thickening of the adventitia and vasa vasorum. This leads to intimal fibrosis, often with thrombi. The destruction of the arterial wall leads to both stenotic and ecstatic changes of the lumen, especially occlusion. These affected segments are clearly demarcated from the adjacent normal sites and segmental "skipped" lesions are observed.

3. Pulmonary embolism (PE)

Pulmonary embolism (PE) was clinically described in the early 1800s, and von Virchow first described the connection between venous thrombosis and PE. In 1922, Wharton and Pierson reported the first radiographic description of PE [8].

Three primary influences predispose a patient to thrombus formation; these form the Virchow triad: (1) endothelial injury, (2) stasis or turbulence of blood flow, and (3) blood hypercoagulability. More than 90% of all PEs arise from thrombi within the large deep veins of the legs, typically the popliteal vein and the larger veins above it. Some of the factors predisposing to PE include prolonged bed rest or immobilization, myocardial infarction, tissue damage (surgery, fracture, and burns), cancer, prosthetic cardiac valves, disseminated intravascular coagulation, anticoagulant therapy, atrial fibrillation, cardiomyopathy, nephrotic syndrome, hyperestrogenic states, oral contraceptive use, sickle cell anaemia and cigarette smoking. Computed tomographic (CT) pulmonary angiography is gaining wide acceptance as a first-line examination for the detection of PE [9]. With the development of narrow collimation, multi–detector row CT, and more powerful workstations for analysis and review, CT pulmonary angiography has become more accurate in the detection of PE and more widely used in diagnosis [10, 11]. Some studies have shown that CT pulmonary angiography is more cost-effective than conventional angiography in the work-up of patients suspected of having PE [12, 13]. Investigators in other studies, including a recent meta-analysis, have recommended using CT pulmonary angiography as the modality of choice in the assessment of patients suspected of having PE [14, 15].

4. Renovascular Disease

For all practical purposes, the management of renovascular disease means the management of Renal Artery Stenosis (RAS). RAS is divided into 2 categories: atheromatous and non atheromatous [16]. Atheromatous RAS occurs mainly in men over the age of 50 years usually in association with DM and hypertension. It tends to affect the proximal third of the renal artery and may involve the origin of the artery. It has been shown that angiography underestimates the extent of ostial stenosis, and that CTA gives a more

accurate diagnosis [17]. Stenosis may be smooth and symmetrical, or eccentric and asymmetrical.

Nonatheromatous RAS- Fibromuscular Dysplasia (FMD) is the most common cause of a nonatheromatous RAS. It typically occurs in young women. The most common form of FMD is medial fibroplasia, where the typical 'string of beads' sign is seen on angiography.

Others are intimal fibroplasias, fibromuscular hypoplasia and subadventitial fibroplasias. The aorta is spared but other major arteries particularly the external iliac and carotid arteries are involved. FMD dilates easily at lower pressures at angioplasty and shows excellent long term results. The other types characterised by smooth stenosis, do not dilate satisfactorily.

5. Aneurysm

The word "aneurysm" comes from the Greek word *aneurysma* (*ana*, meaning across, and *eurys*, meaning broad) and denotes an abnormal dilatation of an artery. Aneurysm is defined as a focal dilatation with at least a 50% increase over normal arterial diameter.

5-1 Abdominal aortic aneurysm

Abdominal aortic aneurysms (AAAs) represent a degenerative process of the abdominal aorta that is often attributed to atherosclerosis; however, the exact cause is not known. A familiar clustering of AAAs has been noted in 15-25% of patients undergoing repair of AAA. Degenerative aneurysms account for more than 90% of all infrarenal AAAs [18]. Other causes include infection, cystic medial necrosis, arteritis, trauma, inherited connective-tissue disorders, and anastomotic disruption.

5-2 Thoracic aorta aneurysm

Aneurysms of the thoracic aorta are most often due to atherosclerotic disease [19]. Other causes include degeneration of the medial layer of the aortic wall, either idiopathically or due to genetic disorders such as Marfan's syndrome,

Ehlers-Danlos syndrome, aortic dissection; syphilis or other bacterial infections. Aneurysms of the ascending thoracic aorta most often result from the process of cystic medial degeneration (or cystic medial necrosis). Such aneurysms often involve the aortic root and may consequently result in aortic regurgitation. The term *annuloaortic ectasia* is often used to describe this condition.

5-3 Popliteal aneurysm

The popliteal artery is considered aneurysmal if its diameter exceeds 0.7 cm [20]. Aneurysms may rarely be associated with connective tissue diseases such as Marfan syndrome or Ehlers-Danlos syndrome or, even more rarely, with pregnancy. True aneurysms of the popliteal artery are the most common peripheral arterial aneurysms. Popliteal artery aneurysms (PAAs) are relatively uncommon compared with abdominal aortic aneurysms (AAAs), but recent studies have identified an increase in the prevalence of PAAs that may be due to greater access to imaging modalities such as US. Consequently, reports vary as to the ratio of PAAs to AAAs, which ranges from 1:8 to 1:23 [21, 22]. PAAs are associated with aneurysms in other locations. An AAA is present in 30%–50% of patients with a PAA. In contrast, PAAs are present in only about 10%–14% of patients with AAAs [22, 23]. PAAs are bilateral in 50%–70% of cases. These associations have important implications. In patients with a PAA, it is important to look for AAAs and a contralateral PAA. PAAs are usually found during the 6th and 7th decades of life and have a strong male predilection, with a male: female ratio ranging from 10:1 to 30:1 in published reports [23-25]. It is very important to diagnose PAAs because of the risk of limb-threatening thrombotic complications. About 45% of patients with PAAs are asymptomatic at the time of diagnosis.

6. Small vessel disease

Small vessel disease refers to the diseases affecting the arterioles. The formation of atherosclerotic, or fatty, deposits along the inner arterial walls is

the most common arterial disease. This can result in coronary artery disease, cerebrovascular accidents and arteriosclerosis obliterans when the lower limbs are affected. Predisposing factors include male sex, age above 50, cigarette smoking, hyperlipidaemia and DM. People with a family history of early arteriosclerosis and people with diabetes, high blood pressure, or very high cholesterol may develop arteriosclerosis obliterans at an earlier age.

JUSTIFICATION OF STUDY

With new and powerful MDCT scanners being introduced in the country, there is a growing need to make full use of the equipment. MDCTA is a relatively new modality in Kenya that provides high resolution three dimensional vascular imaging as well as excellent bone and soft tissue spatial relationship. Vascular pathologies are on the increase globally and this is related in part to the increasing incidence of atherosclerosis [26].

MDCTA is relatively new and thus no studies have been done locally or in East Africa. Like all new technologies a learning curve exists for creating and interpreting CT angiographic studies. This dissertation is aimed at improving these early stages of learning and also in expending the later stages of updating and incorporating new advancements. Knowledge of this would offer added information to the physician and impact on the holistic approach to the management of vascular pathology.

OBJECTIVES OF STUDY

Broad objective:

To study the occurrence and pattern of vasculopathy as seen on MDCTA

Specific objectives:

1. To determine the pattern of vasculopathy based on MDCTA.

2. To determine the common symptoms for which CTA is requested and the modes of presentation of the vascular pathology based on the clinical presentation as given by the referring physician.

STUDY METHODOLOGY

Study area

The study was carried out at the X-ray department of Kenyatta National Hospital (KNH).

Study population

The study population consisted of patients from the wards, casualty department, clinics and from private facilities that underwent CT Angiography.

Sample size justification

The sample size was all the patients who were referred for CTA and could afford to pay for the examination during the 6 month study period. On average

two to three patients were imaged per week. The sample size was determined following the formula by Fisher et al (1998).

$$n = \frac{z^2 p (1-p)}{d^2}$$

Where n = desired sample size

z = standard normal distribution

p = known prevalence rate for the factor of interest under study

d = the level of significant desired

When this formula is applied at d = 0.05, z = 1.96, and p = 5.2 %

$$n = \frac{1.96^2 * 0.052(1-0.052)}{0.05^2}$$

n=57

The minimum sample was 57. However, 73 CTA were sampled.

Technique

CTA was performed using a Phillips 16-slice helical Brilliance machine in KNH. Only the standard procedure for MDCTA was followed. This was as follows:

The patient fasted for 6 hours prior to the examination. With the patient supine a 19 or 21-guage cannula was inserted into the antecubital vein. 100-120cc of non ionic contrast media (Iopromide 370) was administered with a Medrad power injector at a rate of 5cc/sec. A delay of 25-30sec for arterial imaging of the chest and abdomen and a delay of 60 sec for the venous system was allowed to yield excellent images. The pitch was increased to 2 and the

narrowest collimation used. Images were then reconstructed at 1mm intervals. Surface rendering and Maximum Intensity Projection (MIP) were used to generate 3 D images. Representative images were selected for printing and forwarded to the physician with the report of the findings. The images were reviewed by the researcher and a consultant radiologist. A few are produced in the book as illustrations. (Page 29)

Sampling method

Patients sent for CTA during the study period were recruited for the study.

Inclusion criteria

Patients who had and did not have notable abnormalities on CTA were included in the study. The main aim of the study was to describe the pattern of findings on CTA.

Exclusion criteria

Patient who the imaging technique was not done accurately e.g. delay in contrast tracking were excluded from the study.

Data management

Data collection

The principal investigator was assisted by colleagues in the X-ray department Kenyatta National Hospital. Relevant data of eligible patients was collected. This included looking at all the images on the computer counsel as they were saved on the hard disc for some time. The available clinical summary and the angiographic diagnosis were recorded on the data collection sheet. With the help of a biostatistician the data was entered into the computer software SPSS and analysed.

Data analysis

Data analysis was done using Software Programme for Social Science research (SPSS) and Microsoft Excel for Windows Vista. Results were presented in form of frequency distributions and descriptive statistics. The chi-square test for independence was used to test associations. Z tests used for proportional and mean differences were also applied. The level of significance was set at $\alpha=0.05$

ETHICAL CONSIDERATIONS

Before commencement of the study, a copy of the proposal was sent to the KNH ethical committee for approval. Patient's name was not recorded during the study in order to maintain confidentiality. Information acquired was used exclusively for research. For referral purposes only the patient's hospital number was required.

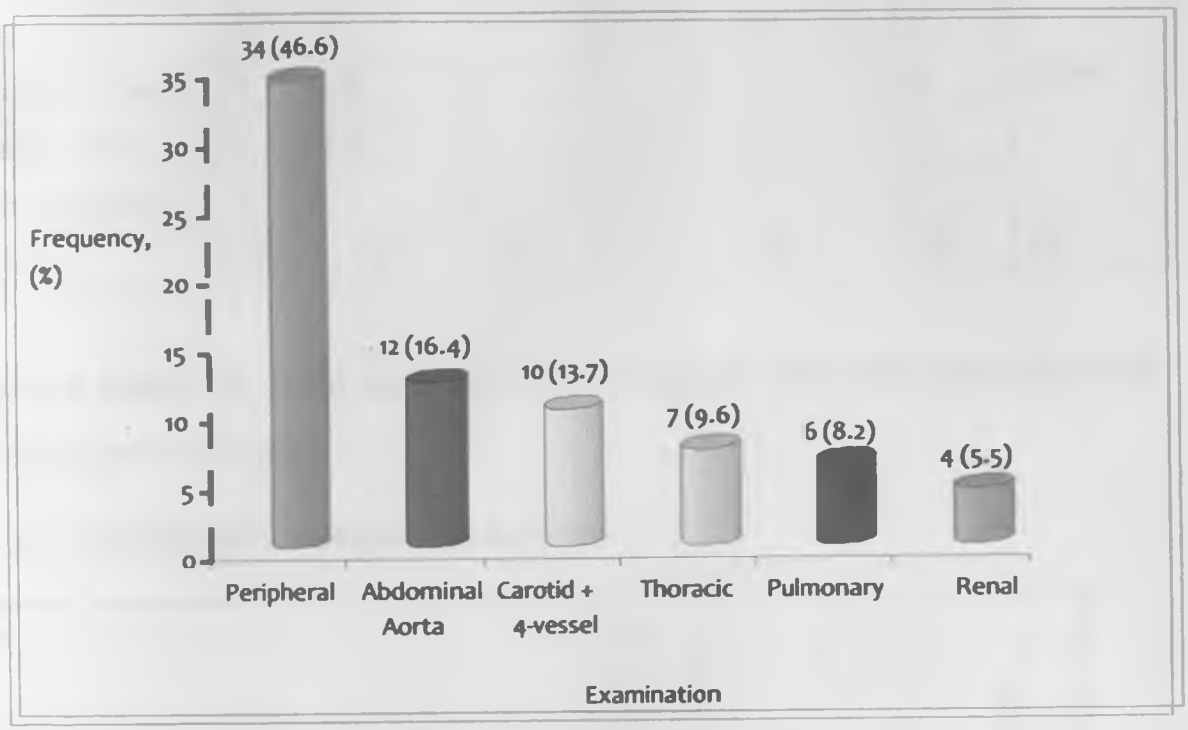
No other examination was done on the patient apart from the one requested by the primary physician.

The results of this study will be delivered to KNH ethical committee after approval by the university, to assist in forming data base for future studies and reference and to facilitate possible improvement in patient care.

RESULTS

73 patients underwent MDCTA at KNH from September 2008 to February 2009.

Figure 1: Distribution of CTA by region (n = 73)



The most frequent examination was peripheral with 46.6% as shown in figure 1. This was followed by abdominal aorta CTA with 16.4%. The remarkable difference in frequency suggests the high prevalence of Peripheral vascular disease in Kenya.

Table 1: Distribution of Age by Sites

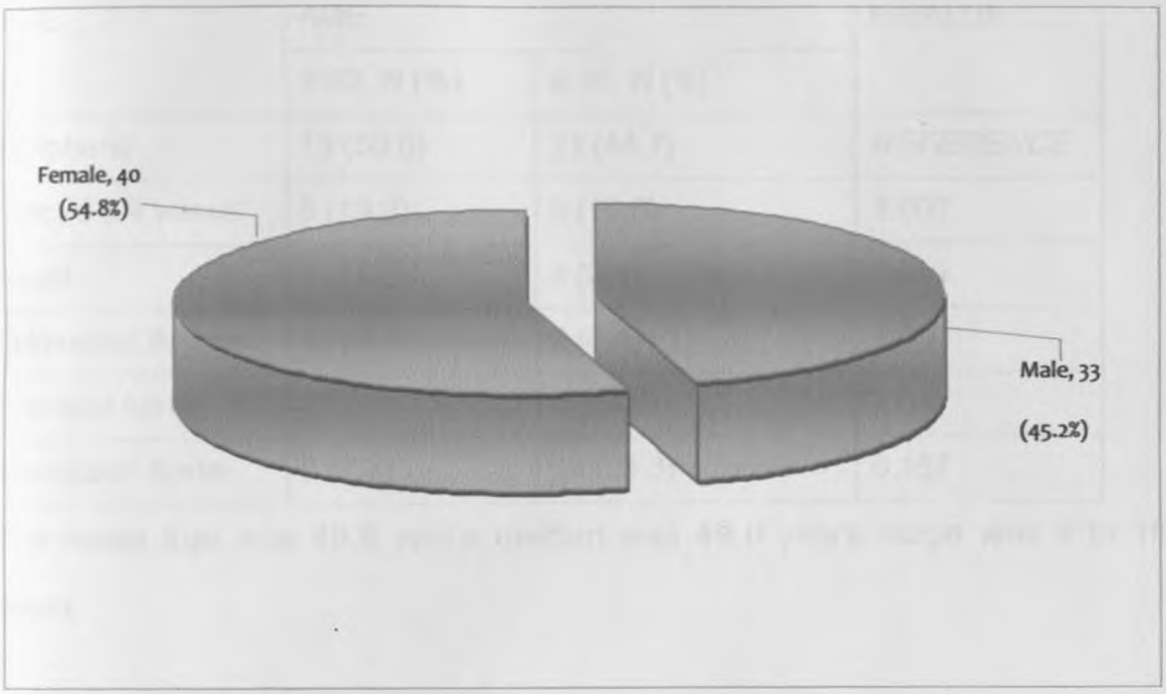
Site	Age						P-value
	<30	30-39	40-49	50-59	60-69	70+	
Peripheral	10	4	2	4	7	7	
Carotid & 4 vessel	3	2	3	1	0	1	
Renal	2	1	1	0	0	0	
Pulmonary Artery	1	2	1	1	1	0	*0.447*
Thoracic Aorta	0	0	1	2	3	1	
Abdominal Aorta	1	1	3	0	4	3	
TOTAL	17	10	11	8	15	12	73

Patients below 30 years were the most common. The least common were those aged 50-59 years.

Table 2: Distribution of Mean Age by Sites

Site	Age
	Mean (se)
Peripheral	50.2 (4.0)
Carotid & 4 vessel	40.5 (4.9)
Renal	30.0 (6.4)
Pulmonary Artery	41.7 (5.0)
Thoracic Aorta	59.9 (2.8)
Abdominal Aorta	55.7 (6.1)

Figure 2: Distribution by Sex (n = 73)



40(54.8%) of the CT angiography images belonged to female patients while males were 33(45.2%). The male to female ratio was 1:1.2.

Table 3: Sex distribution and the study group

SITE	SEX		P-VALUE
	MALE, N (%)	FEMALE, N (%)	
Peripheral	21 (63.6)	13 (32.5)	*REFERENCE*
Carotid & 4 vessel	4 (12.1)	6 (15.0)	0.287
Renal	0	4 (10.0)	0.073
Pulmonary Artery	1	5 (12.5)	-
Thoracic aorta	4 (12.1)	3 (7.5)	1.000
Abdominal aorta	3 (9.1)	9 (22.5)	*0.030*

The prevalence of males in peripheral CTA is noted.

Table 4: Distribution of Age by Sites

SITE	AGE		P-VALUE
	< 40, N (%)	≥ 40, N (%)	
Peripheral	13 (50.0)	21 (44.7)	*REFERENCE*
Carotid & 4 vessel	5 (19.2)	5 (10.6)	1.000
Renal	3 (11.5)	1 (2.1)	0.319
Pulmonary Artery	3 (11.5)	3 (6.4)	1.000
Thoracic Aorta	0	7 (14.9)	-
Abdominal Aorta	2 (7.7)	10 (21.3)	0.157

The mean age was 48.8 years median was 49.0 years range was 4 to 100 years.

Table 5: History of Risk Diseases

CTA SITE	DM	HTN	HIV
Peripheral	13	7	3
Carotid & 4 vessel	2	1	0
Renal	0	4	0
Pulmonary artery	1	1	0
Thoracic aorta	1	5	0
Abdominal aorta	5	5	0
Total	23	23	3

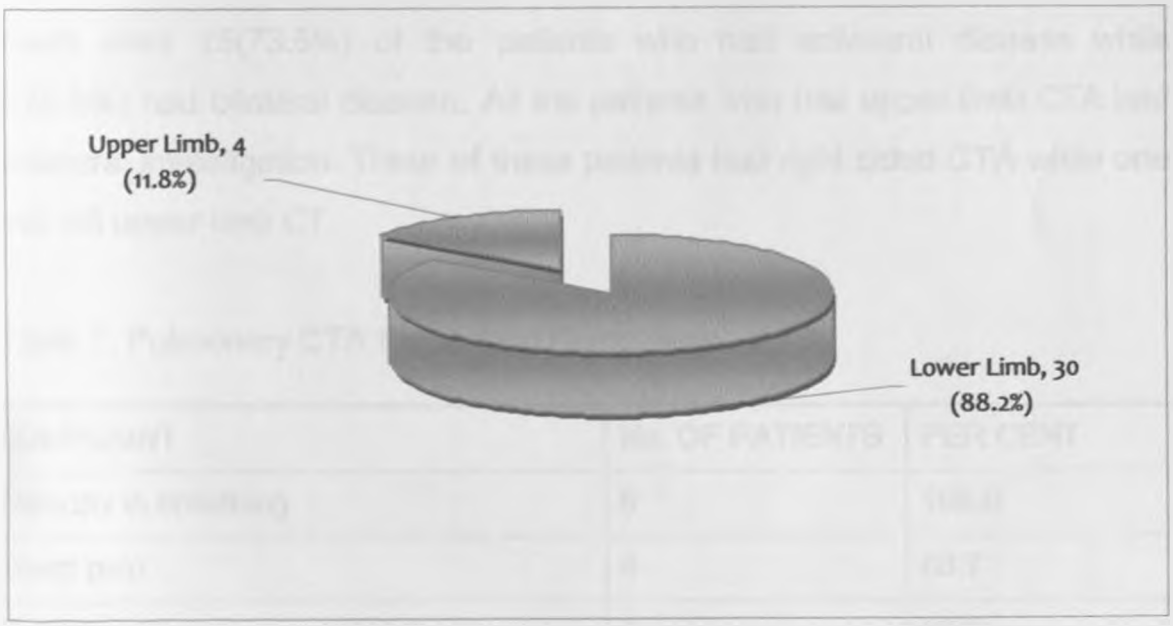
There were 23(31.5%) patients who presented with a history of DM and 23(31.5%) had hypertension. There were 12(16.4%) presented with both DM and hypertension.

Table 6: Distribution of cigarette smoking by site

CTA SITE	CIGARETTE SMOKING ,N %	NON SMOKERS, N %
Peripheral	12 (35.3%)	22(64.7%)
Abdominal Aorta	5 (41.7%)	7(58.3%)
Thoracic Aorta	1 (14.3%)	6(85.7%)
Carotid and 4-vessel	2 (20%)	8(80%)
Pulmonary Artery	1 (16.7%)	5(83.3%)
Renal	0	4(100%)

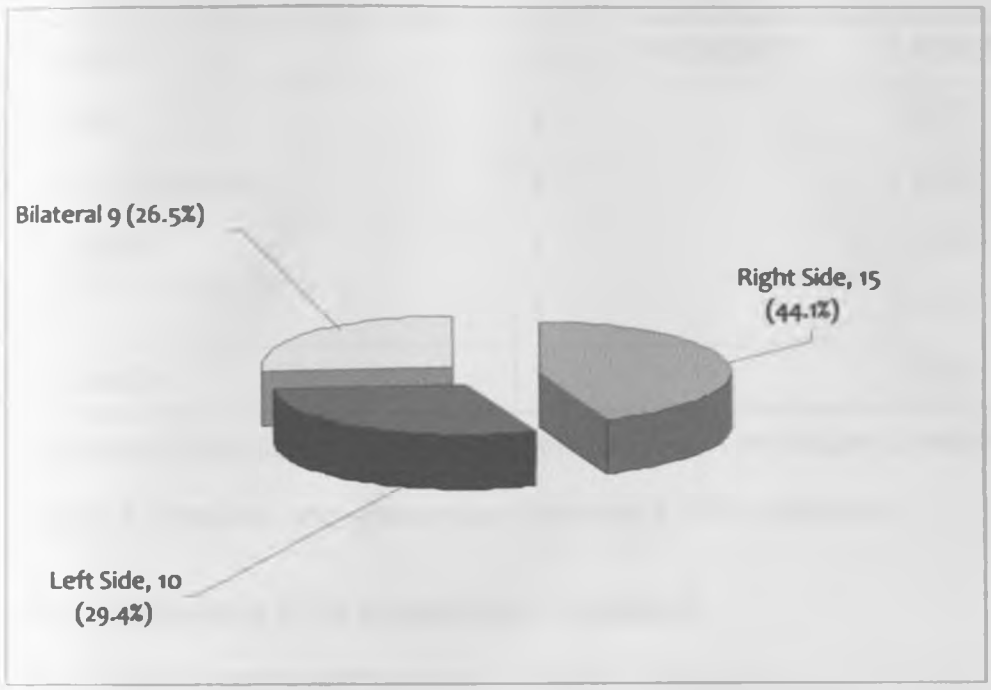
Those patients who smoked were 21 (28.8%) with a high percentage of 41.7 in patients with abdominal aorta pathology followed by peripheral with 35.3%. All patients who smoked had vascular pathology.

Figure 3: Investigations for Peripheral CTA



There were 30(88.2%) patients who had lower limb CT angiography of which 29(96.7%) had pathology and only 1(3.3%) had a normal examination. 4(11.8%) has upper limb CTA. There were 15(50%) male and 15(50%) female patients who had lower limb CTA. Only 1 of the 4 patients who underwent upper limb CTA was female was the only one with a normal examination.

Figure 4: Affected limb (n = 34)



There were 25(73.5%) of the patients who had unilateral disease while 9(26.5%) had bilateral disease. All the patients who had upper limb CTA had unilateral investigation. Three of these patients had right sided CTA while one had left upper limb CT.

Table 7: Pulmonary CTA Presenting Complaints

COMPLAINT	No. OF PATIENTS	PER CENT
Difficulty in breathing	6	100.0
Chest pain	4	66.7
Cough	4	66.7
History of DVT	3	50.0
Haemoptysis	2	33.3
Other	1	16.7

Other included a neck swelling proven to be lymphoma. All patients who underwent pulmonary CTA presented with difficulty in breathing,

Table 8: Thoracic Aorta CTA Presenting Complaints

COMPLAINT	No. OF PATIENTS	PER CENT
Chest pain	6	85.7
Difficulty in breathing	5	83.3
Haemoptysis	1	16.7
Trauma	1	16.7
Aortic Ectasia	1	16.7

A diagnosis of aortic ectasia had been made on echocardiography and CTA was used to confirm and determine the extent of the disease.

Table 9: Abdominal CTA Presenting Complaints

PRESENTING COMPLAINT	No. OF PATIENTS	PER CENT
Mass	11	100.0
Abdominal aortic aneurysm repair	1	9.1

Table 10: Carotid and 4-Vessels CTA Presenting Complaints

COMPLAINT	No. OF PATIENTS	PER CENT
Headache	7	70.0
Visual disturbance	3	30.0
Syncope	2	20.0
Seizure	2	20.0
Paralysis	3	30.0
Speech disorder	2	20.0

Table 11: Distribution of pathology in peripheral CTA

PATHOLOGY	No. OF PATIENTS	PER CENT
Obstruction		
• Atheromatous	14	32.1
• Stenosis	3	10.7
Aneurysm	3	10.7
Small vessels	3	10.7
AVM	2	7.1
Other (specified)	9	32.1

Other included fracture femur (1), Klippel Trenauray syndrome (2), tumour through the popliteal artery(1), hydatid cyst right lobe of liver(1), thrombus (2), popliteal abcess(1) and dissecting abdominal aortic aneurysm(1).

Table 12: Peripheral CTA Presenting Complaints

COMPLAINT	No. OF PATIENTS	PER CENT
Pain	20	58.8
Muscle cramping/fatigue during exercise	19	55.9
Numbness	18	52.9
Wound	7	20.6
Gangrene	10	29.4
Colour change	12	35.3
Swelling	18	52.9
Limb amputation	4	11.8
Other	10	29.4

There was notable overlap in the presenting complains

Others included; associated medical conditions like Venous Malformation (1), Rheumatic Heart disease (1), Bladder Cancer (1), Pelvic Fracture (1), Necrotising fasciitis (1), Diaphyseal aclasia (1).

Table 13: Abnormal pulses and lower limb CTA findings

Abnormal Pulse	MDCTA Findings		P-value
	Abnormal	Normal	
Femoral (16)	12 (85.7%)	4 (20.0)	<0.001
Popliteal (23)	15 (88.2)	8 (47.1)	0.010
Dosalis Pedis(25)	14 (93.3)	11 (57.9)	0.020

The abnormal pulses were either weak or absent.

Table 14: Findings in Peripheral CTA

FINDINGS LOWER LIMB	No. OF PATIENTS	PER CENT
Normal findings	1	3.3
Abnormal findings	29	96.7
CFA	6	20.7
Superficial femoral	6	20.7
Popliteal	16	55.1
Anterior tibial	11	37.9
Post tibial	12	41.4
Dosalis pedis	24	82.8
UPPER LIMB		
Normal findings	1	25.0
Abnormal findings	3	75.0
Axilliary artery	1	25.0
Brachial	1	25.0
Radial	1	25.0
Ulna	1	25.0

The specific details of the pathologies are outlined in the discussion. (Page 34)

Table 15: Pulmonary CTA findings

FINDINGS	No. OF PATIENTS	PER CENT
Normal	1	16.7
Abnormal	5	83.3
Obstruction (5)		
• MPA	2	33.3
• Bilateral segmental	3	50.0

The patient with normal pulmonary vessels had features of Congestive cardiac failure (CCF)

Table 16: Carotid and 4 vessel CTA findings

FINDINGS	No. OF PATIENTS	PER CENT
Normal	1	10.0
Abnormal	9	90.0
Aneurysm	2	20.0
AVM	2	20.0
CBI	3	30.0
Other	3	30.0

Other included glomus jugulare tumour (1), middle cerebral artery infarcts (2)

Table 17: Renal CTA findings

FINDINGS	No. OF PATIENTS	PER CENT
Normal	0	
Abnormal	4	100.0
Stenosis	4	100.0
Other	2	50.0

Other associated findings included a saccular aneurysm of the renal artery (1) and a hypoplastic renal artery.

Table 18: Thoracic Aorta CTA findings

FINDINGS	No. OF PATIENTS	PER CENT
Normal	2	28.6
Abnormal	5	71.4
Aneurysm	5	71.4
Dissection	3	42.9
Other	4	57.1

Other associated findings included rib fractures and lung collapse (1), aortic dissection extending to abdominal aorta and common iliacs (1), cardiomegally (1), small left kidney (1)

Table 19: Abdominal aorta CTA findings

FINDINGS	No. OF PATIENTS	PER CENT
Normal	1	8.3
Abnormal vessels	11	91.7
Aneurysm	10	83.3
Dissection	2	16.7
Other	4	33.3

Other findings included bilateral hydronephrosis and hydroureter (2), bilateral renal artery thrombosis (1), liver mass with arteriovenous shunting (1).

Figure 5: Overall Vessel Abnormality in all examinations done

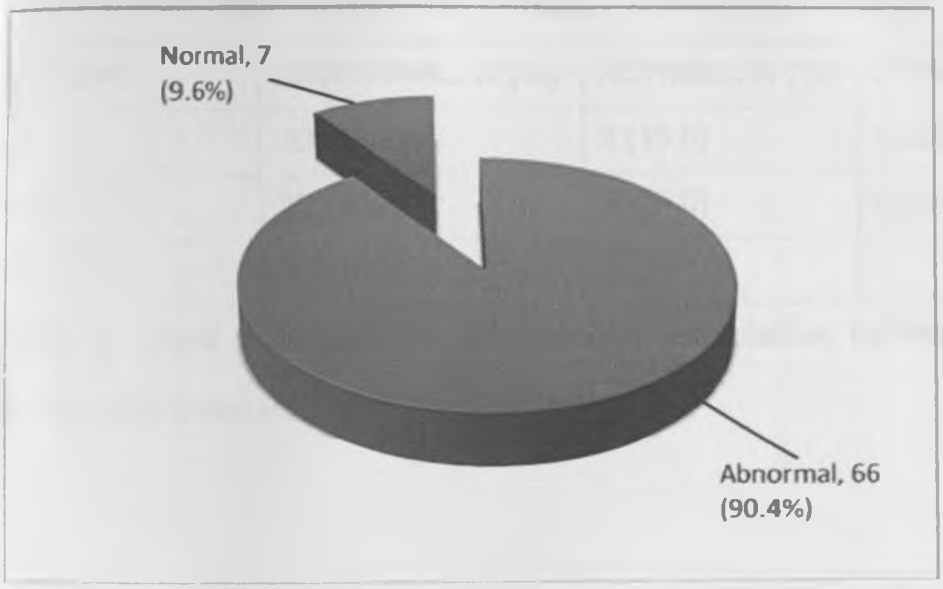


Table 20: Associations between Baseline Factors and Vessel Findings

BASELINE	VESSEL		P-VALUE
	ABNORMAL, N (%)	NORMAL, N (%)	
Sex			
• Male	32 (43.8)	1 (1.4)	0.379
• Female	34(46.6)	6 (8.2)	
Age			
• < 40	24 (32.9)	2 (2.7)	0.914
• ≥ 40	42 (57.5)	5 (6.8)	
Smoking			
• Yes	21(28.8)	0 (0)	0.101
• No	45(61.6)	7 (100.0)	

Baseline factors are the common values that were filled for all patients who had CTA done. These included the sex, age, smoking, history of DM and HTN

Table 20 shows that there was no significant association between gender, age and cigarette smoking with the presence or absence of vascular pathology.

Table 21: Associations between Clinical Factors and Findings

BASELINE	ABNORMAL, N (%)	NORMAL, N (%)	P-VALUE
DM	20 (39.2)	3 (15.0)	0.050
HTN	20 (39.2)	3 (15.0)	0.050
HIV	3 (5.9)	0	-

Table 21 show that there is a significant association between the diabetes mellitus, hypertension and vascular pathology.

ILLUSTRATONS

Picture 1

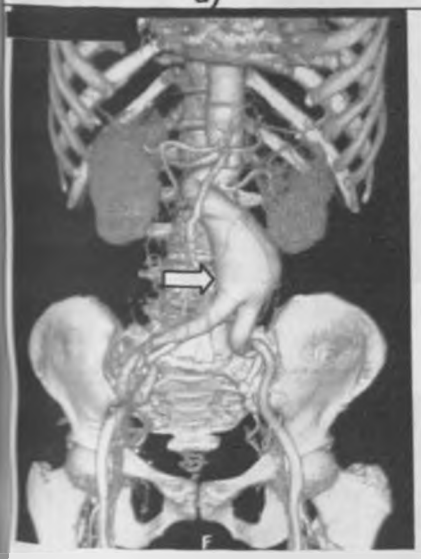
a)

b)

a)Volume rendered anc b) MIP images showinç right femoral artery cut· off (arrow) due tc fracture femur (arrow head).

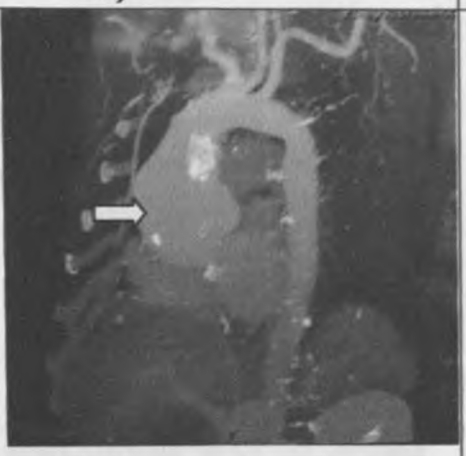
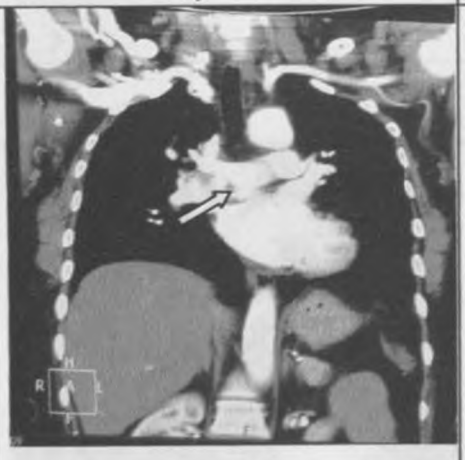
Picture 2

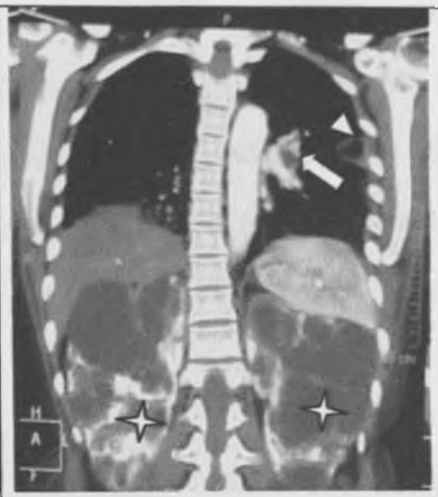
a)



b)

a)Volume rendered anc b) MIP images showinç an infrarenal saccular aortic aneurysm (arrows)

Picture 3 a)	b)	
		a)axial and b) MIF images showing aneurysmal dilatation o the ascending aorta Aortic ectasia (arrows)
Picture 4 a)	b)	
		a)Axial and b) corona images showing pulmonary embolus o the right pulmonary artery (arrows)
Picture 5 a)	b)	
		MIP images (a and b) showing aneurysm of the common femoral artery (arrows)

Picture 6 a)	b)	
		Axial and corona images showing a pulmonary embolism or the left pulmonary artery (arrows). There is an associated left pleura effusion (arrow heads) The patient also had incidental polycystic renal disease (stars)
Picture 7 a)	b)	
		Takayasu's disease. a volume rendered and MIP images showing aneurysmal dilatation of the entire aorta with multiple associated constricted areas

DISCUSSION

The overall objective of the study was to determine the pattern of vascular pathology as shown on MDCTA. A total of 73 patients were enrolled for the study. The study showed demonstrable pathology in 90.4% of the patients. The age range of patients scanned was 4 to 100 years. The mean age was 48.8 years with a median of 49.0 years. The male to female ratio was 1:1.2. Lower limb peripheral CTA was the most common investigation seen in 30(41.1%) of the patients.

CTA findings are discussed under the following subheadings

- Peripheral vascular disease
- Abdominal aortic aneurysm
- Thoracic aneurysm
- Pulmonary embolism
- Carotid and 4 vessel CTA
- Renal artery stenosis

Peripheral vascular disease

Peripheral arterial disease is a local manifestation of atherosclerosis in the lower limb distal to the aortic bifurcation, which is a major problem in those who are 55 years and above.[6] In patients with peripheral arterial disease, the level, multiplicity, and severity of stenosis show significant variation that ultimately impacts on clinical decision making [27, 28]. In this series 20(58.9%) of those who underwent peripheral CTA had peripheral occlusive vascular disease (Table 11). Of these 16(80%) were over 50 years old. These findings correlate with previous studies done elsewhere [27]. Diabetes mellitus and hypertension are known risk factors. In this study 13(38.2%) patients who had

peripheral CTA done were diabetic while 7(33.3%) were hypertensive. There were 6(17.6%) patients who had both DM and hypertension (Table 5). Cigarette smoking is a major risk factor for developing peripheral vascular disease. There were 12(35.3%) patients who smoked tobacco and presented with peripheral vascular disease (Table 6). There was significant correlation between abnormal pulses detected clinically and associated CTA findings with p-values of <0.02 (Table 13). Other associated incidental findings included hydatid cysts in the left lobe of the liver and a dissecting aortic aneurysm. There were two patients with aneurysm in the superficial femoral artery and in the popliteal artery. There were 16 (47.1%) patients who presented with major vessel disease while only 3(8.8%) had small vessel disease.

Patients under 30 years were the commonest age group to undergo peripheral CTA (Table11). There were 3(30%) female patients and 7(70%) male patients. Upper limb CTA was done in 2(66.7%) of the female patients. Lower limb trauma with femoral fracture was the commonest indication for lower limb CTA. This was found in 3(42.8%) of the male patients. They presented with vessel cut-off of the common femoral artery, superficial femoral and profunda artery. Multiple arterial thrombi were seen in 2(25%) male patients who presented with a history of rheumatic heart disease with paradoxic thrombi in the lower limb arteries.

There were 2(5.8%) female patients who were diagnosed with Klippel-Trénaunay-Weber syndrome. These were 4 and 17 years old. They both presented with varicose veins, bone and soft tissue hypertrophy. Klippel-Trénaunay-Weber syndrome consists of the triad of cutaneous hemangioma, bone and soft-tissue hypertrophy, and varicose veins [30]. The syndrome is

usually unilateral and involves the lower extremity. The diagnosis can be made when any two of the three features are present.

In this study there was one 43 year old male patient who presented with diaphyseal aclasia (multiple osteochondromas) involving the popliteal region. The tumour was shown to encase the popliteal artery. An osteochondroma may occur in any bone that is formed by enchondral bone growth. It is intimately associated with the growth plate. One theory of pathogenesis describes a focus of ectopically oriented physis growing at right angles to the longitudinal axis of the bone [31]. Symptoms relate to local pressure and mass effect. There may be nerve impingement or compromise of local blood flow. The patient had both features of nerve impingement and compromised distal blood flow.

Four patients had upper limb CT angiography. Their findings included an axillary artery aneurysm, radial artery occlusion and a forearm enhancing mass. The other patient had a normal examination. All these patients were under 40 years old.

Abdominal Aortic Aneurysm

Most abdominal aortic aneurysms are true aneurysms. A true aortic aneurysm is a localized dilatation of the aorta caused by weakening of its wall; it involves all three layers (intima, media, and adventitia) of the arterial wall. A pseudoaneurysm (false aneurysm) is a collection of flowing blood that communicates with the arterial lumen but is not enclosed by the normal vessel wall; it is contained only by the adventitia or surrounding soft tissue Aneurysms may develop in any segment of the aorta, but most involve the aortic segment below the renal arteries. An aortic diameter of 3 cm or more on CTA is used to define an abdominal aortic aneurysm [32]. Aneurysmal dilatation

of the abdominal aorta is a disease associated with aging. It is rare before age 50. It is found in 2%–4% of the population older than 50 years [33]. The average age at the time of diagnosis is 65–70 years, and more men than women are affected. There were 12 patients who had abdominal aortic CTA in this series (Figure 1). The average age of patients was 55.7. The range of ages was 6 to 83 years with a standard error of 6.1. There were 10(83.3%) patients who had AAA (Table 19). The youngest was 6 years old. 3(25%) of the patients had associated aortic dissection. One patient had extensive aneurysm extending to the thoracic aorta. There were two patients who had associated bilateral hydronephrosis and hydroureter. There was one patient who had stenting done for AAA. The CTA showed thickening of the aorta. One patient had a liver mass with arteriovenous shunting. In this patient the abdominal aorta was normal. CTA was diagnostic in all the abdominal aorta angiograms done in this series.

Abdominal aortic aneurysms were readily diagnosed through the combined analysis of axial and multiplanar reformatted images and MIP reconstructions. Combined analysis of all images was done because evaluation of axial images alone has been reported to over-estimate the proximal extent of the aneurysm [34-36]. Romano et al found the sensitivity of CTA in AAA to be 93% [37]. This correlates well with this study which shows a sensitivity of 83.3%.

Pulmonary embolism

CT pulmonary angiography is gaining wide acceptance as the first-line in the detection of pulmonary embolism [38, 39]. With the development of narrow collimation, multi–detector row CT, and more powerful workstations for analysis and review, CT pulmonary angiography has become more accurate

in the detection of PE and more widely used in diagnosis [40, 41]. In the study 6 patients had CT pulmonary angiography (Table 1 and 15). 5(83.3%) had pulmonary embolism involving the main pulmonary artery, 3 of the patients had associated involvement of the segmental and subsegmental branches. There was only one patient who had history of previous deep venous thrombosis. One patient had features of congestive cardiac failure and was on treatment for a lymphoma. All the patients presented with difficulty in breathing (Table 7).

Renal artery stenosis

Although renal artery stenosis is the cause of hypertension in a small minority of patients, identification of these patients is important since it may allow use of a corrective interventional treatment in place of lifelong medical therapy [42]. CT angiography provides direct visualization of the vasculature during the arterial phase of contrast media infusion. CT volume data can be viewed from an infinite number of projections, providing a clear advantage over conventional angiography for the characterization of eccentric stenosis and vascular calcifications. A number of authors have reported the accuracy of CT angiography for renal artery stenosis [43-47], and several studies have addressed optimization of data acquisition protocols and rendering algorithms [47, 48]. In this study there were 4 patients who had renal CT angiography (Figure 1). They were all female. The age range was 17-45 years and they all presented with hypertension. 2(50%) had fibromuscular dysplasia with the classic renal artery beading appearance. These patients were 22 and 45 years old. FMD mainly affects females with a male: female ratio of 1:3-5 [49]. In one of the patients with bilateral RAS a saccular aneurysm of the right renal artery was also found. One patient had an associated hypoplastic right renal artery (Table 17). Boudewijn et al [50] performed a meta-analysis on

diagnostic tests for renal artery stenosis in patients suspected of having renovascular hypertension. They found that computed tomography angiography and gadolinium-enhanced, three-dimensional magnetic resonance angiography performed significantly better than the other diagnostic tests. Other studies showed that RAS is common in patients over 50 years and is mainly due to atherosclerosis. This was not the finding in this series as all the patients were under 50 years.

Thoracic aorta aneurysm

There were 5(71.4%) of patients who had thoracic aortic aneurysm (Table 18). 3(50%) had associated aortic dissection. There was one patient with Takayasu disease involving the entire aorta and its branches to the iliac bifurcation. The pulmonary vessels were not involved. There has been one case of Takayasu arteritis reported in Kenya at Kijabe Mission Hospital [51]. However angiography was not done for the patient. 5(71.3%) of the patients were hypertensive and only one had history of Diabetes mellitus. The patients presented with chest pain and shortness of breath. One patient had chest trauma with rib fractures and left lung collapse.

Carotid and 4 vessel CTA

There were 10(13.7%) patients who had carotid and 4 vessel CTA (Figure 1, Table 12 and 16). The age range was 23-70 years. The male: female ratio was 2:3. Headache was the most common presenting symptom seen in 7(70%) of the patients. 2(20%) patients had common carotid artery aneurysms. Carotid body tumours were found in 3(30%) of the patients. One patient had glomus jugulare tumour which invaded the base of skull. A normal study was seen in one patient (Table 16).

CONCLUSION

Based on the findings of this study and on objectives that were set, the following conclusions were made:

1. CT angiography has a high sensitivity in detecting vasculopathy. It is very useful together with the clinical history, results of other pathological tests, in the final diagnosis of vascular pathology.
2. The pattern of vascular pathology as seen in KNH is comparable to those in other setups. Vascular pathology was most common in patients over 60years. Lower limb peripheral CT angiography was the most common investigation.

RECOMMENDATIONS

1. Studies in the individual regions need to be done in our setup. Picking a pathology and studying it extensively would give more comprehensive findings and reduce the error index. This would be even more appropriate if done over long study periods.
2. Follow up is necessary with CT angiography to assess the progression of the disease or the response to therapy.
3. Comparative studies should be done to assess the sensitivities of MRA, DSA and CTA.

REFERENCES

1. Wissler RW: Principles of the pathogenesis of atherosclerosis. Braunwald E eds. Heart Disease: A Textbook of Cardiovascular Medicine. 1980, pp. 1221-1245 W.B. Saunders Co, Philadelphia.
2. Hughson WG, Mann JI, Garrod A. Intermittent Claudication: prevalence and risk factors. *Radiology* 1978 1:1379-1381.
3. Goldman L, Bennett JC: Atherosclerotic peripheral arterial disease. In: Cecil Textbook of Medicine. 21st ed. WB Saunders Co; 2000.
4. Rubin GD. 3D imaging with MDCTA. European Journal of Radiology 2003; 45 suppl: S37-41.
5. Ofer A, Samy SN, Shai L, Epelman M, Fischer D. Multidetector CTA of peripheral vascular disease. A prospective comparison with intra-arterial digital subtraction angiography. AJR 2003; 180: 719-724.
6. Rydberg J, Buckwalter KA, Caldemeyer KS, et al. Multisection CT: scanning techniques and clinical applications. *RadioGraphics* 2000; 20:1787 -1806.
7. Ishikawa K. Natural history and classification of occlusive thromboaortopathy (takayasu's disease) circulation *Journal of Vascular Surgery*1978; 37: 27-35.
8. Wharton LR, Pierson JW: Minor forms of pulmonary embolism after abdominal operations. JAMA 1922; 79: 1904-1910.
9. Costello P, Gupta KB. CT angiography gains acceptance in diagnosis of pulmonary emboli. Diagn Imaging (San Franc) 2000; 22:43–45, 49, 87.
10. Raptopoulos V, Boiselle PM. Multi–detector row spiral CT pulmonary angiography: comparison with single–detector row spiral CT. Radiology 2001; 221:606–613.
11. Qanadli SD, Hajjam ME, Mesurolle B, et al. Pulmonary embolism detection: prospective evaluation of dual-section helical CT versus selective pulmonary arteriography in 157 patients. Radiology 2000; 217:447–455.
12. Van Erkel AR, van Rossum AB, Bloem JL, Kievit J, Pattynama PM. Spiral CT angiography for suspected pulmonary embolism: a cost-effectiveness analysis. Radiology 1996; 201:29–36.
13. Kim KI, Muller NL, Mayo JR. Clinically suspected pulmonary embolism: Utility of spiral CT. *Radiology.* 1999; 210:693-697.

14. McEwan L, Gandhi M, Andersen J, Manthey K. Can CT pulmonary angiography replace ventilation-perfusion scans as a first line investigation for pulmonary emboli? Australas Radiol 1999; 43:311–314.
15. Blachere H, Latrabe V, Montaudon M. Pulmonary embolism revealed on helical CT angiography: comparison with ventilation-perfusion radionuclide lung scanning. AJR Am J Roentgenol 2000; 174:1041–1047.
16. Grainger & Allison's Diagnostic Radiology: A Text Book of Medical Imaging, 4th Ed. Churchhill Livingstone Elsevier2001. Pages 965-997.
17. Kaatee R, Wilting JE. CT Angiography of the renal arteries. *Medica*mundi 1997; 41: 18.
18. Ailawadi G, Eliason JL, Upchurch GR Jr. Current concepts in the pathogenesis of abdominal aortic aneurysm. *J Vasc Surg*. Sep 2003; 38(3):584-8.
19. Posniak HV, Oslon MC, Demos CT et al. CT of thoracic aortic aneurysms. Radiographics 1990; 10:839-855.
20. Wright BL, Matchett JW, Cruz PC et al. Popliteal artery disease: Diagnosis and treatment. Radiographics 2004; 24:467-479.
21. Dent TL, Lindenauer SM, Ernst CB, Fry WJ. Multiple arteriosclerotic artery aneurysms. Arch Surg 1972; 105:338-344.
22. Graham LM. Femoral and popliteal aneurysms. In: Rutherford RB, eds. Vascular surgery. 5th ed. Philadelphia, Pa: Saunders, 2000; 1345-1368.
23. Diwan A, Sarkar R, Stanley JC, Zelenock GB, Wakefield TW. Incidence of femoral and popliteal artery aneurysms in patients with abdominal aortic aneurysms. J Vasc Surg 2000; 31:863-869.
24. Crawford ES, Debakey ME. Popliteal artery arteriosclerotic aneurysm. Circulation 1965; 32:515-516.
25. Friesen G, Ivins JC, James JM. Popliteal aneurysms. Surgery 1962; 51:90-98.
26. Gaziano JM. Epidemiology of risk-factor reduction. In: Loscalzo J, Creager MA, Dzau VJ, eds. *Vascular Medicine*. Boston, Mass: Little, Brown; 1996:569-586

27. Meijer WT, Hoes AW, Rutgers D, Bots ML, Hofman A, Grobbee DE. Peripheral arterial disease in the elderly: The Rotterdam Study. *Arterioscler Thromb Vasc Biol* 1998;18 : 185-192.
28. Picus D, Hicks ME, Darcy MD, Kleinhoffer MA. Comparison of nonsubtracted digital angiography and conventional screen-film angiography for the evaluation of patients with peripheral vascular disease. *J Vasc Interv Radiol* 1991; 2:359 -364.
29. Malden ES, Picus D, Vesely TM, Darcy MD, Hicks ME. Peripheral vascular disease: evaluation with stepping DSA and conventional screen-film angiography. *Radiology* 1994; 191: 149-153.
30. Murphey MD, Fairbairn KJ, Parman LM, Baxter KG, Parsa MB, Smith WS. Musculoskeletal angiomatous lesions: radiologic-pathologic correlation. RadioGraphics 1995; 15:893-917.
31. Resnick D, Kyriakos M, Greenway G. Tumors and tumor-like lesions of bone: imaging and pathology of specific lesions. In: Resnick D, Niwayama G, eds. Diagnosis of bone and joint disorders. 2nd ed. Philadelphia, Pa: Saunders, 1989; 3617-3888.
32. Scott RA, Ashton HA, Kay DN. Abdominal aortic aneurysm in 4,237 screened patients: prevalence, development and management over 6 years. Br J Surg 1991; 78:1122–1125.
33. Bengtsson H, Bergqvist D, Sternby NH. Increasing prevalence of abdominal aortic aneurysms: a necropsy study. Eur J Surg 1992; 158:19–23.
34. Papanicolaou N, Wittenberg J, Ferruci JT Jr, et al. Preoperative evaluation of abdominal aortic aneurysms by computed tomography. *AJR* 1986;146:711-715
35. Van Hoe L, Baert AL, Gryspeerdt S, et al. Supraand juxtarenal aneurysms of the abdominal aorta: preoperative assessment with thin-section spiral CT. *Radiology* 1996;198:443-448
36. Cohan RH, Siegel CL, Korobkin M, et al. Abdominal aortic aneurysm: CT evaluation of renal artery involvement.

37. Romano M, Mainenti PP et al. Multidetector row CT angiography of the abdominal aorta and lower extremities in patients with peripheral arterial occlusive disease: diagnostic accuracy and interobserver agreement. Eur J Radiol. 2004 Jun; 50(3):303-8.
38. Costello P, Gupta KB. CT angiography gains acceptance in diagnosis of pulmonary embolism. Diagn Imaging (San Franc) 2000; 22: 43-35, 49, 87.
39. McEwan L, Gandhi M, Andersen J, Manthey K. Can CT pulmonary angiography replace ventilation-perfusion scans as a first line investigation for pulmonary emboli? Australas Radiol 1999; 43:311–314.
40. Raptopoulos V, Boiselle PM. Multi–detector row spiral CT pulmonary angiography: comparison with single–detector row spiral CT. Radiology 2001; 221:606–613.
41. Qanadli SD, Hajjam ME, Mesurolle B, et al. Pulmonary embolism detection: prospective evaluation of dual-section helical CT versus selective pulmonary arteriography in 157 patients. Radiology 2000; 217:447–455.
42. Ram CVS, Clagett GP, Radford LR. Renovascular hypertension. Semin Nephrol 1995; 15:152-174.
43. Beregi JP, Elkohen M, Deklunder G, et al. Helical CT angiography compared with arteriography in the detection of renal artery stenosis. AJR 1996; 167:495-501.
44. Galanski M, Prokop M, Chavan A, et al. Renal arterial stenoses: helical CT angiography. Radiology 1993; 189:185-192.
45. Rubin GD, Alfrey EJ, Dake MD, et al. Assessment of living renal donors with helical CT. Radiology 1995; 195:457-462.
46. Rubin GD, Dake M, Napel S, et al. Helical CT of renal artery stenosis: comparison of three-dimensional rendering techniques. Radiology 1994; 190:181-189.
47. Brink JA, Lim JT, Wang G, et al. Technical optimization of helical CT for depiction of renal artery stenosis: in vitro analysis. Radiology 1995; 194:157-163.

48. Davros WJ, Obuchowski NA, Berman PM, et al. A phantom study: evaluation of renal artery stenosis using helical CT and 3D reconstructions. J Comput Assist Tomogr 1997; 21:156-161.
49. Weaver FA, Kuehne JP, Papanicolaou G. A recent institutional experience with renovascular hypertension. *Am Surg*. Mar 1996; 62(3):241-5.
50. Boudejwijn G,Nelemans JP, Kessels GH et al. Diagnostic tests for renal artery stenosis in patients suspected of having renovascular hypertension. Annals of Internal Medicine 2001; 135: 401-441.
51. Fielder JF. A 23-year-old woman admitted to Kijabe Mission Hospital with bilateral lower extremity gangrene. MedGenMed. 2004 Mar 15; 6(1):56.

DATA COLLECTION SHEET

Patient's serial number: _____

Age_____

Sex MALE ☐ FEMALE ☐

Investigation

Carotid/ 4- Vessel ☐

Pulmonary ☐

Thoracic aorta ☐

Abdominal aorta ☐

Renal ☐

Peripheral ☐ Upper limb ☐

Lower limb ☐

Co-morbids

	Yes	No
Diabetes mellitus	☐	☐
Hypertension	☐	☐

Other (specify) _____

Smoker Yes ☐ No ☐

1. PERIPHERAL

A)

Presenting symptoms	Yes	No
Pain		
Muscle cramping/ fatigue during exercise		
Numbness		
Wound		
Gangrene		
Colour change		
Swelling		
Other (specify)		

0

B)

Pulses	Normal	Abnormal
femoral pulse		
popliteal pulse		
dosalis pedis pulse		
brachial pulse		
radial pulse		

C)

MDCTA findings		Pathology	Level
Artery	Aorta		
	Iliac		
	Superficial femoral		
	Deep femoral		
	Popliteal		
	Anterior tibial		
	Posterior tibial		
	Peroneal		
	Distal		
	Brachial		
	Radial		
Normal			

Pathology

A-Block i) atheromatous

ii) stenosis

B-Aneurysm

C-Small vessel disease

D-Arteriovenous malformation

E-Trauma (specify)

F-Tumour Mass

G- Amputation

a. lower limb

1. above knee
2. below knee

b. upper limb

1. above elbow
2. below elbow

H- Other (specify)

2. PULMONARY CTA

A)

Presenting Symptom	Yes	No
Difficulty breathing		
Chest pain		
Cough		
History of DVT		
Haemoptysis		
Other (specify)		

B)

MDCTA Findings	Pathology	Level Rt Lt
Block- main pulmonary artery		
Pulmonary artery		
Segmental branch		
Tumour mass		
Other (specify)		

2. CAROTID AND 4-VESSEL CTA

A)

Presenting Symptom	Yes	No
Headache		
Visual disturbance		
Syncope		
Seizures		
Paralysis		
Speech disturbance		
Other (specify)		

B)

MDCTA findings	Pathology	Level Rt Lt
AVM		
Stenosis		
Atherosclerosis		
Non-atheromatous vascular stenosis		
Aneurysm		
Other (specify)		

Level A- Cervical Internal Carotid Artery

B- Cervical Vertebral Artery

C- Basilar Artery

D- Posterior Cerebral Artery

E- Anterior Cerebral Artery

F- Middle Cerebral Artery

3. RENAL CTA

A)

Presenting Symptom	Pathology	Level
Transplant donor		
Transplant recipient		
Hypertension		
Other (specify)		

B)

MDCTA Findings	Pathology	Level Rt Lt
Accessory Renal		
Renal Artery		
AVM		
Other (specify)		

4. THORACIC AORTA

A)

Presenting Symptom	Pathology
Chest pain	
Difficulty breathing	
Other (specify)	

B)

MDCTA Findings	Pathology
Aneurysm	
Dissection	
AVM	
Other (specify)	

5. ABDOMINAL AORTA

A)

Presenting Symptom	Pathology
mass	
Other (specify)	

B)

MDCTA Findings	Pathology
Aneurysm	
Dissection	
AVM	
Other (specify)	