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Computed tomography angiographic evaluation of vascular pathology in a Nigerian tertiary hospital

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Computed Tomography Angiography has progressively replaced the invasive conventional angiography, and has now become the preferred modality for the diagnosis and characterization of most cardiovascular abnormalities. Computed Tomography Angiography (CTA) alone is mostly sufficient to adequately evaluate vascular lesions in various disease conditions. This study reports the institutional evaluation of various vascular lesions on a 64 64 slice Computed Tomography (CT) scanner over an eight-year duration. It evaluates the major clinical indications for angiography studies and spectrum of findings on CTA, any agreement between major clinical diagnosis and CTA findings over an eight-year period at a major referral tertiary hospital in South-West Nigeria was also determined in this hospital based retrospective study of patients with suspected vascular lesions throughout the body evaluated with CTA from January 2011 to December 2018. All CTA scans were performed using a 64-slice Multidetector Toshiba Aquilion Computed Tomography scanner. The demographics, clinical diagnosis, type of CT angiography, and result of the CT angiography procedure data were extracted and documented. The data was analysed using IBM SPSS version 23.0. A total of 305 patients were studied. Among the extra-cranial CTA studies, pulmonary thrombo-embolism (38/184) was the commonest reason for CTA. There was fair significant agreement between clinical diagnosis of PTE and CTA diagnosis of PTE, but weak agreement between Aneurysms/AVMs and corresponding findings on CTA. The commonest CTA examination was cranial angiographies followed by pulmonary CTAs. The Hospital incidence of aneurysms was 2.6 times that of AVMs in this study.

Key words: Computed tomography, angiography, vascular lesion, aneurysms, arterio-venous malformation.

INTRODUCTION

Computed tomography angiography has progressively replaced the invasive conventional angiography, as the preferred modality for the diagnosis and characterization of most cardiovascular abnormalities (Rubin et al., 2014). The tremendous technological development in Computed tomography over time (Rubin et al., 2014; Ginat and

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Gupta, 2014; Pelc, 2014), has transformed CT angiography into an important diagnostic tool that provides important scientific insights into vascular disease diagnosis and management that has transformed the standard of clinical care (Mohan et al., 2016). Nowadays, CT angiography and MR angiography have virtually replaced diagnostic intraarterial angiography for the treatment planning of patients with steno-occlusive/atherosclerosis disease as it is less invasive, faster and capable of providing an effective map of the disease process which is critical to treatment planning (Rubin et al., 2014; Kumar et al., 2016). However, compared to MRA, CTA is easier to use; faster in examining large volumes; considerably less expensive; less susceptible to motion artefacts; less dependent on hemodynamic effects; and more widely available (Rubin et al., 2014; Saleh, 2014; Ahmed et al., 2017).

Digital subtraction angiography displays high spatial resolution and offers opportunity for diagnosis and therapeutic intervention during a single session. Its use have been limited by high cost of examination, discomfort to patients, and the risks of being an invasive procedure, particularly when concurrent intervention was not indicated; inability to demonstrate the vessel wall, perivascular tissue, and end-organ parenchyma; poor three-dimensional (3D) spatial discrimination owing to the projections nature of the acquisition; the need for multiple contrast material injections and repeated exposure to ionizing radiation to characterize spatial relationships; as well as downstream luminal opacification limited by selective arterial injection of contrast material (Rubin et al., 2014).

Several studies have validated CTA as an excellent tool for evaluating steno-occlusive disease (Suzuki et al., 2016; Chidambaram et al., 2016; Qenawy et al., 2015). Nguyen-Huynh et al. (2008) corroborated the fact that CTA is an accurate and reliable assessment tool for intracranial steno-occlusive disease. They reported a CTA sensitivity and specificity of 97.1 and 99.5% for >50%; and 100% sensitivity and specificity in complete arterial occlusions as confirmed by Digital subtraction angiography (Nguyen-Huynh et al., 2008).

Apart from the CTA primary axial images, the reformatted Shaded Surface Display (SSD), Maximum Intensity Projection (MIP) and Volume Rendering (VR) techniques has made it possible to evaluate the major intra- and extracerebral blood vessels (Mohan et al., 2016). Furthermore, these viewing techniques have facilitated detailed coronary vessel evaluation, such as plaque composition, extent of vessel remodelling, extracardiac findings, aberrant coronary artery course, and other numerous pathologies (Sun and Xu, 2014). Other CT angiography uses are in renal vascular tree evaluation (Walls and Rajagopalan, 2013), evaluation of in-stent restenosis, particularly in the iliac and femoral arteries (Beckman and Creager, 2013), and in peripheral vascular imaging (Mishra et al., 2017). Despite the increasing burden of cardiovascular diseases in our population and the reported usefulness of CTA in the management of vascular lesions, there is a paucity of data on vascular lesion evaluated by 64 slice MDCT in the environment.

METHODOLOGY

All patients that had CT angiography scans over the 8-year duration from February 2011 to December 2018, following referral for suspected vascular lesions were recruited into this study. The study setting was the Radiology Department of a major tertiary and referral hospital in the South West Nigeria. The hospital serves as a referral centre for the people from other states in South West Nigeria. Using a retrospective study design, data of the 305 patients seen during the study period were retrieved from the departmental records. The age, sex, clinical diagnosis and body part angiography requested were all retrieved. CTA reports and images were also retrieved for analysis. Inclusion criteria for this study were all subjects referred for CTA for various vascular conditions, irrespective of their age and gender during the study period. Subjects that have most demographic and clinical information details were recorded and record of subjects that had clear images of diagnostic value and devoid of artefacts were evaluated. Data of patients with scanty demographic and clinical information as well as non-diagnostic images were excluded. Although secondary data was employed, this study was conducted according to the principle of Helsinki declaration (Helsinki, 1978). Confidentiality of patients preserved by assigning numbers to each eligible patient in place of real names.

All CTA images were acquired by 64 slice Toshiba Aquilion CT. All patients were either fasted overnight or for 4 to 6 h prior to the study. Intravenous cannulation was done after obtaining informed consent. Patients were positioned in line with the requested CT angiography protocol. Contrast dose and rate were calculated based on patient’s weight. The appropriate body part angiography protocol was selected. Triggering Hounsfield unit value set according to the type of angiography examination and Region of interest was kept on desired artery. Auto-triggering technique was employed for the CTA scans. After completion of the scan, the VR, MIP and MPR images were generated from the acquired axial images with the inbuilt vessel software. All reconstructed 3D and native Images were saved on the hospital server. The data was analysed with IBM SPSS version 23.0 Chicago: SPSS Inc. Tables of case frequencies and percentages and bar charts were used to display the data. Test of association was also carried out as appropriate. P values <0.05 were considered statistically significant.

RESULTS

Three hundred and five subjects who had computed tomographic angiography examination for various clinical indications at a tertiary hospital in Southwest Nigeria over the 8-year duration, from January 2011 to December 2018, were recruited into this study. The mean age of the patients was 46.0 ± 20.3 years with a range of 8 months to 93 years. The males in this study were 170 (55.7%), while 135 (44.3%) were females with an M: F of 1.3:1.

As shown in Table 1, the clinical diagnosis varies among the study population. In total, the clinical

Table 1. Sex and clinical diagnosis among the study population.

Variable	Number of cases	%
Sex		
Male	170	55.7
Female	135	44.3
Clinical diagnosis		
Cranial lesions		
Intracranial lesions (129)		
Intracranial aneurysm	33	10.8
Subarachnoid haemorrhage	28	9.2
Intracranial Space occupying lesion	24	7.9
Haemorrhagic CVD	20	6.6
Intracranial AVM	10	3.3
Other intracranial vascular lesion	7	2.3
Follow up post aneurysm clipping	4	1.3
Cranial vascular lesion (lower lip/scalp/orbit)	3	1
Extra cranial lesions (182)		
Pulmonary thrombo-embolism	38	12.4
Extracranial aneurysms	16	5.2
Peripheral AVM	12	3.9
Aortoiliac Vaso-occlusive disease	22	7.2
Vascular injury (fractured bones/ligation)	16	5.2
Neck tumours/ Masses	10	3.3
Renal artery (20)		
I). Allograft Donor	11	3.6
ii). Renal artery stenosis	9	3
Soft tissue sarcoma	8	2.6
Ear/ parapharyngeal masses	6	2
Peripheral vascular disease	8	2.6
Vascular masses	3	1
Others	23	7.5

CVD= Cerebrovascular disease, AVM= Arterio-venous malformation. Others= Left internal jugular vein injury, left femoral artery ligation, Right femoral artery pseudo-aneurysm, vascular renal tumours, vascular tumours of the sphenoidal tumour and right antrum, vascular laryngeal mass etc.

diagnoses in most of the studies (182/305 patients) were suspected extra cranial vascular lesions. Cranial vascular lesions were suspected in 129/305 (42.3%) cases. Out of these 129 cases, suspected intracranial lesions were the reasons for CTA in 126 cases. Among the extra-cranial CTA studies, pulmonary thrombo-embolism was the most prevalent diagnosis in thirty-eight cases. Aorto-iliac occlusive disease was recorded by referring physicians in 22/184 subjects, while 16/184 had vascular injury from fractured bones or from ligated vessels. In addition, peripheral arterial diseases were also recorded in eight patients. Evaluating the top eight computed tomographic angiography examinations carried out among the study population; Table 2 showed that most patients had cranial/cerebral CTA (45.6%) followed by pulmonary artery CTA (16.1%) and lower limb CTA (15.7%) respectively. The least CTA examinations were hepatic (0.3%) and cardiac CTAs (0.3%), as shown in Table 2.

Cranial CTA findings among the study population

CT result showed that most of the patients (84.6%) had various abnormalities on CTA. No abnormality was documented in 15.4%. In all the patients, 47.9% had vascular abnormalities on CTA. This is followed by intracranial tumours (16.7%) and intracerebral bleed (6.97%). Other non-major CT findings include: background cerebral atrophy and maxillary sinusitis, cardiomegaly, chronic interstitial lung disease and emphysema, disseminated pulmonary tuberculosis, rib and T3 vertebral fractures, lung consolidation and

Table 2. Requested computed tomographic angiography studies in the study population.

Requested examination	Case frequency	Case percentage
Cranial CTA	139	45.6
Carotid/Neck CTA	30	9.8
Chest/Pulmonary CTA	49	16.1
Lower limb CTA	48	15.7
Renal CTA	23	7.5
Aortic CTA	10	3.3
Upper limb CTA	9	3.3
Hepatic CTA	1	0.3
Cardiac CTA	1	0.3

Table 3. Computed tomographic angiography vascular lesion findings

Computed tomography angiographic diagnosis	Frequency	%
Vascular abnormalities (146)		
Aneurysm	51	34.9
Vaso-occlusive disease/ Atherosclerotic disease	23	15.8
Arteriovenous malformation (intracranial 12)	20	13.7
Pulmonary embolism	15	10.3
Vasculitis	2	1.4
Encased vessels	3	2.1
Arterial transection	4	2.7
Other Vascular Abnormalities	46	31.5
Classification of Aneurysms (51)		
Intracranial	39	76.5
Extracranial	12	23.5
Intracranial Aneurysms (39)		
Single	27	69.2
Multiple	12	30.8
Extracranial (12)		
Single	9	75
Multiple	3	25

haemothorax, scalp tumour and acute cerebellar bleed (Figure 1).

As shown in Table 3, out of the 146 patients with vascular abnormalities, 51 (34.9%) were confirmed to be cases of aneurysm on CTA. Arteriovenous malformation was the CTA imaging diagnosis in 20/146 (13.7%) cases, and 23/146 (15.8%) cases had vasso-occlusive disease/ atherosclerotic disease. The least type of abnormal CTA result among the patients on CTA were vasculitis, which was seen in 2 (1.4%) cases and 4 (2.7%) with arterial transection.

Furthermore, 46 (31.5%) of the patients had other vascular abnormalities which includes: arteriovenous fistula of the left External carotid artery and internal jugular vein, carotico-cavenous fistula, haemangioma of the lower lip, iatrogenic A3M3 left cerebral artery segment bleed and intravacerebral bleed. Among patients with aneurysm, 39 (76.5%) were intracranial aneurysm out of which 30.8% (12/39) were multiple aneurysms.

In this study, the extracranial aneurysms seen on CTA occurred at the; abdominal aorta (3), thoracic aorta (2),

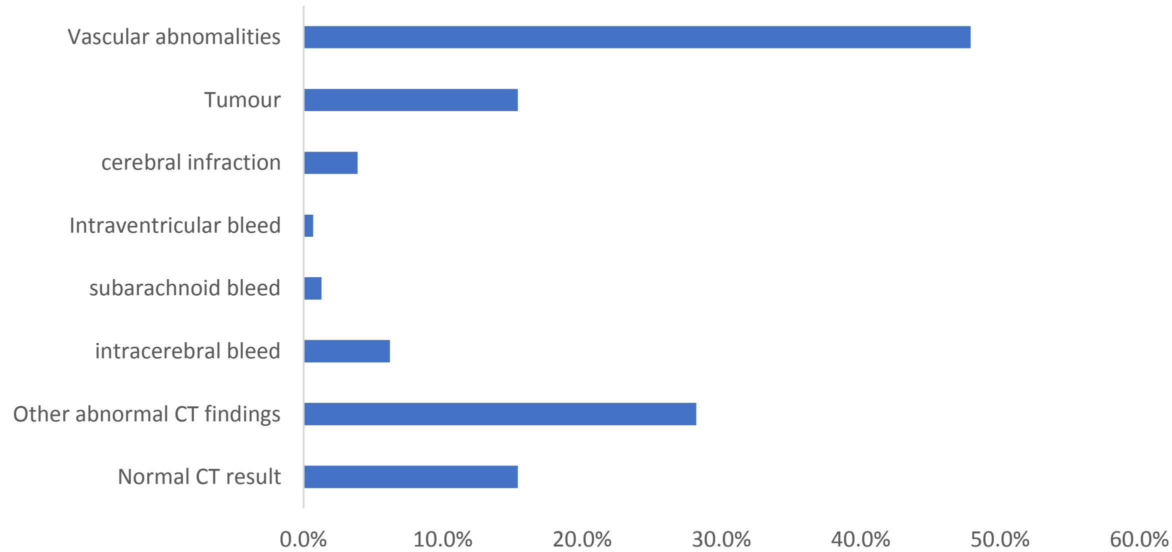

Figure 1. Bar chart showing the top 8 CT findings.

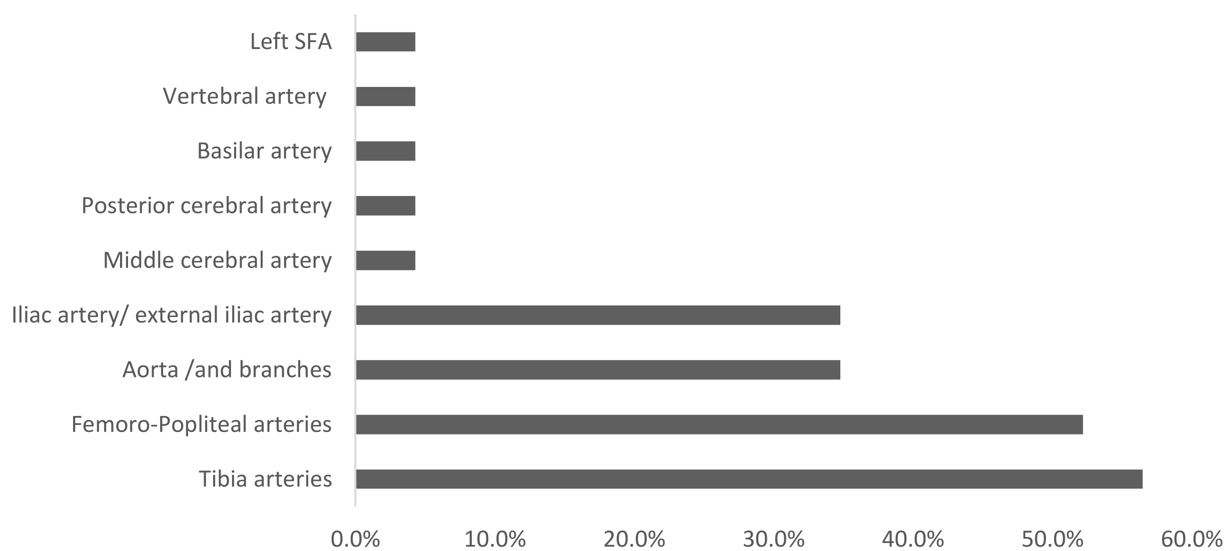

Figure 2. Bar chart showing site of the atherosclerotic disease location of vaso-occlusive disease. SFA = Superficial femoral artery.

axillary artery (2), Superficial femoral aneurysm (2), a case each at the anterior tibia and posterior tibial arteries. Others were a case each of thoracic aortic ectasia and Cirsoid scalp aneurysm. Vasso-occlusive disease was also documented. Majority 13 (56.5%) involved the tibia arteries followed by the femoro-popilteal arteries in 12 subjects (52.2%) (Figure 2).

Other CT findings in the study population were vascular tumours; neck tumours accounted for 14/305 cases (4.59%), intracranial tumour was seen in 11/305 (3.61%) as well as 6 cases (1.97%) of lower limb tumours. A case each of liver mass, ear tumour, and scalp tumour was also seen (Table 4). Figures 3 and 4 show some of the CTA findings in the study population.Test of agreement showed that clinical diagnosis for brain and extracranial aneurysm showed a statistically significant minimal agreement with CTA results for aneurysm (k = 35.4%; p < 0.001). Likewise, Clinical diagnosis of AVM Brain and Peripheral showed a statistically significant minimal agreement with CTA results for AVM (k = 23.3%; p<0.001).

Table 4. Various body part tumours on computed tomographic angiography.

Masses/ Tumours	Case frequency	Percent (n=305)
Neck tumours	14	4.59
Chest tumours	5	1.64
Gluteal/Groin tumours	2	0.66
Upper limb tumours	4	1.31
Lower limb tumours	6	1.97
Intracranial tumours	11	3.61
Renal tumours	2	0.66
Liver	1	0.33
Ear	1	0.33
Head (scalp)	1	0.33

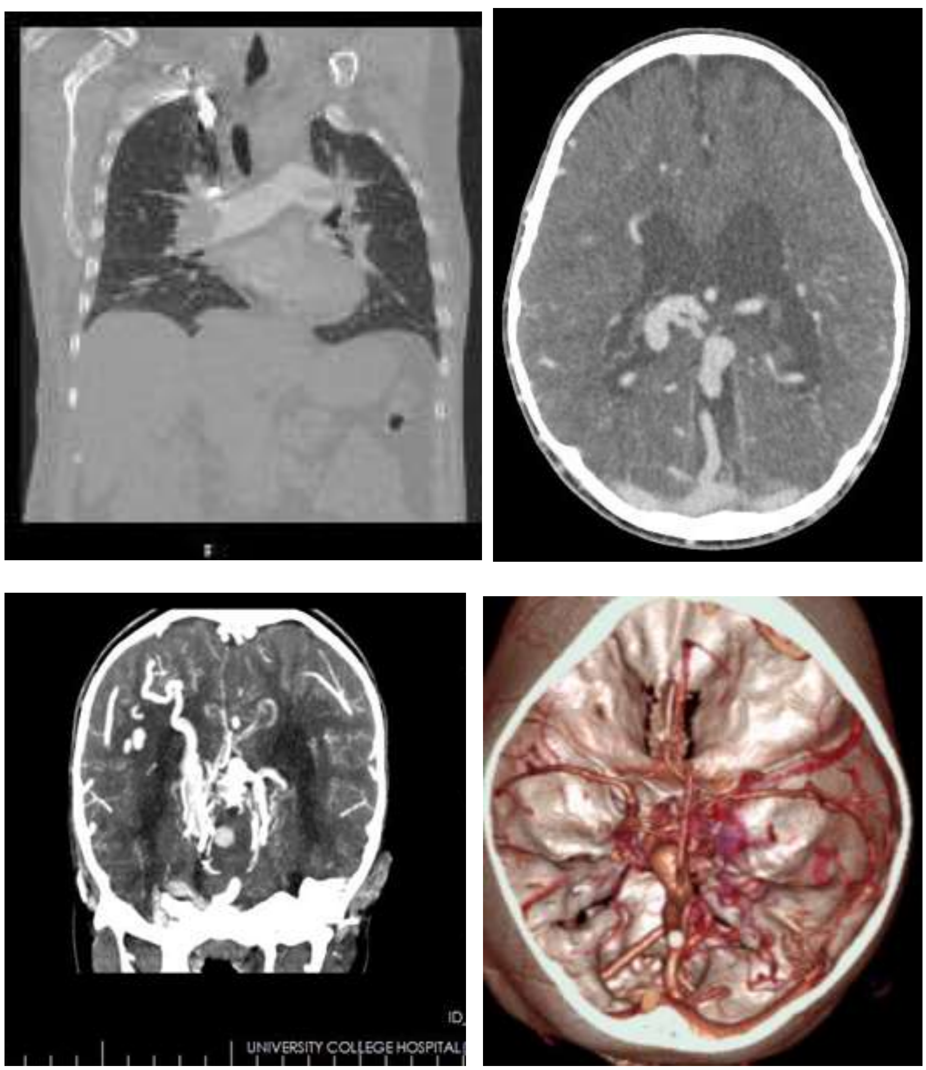

Figure 3. A- Coronal CT MPR showing hypodense filling defect in both right and left main bronchus in Pulmonary embolism, B, C and D- Axial image, coronal reformat and SSD image showing multiple dilated, tortuous arteries and early filling of the Dural sinuses- in Parietal lobe Arterio-venous malformation.

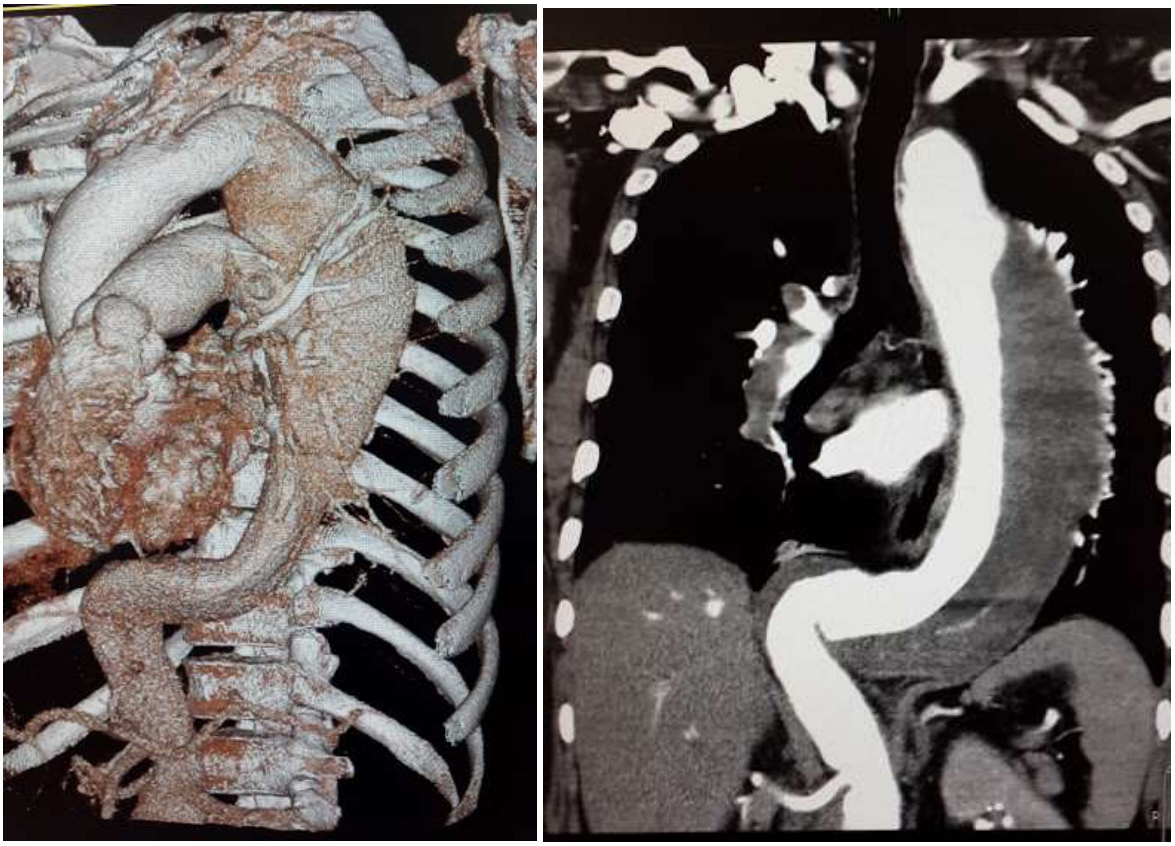

Figure 4. 3-D and Coronal MPR images showing tortuous, dilated thoracic aorta with extensive intramural thrombus on MPR image in descending thoracic aortic aneurysm.

Table 5. Accuracy of top 3 clinical diagnosis compared with CTA results.

Clinical diagnosis	Computed tomography angiography findings					
	Kappa	Sensitivity (%)	Specificity (%)	PPP (%)	NPP (%)	AUC
Intracranial aneurysm	0.354	45.1	89.8	46.9	89.1	0.674
AVM Brain	0.233	30.0	94.4	27.3	95.1	0.622
PTE	0.545	100.0	92.4	40.5	100.0	0.962

PPP= Positive predictive power, NPP= Negative predictive power, AUC= Area under curve, PTE= Pulmonary thrombo-embolism.

However, there was a statistically significant fair level of agreement between clinical diagnosis for PTE and CTA of pulmonary embolism (k = 54.5%; $p < 0.001$) (Table 5).

DISCUSSION

Recent development of non-invasive imaging modalities, especially CTA has provided new useful tools gaining acceptance as quicker and safer alternatives to Digital subtraction angiography (DSA) for the diagnosis of some vascular lesions. In this 8-year retrospective study of suspected vascular lesion evaluated by 64 slice Multidetector CT angiography, a total of three hundred and five patients were evaluated. The mean age of 46 years among the participants was lower than the 56-57 years reported by Ikpeme et al. (2014) in previous study on CTA in Nigeria. However, it is worthy to note that this study was done among a selected cranial vascular lesion cohort and not among the general population of patients with suspected vascular lesion from all parts of the body. Findings from this current study also showed a preponderance of male, with a Male: Female ratio of 1.3:1. This is similar to previous studies among patients with suspected vascular lesion in the Northern, South East and South West Nigeria (Anas and Suwaid, 2012; Adejoh et al., 2015; Ogbole et al., 2010). Previous studies have shown that most CTA studies were predominantly requests for, for the evaluation of cranial lesions (Anas and Suwaid, 2012; Ogbole et al., 2010). This is in agreement with the result from this study which showed that patient referral was majorly for cranial CT angiography in 46% of the cases.

CTA findings from the current study showed no abnormality in 15% of all cases. This is lower than that reported by Anas and Muhammad, albeit their findings were among paediatric age group (Anas and Suwaid, 2012).

Expectedly, vascular lesions predominate in the CTA diagnosis in this study. The leading vascular lesions were aneurysms, vasso-occlusive disease/atherosclerosis disease, and AVMs. Although most of the cases of aneurysms and AVMs were intracranial vascular anomalies, intracranial aneurysms were 3 times as common as AVMs of the brain in the current study. This finding is in agreement with the work of Ogbole et al. (2010), which documented more aneurysms than AVMs. However, this study shows an increase in the average annual hospital incidence of about 6 intracranial vascular anomaly/year in Ibadan compared to previous study (Ogbole et al., 2010). This may be due to the larger sample size employed in this current study compared to the former, the advanced imaging modality used in the current study and increased awareness among the medical community in the hospital. Among the intracranial aneurysm cases in this study, 30.8% had multiple aneurysms. This is a higher than the figures reported in the ISAT trial by Molyneux et al. (2015) in which 21.3% of intracranial aneurysm patients had multiple aneurysm. However, in contrast, a study with a smaller sample size of 37 patients by Anderson et al. reported a higher proportion of 15/37 cases (40.5%) of patients with intracranial aneurysm with multiple aneurysm (Anderson et al., 1997). The sample size, geographical and dietary factors may responsible for the observed differences.

In the report of Nguyen-Huynh et al. (2008), out of 23 patients with steno-occlusive disease, two patients had ICAD of which more than one occlusion sites (2) was identified in one of the patients on CTA, which is in agreement with findings in this current study. This is also similar to reports from previous studies (Rotzinger et al., 2017) which documented a large individual variation of occlusion sites and degrees in patients with acute ischaemic stroke on CTA. Furthermore, findings from this study among the patients with peripheral occlusive disease showed a male to female ratio of 2:1, with the tibial arteries being the commonest site of atherosclerotic occlusive lesions which is at variance with the study of Kumar et al. (2016), which reported a male to female ratio of 6:1 and the femoropopliteal pathway as the commonest site of atherosclerotic occlusive lesions in the abdominal aorta and in bilateral lower limb vessels. This observation may be due to the differences in study design. When suspected clinical diagnoses were compared with CTA diagnoses, there were low agreement between suspected aneurysms and AVMs compared to CTA diagnosis. However, there was a fair agreement of clinical diagnosis of pulmonary embolism and CTA findings of evidence of pulmonary embolism. This emphasises the importance of CTA as an important evaluating modality in clinical care.

Conclusion

This study has shown that the commonest CTA examination was cranial followed by Pulmonary CT angiographies. The hospital incidence of intracranial aneurysms was 3 times that of AVMs in this study. There was poor correlation between clinically suspected aneurysmal/arteriovenous malformations and CTA findings. CT angiography is recommended as initial imaging investigation in suspected vascular disease for proper diagnosis and to guide the early institution of appropriate management.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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