ORIGINAL ARTICLE

# PERIPHERAL VASCULAR DISEASE EVALUATION BY MULTIDETECTOR CT ANGIOGRAPHY: INITIAL EXPERIENCE

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## ABSTRACT

To share our experience of CT Angiography on a Multislice CT Scanner in diagnosing different peripheral vascular disorders. Since the installation of multidetector CT (16 detectors) in our institution, 17 patients have undergone CT angiography of the upper and lower limbs. The cases included 11 lower limb and 6 upper limb angiographies. CT angiograms were produced using maximal intensity projection, volume rendering technique, and curved planar reconstruction. All patients were scanned in the supine position with 150-180 cc Non ionic contrast medium injected at a rate of 4 cc/sec. Images were then transferred to a dedicated workstation (VITREA2) for 3-D reconstruction and analysis. The findings were then prospectively compared with the surgical outcome or clinical progression of the disease. All the patients withstood the procedure well, with diagnostically adequate vascular enhancement. No image degradation and no serious post procedure complications due to the amount of contrast or the radiation dosage used were noted. CT angiography allowed a comprehensive diagnostic workup in all cases thus aiding their management. In all the cases results of CTA correlated well with other diagnostic modalities and with surgical or clinical findings. Our initial experience of CT angiography with 16 row MDCT has clearly demonstrated its efficacy as a promising, fast, accurate, non-invasive and safe imaging modality of choice in cases of peripheral vascular disease and as a useful screening modality in cases of peripheral vascular diseases for diagnosis, and type of treatment.

**KEY WORDS:** MDCT, CTA, peripheral vascular disease

## Introduction

The traditional means of evaluating vascular anatomy with conventional angiography was slowly replaced by digital subtraction angiography (DSA). Although considered as a gold standard in the evaluation of peripheral vascular disease, the role of DSA has now been challenged by recent advances in technology, like Doppler ultrasound, CT Angiography (CTA) and contrast enhanced magnetic resonance angiography (MRA).

Though not considered a primary vascular imaging modality untill a few years ago, CTA has experienced a technological quantum leap with the introduction of MDCT and has gained widespread acceptance in the imaging of the aorta, carotid, renal and iliac vessels.[1,2]

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The introduction of multiple detectors with isotropic imaging capabilities has enabled CTA to surpass even MRA with regard to spatial resolution.[3]

After attaining the capability of performing CT angiography (CTA) on our new 16 detector rows equipment, it was one of our prime goals to come up with local data on the subject. To our best knowledge, there has not been any published data on CTA in Pakistani literature. Thus, inspite of the fact that CTA is a technology that has been there for quite some time, we picked up on the idea of sharing our personal experience with this exceptional technique.

## Materials and Methods

From 01- 05- 2008 to 31- 10- 2008, 17 patients underwent CTA for the evaluation of peripheral vascular disease at our institute. This included 11 angiographies for lower limb disease and the other 6 for upper limb disease.

All the patients referred for the procedure were included in the study. We intended not to include patients who had contraindications for the procedure like contrast allergy. The other criteria for exclusion, was patients who had undergone vascular surgery or stenting as a treatment. None of our patients however had any contraindications and none had undergone previous interventions.

CT Angiography was performed on 16 detector row scanner (Toshiba Health Japan). On the basis of digital scout, the area of interest was selected. For lower limb procedures this included an area from above the kidneys to the toes. For upper limb angiographies we included the region from root of aorta to tips of the fingers with arms raised above the head on either side. Non-Ionic contrast medium (300 mg iodine/ml) was injected as a bolus from automated power injector. Volume of contrast used varied between 150 to 180 ml, depending on body habitus of patient, injected in an ante-cubital vein at a rate of 4 ml/sec. Time delay till the start of imaging was determined for each patient by using a bolus-tracking technique (SureStart ™). Imaging was started when the density in a selected ROI of descending aorta reached.

The acquisition time averaged 25 seconds. The images were instantly transferred to the on line work station-VITREA 2. Sliding maximum intensity projections were obtained with transverse, coronal, and sagittal projections. We also routinely acquired volume rendered images in different planes including curved reformations. All image interpretations were performed at the Vitrea 2 workstation and two radiologists reached a diagnosis with consensus.

## Results

The age range of our patients was between 21 years and 67 years. A predominantly male population was seen (70%). 14 patients had signs and symptoms of limb ischemia. Most commonly encountered symptom was pain followed by discoloration and absent pulses. 11 patients were diabetic. Three patients had history of trauma and a vascular injury was suspected. In all of our patients, there was no technical failure. The procedure was well tolerated in all patients and in no study was there any image degradation due to motion artifacts.

The CT Angiography was normal in 4(23%) cases. Rest of the 13(77%) cases had positive, pathological findings.

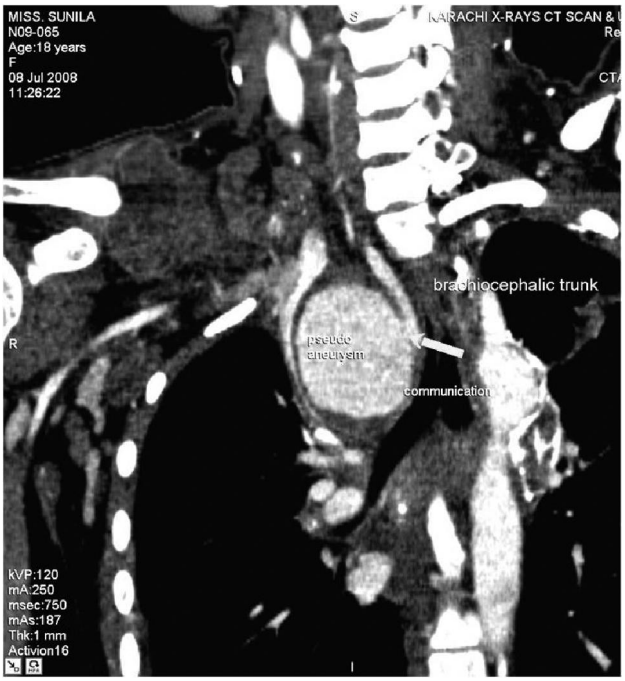


**Figure 1:** (a)**:** Coronal reformatted image showing pseudo-aneurysm arising from right brachiocephalic trunk, compressing surrounding structures

**Figure 1:** (b): 3D volume rendered image of the same patient with excellent demonstration of the pseudo-aneurysm and other normal structures.

Out of the 11(64%) cases of lower limb CTA, three (27%) cases were normal. In the remaining 8(73%), one was having Buerger's disease involving the right popliteal artery with characteristic cork screw collaterals. Another had occlusion of superficial femoral artery at mid thigh level due to a thrombus that was later confirmed on surgery. Rest of the six patients has multi level atherosclerotic disease involving bilateral arteries at different levels. Two patients had undergone previous Doppler evaluations. CT findings not only correlated well but also provided additional information, regarding degree of collateralization and reformation of vessel lumen. Another patient had a previous magnetic resonance angiography, which however was considered inconclusive and a CTA was thus requested. Only one case of the 6 upper limb CTAs, was normal. Of the pathological cases, the first case was of takayasu's arteritis in the right subclavian artery. Biopsy of the artery was performed later that proved our diagnosis. Another one had pseudo-aneurysm of right Brachiocepahlic Trunk. Initially this patient was suspected clinically of having the pseudo-aneurysm of the subclavian artery. A surgical procedure was later performed for the vessel repair. A different patient was suspected of having a left cervical rib resulting in the ischemic symptoms in left upper limb. On CTA this patient was found to have almost 60% stenosis at the origin of left subclavian artery and a cervical rib was also found. The other 3 patients had variable degree of atherosclerotic disease at different levels. None of these patients had undergone previous imaging.


**Figure 2:** (a): Delayed axial image from upper limb CTA showing thrombus within right subclavian and axillary arteries in a case of Takayasu's arteritis.

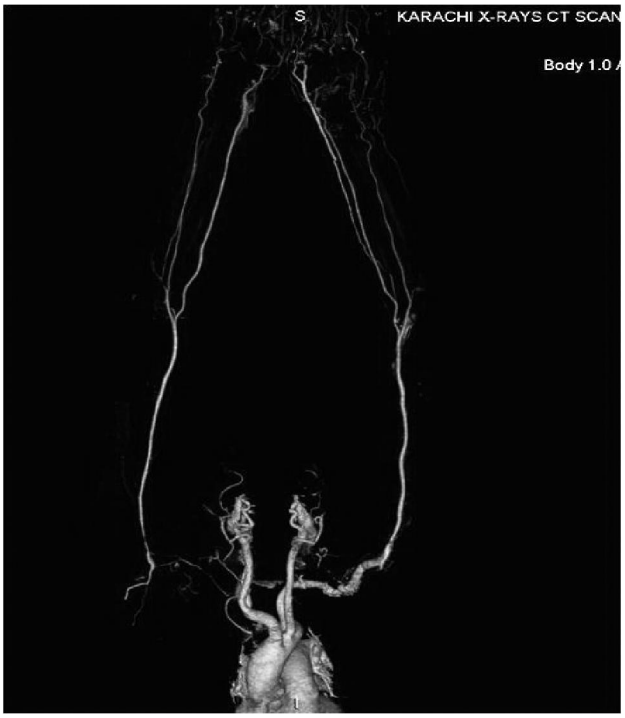


**Figure 2:** (b): Volume rendered MIP image showing occluded segments of right subclavian and axillary arteries (Takayasu's arteritis).

**Figure 3**: Volume rendered MIP image showing occluded segment of right popliteal artery and characteristic cork screw collaterals in a case of Buerger's disease.

## Discussion

With the introduction of multiple detectors and resultant multiplanar imaging capabilities, CT angiography (CTA) has emerged as the leading modality in peripheral vascular evaluation[3].

Of the total of 17 CTA cases, 13 were positive and these cases on prospective follow up showed excellent clinical and surgical correlation. The MDCT clearly demonstrated the abnormality in few seconds and with 100% operative correlation. Thus CTA helped in a comprehensive diagnostic workup within a short time.

The aim of CTA in peripheral vascular disease (PVD) patients is to delineate the presence or absence of significant obstruction to blood flow, the site and anatomical extent of obstruction, the status of collateral flow and distal vasculature; for planning treatment as well as to monitor the results of therapy and disease progression.[1,7] In published literature CT Angiography is seen to have more than 92% sensitivity, 96.2% specificity and an overall accuracy of more than 95.5% in the evaluation of peripheral vascular disease.[1] The advantage of CTA in cases of PVD is in the detection and characterization of atherosclerotic plaques and the presence or absence of calcification within it. This is significant as the plaque morphology being heterogenous, some are more prone to calcify, while soft plaques are the potentially dangerous ones, due to their propensity to rupture and throw distal emboli. In addition, by being able to more clearly define a plaque and its morphology, the effect of various therapies on progression or regression of plaques can be monitored.[3] The additional benefit of cross-sectional CT is in simultaneously depicting extraluminal structures causing arterial obstruction, as in our case the cervical rib causing occlusion of left subclavian artery. The major disadvantage of CTA however is the radiation dose and the absence of any hemodynamic assessment, which is obtained by Doppler imaging and MRA. In spite of these limitations, CTA is being increasingly used as a screening modality for initial assessment of the presence of vascular disease, its extent and severity, thereby allowing interventional radiologists and vascular surgeons to plan the most appropriate therapeutic method, reducing unnecessary intervention or possible intra-operative difficulty. Thus it is easy to see why CTA has such tremendous growth prospects as a distinct diagnostic imaging modality in recent years. Apart from the fact that the radiation dose is four times less in CTA as compared to DSA, it is faster, non-invasive and combines luminal information provided by conventional angiography with the advantages of cross-sectional CT imaging. The visualization of the wall of the vessels (calcified and soft plaques), along with a simultaneous evaluation of bone and soft tissues and the anatomic relationships of the vessels with adjacent structures is clearly a strength of CTA that cannot be matched by conventional angiography.[3,4]

Colour Doppler is the initial imaging modality of choice in suspected peripheral vascular disease, especially in popliteal disease, but it has a few drawbacks. It is operator dependent, is unable to assess distal vasculature and fails to demonstrate direct evidence of cystic adventitial or popliteal entrapment syndrome.[2,5] As against colour Doppler, CTA is less operator dependent and is clearly of advantage in patients with trauma that are often immobilized and in intense pain. Surgeons prefer CT images to Doppler images as they are presented in a format similar to conventional angiograms with which they are more familiar and comfortable.[7] This was also seen in our experience in two patients, where CTA provided additional information regarding the distal vasculature and collateral formation.

The main competitor to multislice CTA is contrast enhanced dynamic MRA. Both modalities have similar Z-axis resolution, however, MRA has an advantage by the fact that it is unaffected by the presence of vascular calcification.[7] In addition, MRA is a good imaging modality for evaluation of the distal anterior tibial, peroneal and dorsalis pedis arteries. However, CTA scores over MRA by being much faster, less expensive, more widely available, with better patient compliance and with the absence of retrograde flow artifacts. It is also a modality of choice in patients with MR incompatible hardware, indwelling stents and in severely claustrophobic patients.[2,8,9] The inconclusive case of MRA in our study could probably be due to technical factors and low magnetic field strength. The major drawback of CTA is the large amount of intravenous contrast and the ionizing radiation involved. Also, no information is obtained regarding the flow direction and velocity. In addition, CTA may fail to demonstrate short segment stenosis, apart from the fact that horizontally oriented branches are poorly visualized, thus significant lesions may be missed in

certain instances.[7] Despite these limitations, the vast majority of examinations we performed were considered sufficiently diagnostic to avoid more invasive imaging. We did not formally compare the CTA with other imaging modalities as most of the patients had not undergone previous imaging and the number of patients was also small, forming the major limitations of our data. We would however propose a multi-center study to come up with more accurate local data, which could later change the way we manage peripheral vascular disease in our country.

## Conclusion

Our experience of multi detector computed tomographic angiography has clearly demonstrated its efficacy as a promising, new, fast, accurate, safe and non-invasive imaging modality of choice as a useful screening modality in cases of peripheral vascular diseases for diagnosis and for grading of disease and in cases of trauma with suspected arterial injuries. The contrast and radiation dose is well tolerated by all patients and the image quality obtained is comparable to intra-arterial DSA. Some of the inherent limitations of the technique and the time consumed in post-processing can be overcome with technology advances.
Thus it would be appropriate to conclude that CTA is clearly emerging as a screening tool in patients of peripheral vascular disease, in trauma patients with suspected vascular injury, and in the assessment of vascular anatomy and its variants.

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