ORIGINAL RESEARCH PAPER

Volume-8 | Issue-1 | January-2019 | PRINT ISSN No 2277 - 8179

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

ROLE OF MDCT IN EVALUATION OF PERIPHERAL VASCULAR DISEASE OF THE LOWER LIMB ARTERIES AND COMPARISON WITH COLOUR DOPPLER

Radiology

Dr. Rupinder Singh Associate Professor, Department of Radiodiagnosis and Imaging, M.M. Institute of Medical Sciences and Research, Mullana, Ambala.

Dr. Abhiraj Singh Sran Resident, Department of Radiodiagnosis and Imaging, M.M. Institute of Medical Sciences and Research, Mullana, Ambala.

Dr. Avkirat Senior Resident, Department of Radiodiagnosis and Imaging, M.M. Institute of Medical Sciences and Research, Mullana, Ambala.

Dr. Amit Mittal* Professor, Department of Radiodiagnosis and Imaging, M.M. Institute of Medical Sciences and Research, Mullana, Ambala. *Corresponding Author

ABSTRACT

INTRODUCTION: Imaging plays a crucial role in the management of patients with peripheral arterial disease. Due to its limitations colour Doppler ultrasonography is replaced by multidetector computed tomographic angiography prior to any vascular intervention in PAD. In view of this we evaluated the efficacy of MDCT angiography and colour doppler ultrasonography to diagnose peripheral arterial disease in lower limb.

AIMS AND OBJECTIVES: The purpose of this study was to evaluate and compare the role of multi detector computed tomography (MDCT) and Color Doppler ultrasonography (CDUS) in imaging the lower limb arterial tree in peripheral arterial occlusive disease (PAOD) and to derive the benefits and drawbacks of each modality. To assess advantages and disadvantages of volume rendered images and raw images.

MATERIAL AND METHODS: A comparative study included 30 patients with PAD who underwent colour doppler ultrasonography and MDCT angiography in our Institute following which the data was compared and analyzed to derive the benefits and drawbacks of each modality.

RESULTS: In our study, atherosclerosis was the most common cause affecting 25 (83.3%) the patients followed by Buerger's Disease affecting 5 (16.6%) patients. In our study CDUS was better than CT angiography in the diagnosis of early onset (Grade I & II) cases and CTA was better in detecting and diagnosing grade III and IV stenosis. The delineation of the arterial tree, collaterals and vessel wall calcification was better visualized on CTA than CDUS.

CONCLUSION: MDCTA is an excellent tool for diagnosing hemodynamically significant stenosis and is needed to be performed before any vascular intervention is planned. Doppler is also an effective tool which can detect the lesions to a comparable extent when no intervention is planned.

KEYWORDS

CDUS,MDCTA, PAD

INTRODUCTION

Peripheral arterial occlusive disease (PAOD) is the most common condition affecting the arteries of the lower extremity. Due to occlusions and stenosis arterial flow is compromised which results in ischemia of limb, which has manifestations as rest pain, claudication, loss at the local site (ulceration) and potentially amputation. Patients of PAD may be symptomatic or may not be. These patients have increased risk of mortality, stroke and myocardial infarction. It is an independent risk factor for vascular disease in other regions, resulting in increased cardiovascular events and rate of mortality. The functional status of the limb is adversely affected leading to poor quality of life.

The commonest cause of lower limb arterial disease is atherosclerosis. Less common causes include thromboembolism, acute thrombotic occlusion, micro embolism, trauma, vasculitis including vasospastic disorders and Buerger's disease. Atherosclerosis leads to the formation of the atheromatous plaques, which gradually rupture and heal with residual stenosis or complete closure of the lumen. Secondly, if the arterial enlargement compensation process is excessive, it results in aneurysm formation. Not only can we save the limb but also improve the function of the limb by diagnosing and treating this condition.

The standard investigation for peripheral arterial occlusive disease is arteriography. Accurate Anatomical details of the obstructive lesions in arteries affected is depicted. However, the haemodynamic significance of such lesions is not estimated. Recently, advances in CT and duplex scan have raised the possibility that it arteriography could be replaced as the primary imaging modality of imaging for the assessment of ischemia of limb.

Ultrasound imaging provides a measurement of blood velocity through a vessel and colour doppler imaging enables the rapid localization of arterial stenosis and occlusions. Its association with interventional endovascular procedures explains the significant development of colour Doppler these days. Thus it allows the evaluation, quantification and the follow up of the arterial disease by carrying out a precise vascular mapping that can guide the radiological or surgical procedure if necessary. Colour doppler imaging is safe, popular, cost effective, repeatable, non-invasive procedure for investigating lower limb arteries. Ultrasound remains currently an important modality in peripheral arterial occlusive disease evaluation and even if MRA eventually becomes the pre-eminent technique for evaluating this disease, ultrasound will still likely continue to be important diagnostically and have a role in many settings (E.g.- post-angioplasty assessment, pseudoaneurysm).

Lower extremity CT angiography is a fairly new technique when compared to duplex ultrasonography. Peripheral CT became a reality only after when MDCT was introduced in 1998, which allowed for first time the scanning of the entire lower extremities runoff and inflow vessels in a single CT acquisition and with a single contrast medium injection at the adequate spatial resolution. The advantages of MDCT are large increase in imaging acquisition, more coverage of the patient, and high spatial resolution. With advanced post processingtechniques image interpretation is aided. Reconstruction of the arterial tree with the volume rendering techniquesaids in the rapid detection of pathology. Maximum intensity projection (MIP) images are useful for assessing the degree of stenosis qualitatively. Limitation of VR and MIP is obscuration of the vessels by the bones.[1]

MDCT angiography delineates the presence or absence of significant obstruction to the blood flow, the site and anatomical extent of obstruction, the status of collaterals and distal vasculature which is crucial for planning the treatment as well as to monitor the results of therapy and disease progression.[2]

MATERIALS AND METHODS

30 patients presenting with signs and symptoms of peripheral arterial occlusive disease were included in the study.

The inclusion criteria for the present study group was-
All cases of lower limb peripheral vascular disease where USG Doppler and MDCT angiography were done on the patient.

The exclusion criteria for the present study group was–
1) Acute renal failure.
2) Chronic renal failure.
3) Children.
4) Contrast allergy.

Colour Doppler ultrasonography was performed using HD 11 XE(Philips medical system) and the arterial system of the lower limb will be scanned with a linear phased array (6-12MHZ) transducer.

For performing the Doppler scanning of the lower limb arterial system, the patient was made to expose both the lower limbs in the supine position on the scanning couch. The distal common femoral artery was imaged and the Doppler waveform assessment was done visually for any loss of triphasic flow or rounding of the waveform due to significant iliac disease. In the presence of this finding, the iliac arteries were assessed for the evidence of atherosclerotic disease using the curvilinear probe and the abdominal vascular setting. The scan was continued distally from the common femoral artery assessing the superficial femoral artery and popliteal artery in the longitudinal plane, using the linear probe and the lower limb arterial scan pre-set. The extent and severity of the arterial disease was assessed using triplex mode by measuring the peak systolic velocity from the Doppler waveform just proximal to and through the stenosis. The severity of the disease was then classified using the following standard criteria mentioned in the table below.

A complete occlusion was confirmed by reducing the colour scale and/or using the power Doppler. Arteries were evaluated for calibre, lumen, flow velocity and spectral wave pattern. The data collected from the patients was classified according to the level of atherosclerotic disease. The patients who have at least one stenosis in the lower limbs with 50-70% block were classified as having moderate disease and placed into the moderate disease group, in patients whom at least one stenosis measures between 70-99% were classified as having significant disease and were placed into the significant group and in patients with an occlusion were placed in the occlusive group.
The MDCT angiography was performed following assessment by an arterial colour Doppler. The scan direction was cranio-caudal from the level of infrarenal aorta to the pedal arch. All scans were done with 128 slice multidetector spiral CT Ingenuity (Philips medical system,USA) using bolus tracking technique. First survey was taken from diaphragm to foot then small area for localization of bolus will be scanned in the upper abdomen. Then the localization was placed at the descending aorta proximal to origin of the renal arteries. Then contrast was given by the pressure injector (Medrad medical system) at the rate of 4 ml per second and volume 120 cc followed by saline chase of 30 ml at the rate of 4ml per second. The parameter for scanning were of pitch 0.798, rotation time 0.5 seconds, kv-120, mAs -200 and post threshold delay of 3.1 seconds. All images were evaluated in axial, coronal and sagittal planes in maximum intensity projection (MIP). Volume rendering and maximum intensity projection images were obtained from raw images from all the cases. Images were analyzed for calcification, wall thickening, extent pattern of luminal narrowing and the collateral flow.

RESULTS

Males outnumbered females in the study, with males numbering 24 (80%) and females numbering 6 (20%). Age of the patients ranged between 43 to 82 years with a mean age of 61.5 years. Majority of the patients (40%) were in the age group of 61-70 years.15(50%) patients had grade III Claudication based on modified Boyd classification in our study. All the patients with grade IV claudication (16.67%) were smokers.6 (20%) patients had gangrene and all patients with gangrene had a history of smoking. In our study of patients with peripheral arterial disease we found that 20 out of 30 patients (66.67%) had history of smoking and all 20 patients had a history of smoking with more than 20 pack years. 13 out of 30 patients (43.33%) had history of alcohol. Out of all patients who had positive history of smoking and alcohol, 10 patients had positive history of both smoking and alcohol. In our study of peripheral arterial disease we found that 14 out of 30(46.67%) patients had diabetes and 14 out of 30(46.67%) had hypertension out of which 6 patients had both diabetes and hypertension. In our study of PVD it was found out that atherosclerosis was the most common cause affecting 25 (83.3%) the patients followed by Buerger's Disease affecting 5 (16.6%) patients.In our study we observed that as the age advances the degree of stenosis and involvement of larger arteries increases, the risk factors for PAD included hypertension andType2DM. In our study the number of segments with greater than 50% stenosis were 68(6.8%) (Table-2) and 80(8%) (Table-4) detected by CDUS and CTA respectively. The number of segments with less than 50% stenosis were 230 (23.2%) and 171 (17.2%) as detected by CDUS and CTA respectively. The detection rate for the Grade 3 and Grade 4 stenosis is more with the CTA in the distal arterial segments. Both CDUS and CTA were able to detect all the Grade 4 stenosis segments in the aorto-iliac and femoro-popliteal region. The detection rate for the Grade 1 and 2 stenosis was higher for CDUS than CTA in all the three arterial segments. Thus in our study we conclude in detecting hemodynamically significant stenosis MDCTA was significantly better than CDUS. In our study in comparison to CDUS, CTA was significantly better in detecting collaterals and in evaluation of the morphologic features of the runoff arteries in their full length which is an important imaging finding, hence MDCT is needed before vascular intervention. In our study we concluded that that CTA was better than CDUS in detecting vessel wall calcification and in assessing luminal narrowing in densely calcified arteries.

DISCUSSION

Significant association of PVD with male gender was seen in our study. In our study the age factor was significantly associated with an increase in risk for PVD.

It is a known fact that prevalence of PAD increases with increasing age and our study is in correlation with the studies done previously. Smoking tobacco is a major risk factor in the development of PAD. These findings were in agreement with our study in which among the smoking group the incidence and grade of claudication was more than that of nonsmokers. In ourstudyofperipheralvascular diseasea therosclerosiswasthemostcommon cause of PVD followed by TAO. In our study, we concluded that as the age advances the degree of stenosis and involvementoflargerarteriesincreases.Theco-morbiditiesin patients with PVD included hypertension andType2DM in our study.

Studies comparing the MDCTA and Colour Doppler

In our study the grading system used for the degree of stenosis i.e. Grade 0/ Normal – 0 %, Grade I – 0-25%, Grade II – 25-50%, Grade III – 50-75% and Grade IV ->75%(including occlusion) which was in comparison to the grading scale used for stenosis in used in earlier studies done by **Netam SS et al**[6].

Through CDUS in our study we were able to label 19(63.3%), 37(76.6%) and 33 (55%) cases in the aorta, common iliac and external iliac arterial segments respectively as normal (Grade 0 stenosis). CT angiography was able to quantify 22(73.3%), 45(75%) and 43(71.6%) cases in the infrarenal aorta, common iliac and external iliac arterial segments respectively as normal (Grade 0 stenosis). The detection rate for the Grade 4 stenosis was similar for both CDUS and CTA in the mentioned arterial segments of the aorto-iliac group. Colour Doppler Ultrasonography quantified 21(35%), 16(26.6%) and 16(26.6%) cases in the common femoral, superficial femoral and popliteal arterial segments respectively as normal (Grade 0 stenosis). However, the CT angiography was able to detect 28(46.6%), 21(35%) and 20(33.3%)cases in the common femoral, superficial femoral and popliteal arterial segments respectively as normal. The detection rate for the Grade 4 stenosis/ occlusion was similar for both CDUS and CTA in the mentioned arterial segments of the femoro-popliteal region. CDUS detected no abnormality in 21(41.6%), 29(48.3%) and 26(43.3%) cases in the anterior tibial, posterior tibial and peroneal arterial segments respectively (Grade 0 stenosis). However, the CT angiography demonstrated (Grade 0 stenosis) in 25(41.6%), 29(43.33%) and 26(43.3%) cases in the anterior tibial, posterior tibial and peroneal arterial segments respectively. The detection rate for the Grade-3 and Grade 4 stenosis is more with the CTA in the distal arterial segments Colour Doppler The detection rate for the Grade 1 and 2 stenosis was higher for CDUS than CTA in all the three arterial segments. Greater number of the arterial segments with Grade 3 stenosis was detected by the CTA in the femoro-popliteal and tibio-peroneal region than the CDUS. Both CDUS and CTA were able to detect all the Grade 4 stenosis segments in the aorto-iliac and femoro-popliteal region. However CTA was able to quantify more number of segments in the tibio-peroneal region than CDUS due to the non-visibility of the arterial segments because of gangrenous changes. Early stenotic lesions were better picked by the CDUS whereas Grade 3 and 4 lesions were better demonstrated by the CTA. **Kayhan A et al**[5]in 2012 imaged 774 vessel segments in 43 patients by both CDUS and CTA. The total number of diseased segments found with CDUS

was 86(11.1%) versus 130(16.8%) identified by MDCTA.

In present study the number of segments with greater than 50% stenosis were 68(6.8%) and 80(8%) by CDUS and CTA respectively, while A. **Kayhan et al**[5] in 2012 found the number of segments with greater than 50% stenosis were 27(3.49%) and 35(4.52%) on DUS and MDCTA respectively. In respective to >50% stenosis the results of our study is comparable to that of A. **Kayhan et al**[5]in 2012**. Collins R et al**[4] in 2007 and **Met R et al**[3] in 2009 are also found CTA to be more accurate modality in assessing the presence and extent of peripheral arterial disease. The number of segments with less than 50% stenosis were 230 (23.2%) and 171 (17.2%) as detected by CDUS and CTA respectively.

In our study we also found that in comparison to colour doppler ultrasound in detecting hemodynamically significant stenosis, in the lower limb arterial systems MDCTA was significantly better statistically than colour doppler ultrasound.

In our study in comparison to colour doppler ultrasound CTA was significantly better than colour doppler ultrasound in evaluation of the morphologic features of the runoff arteries in their full length which is an important imaging finding and detection of collaterals, hence MDCT is needed before vascular intervention.

In our study we concluded that on CTA was better in assessing luminal narrowing in densely calcified arteries in all groups than CDUS. Patent lumen can be inferred when distal luminal contrast especially with using plain and contrast sequences in CTA. Hence detection of calcification was better on CTA than CDUS.

The ultrasound findings providing information on the Extent and Severity of the disease, Soft tissue plaques, Thrombosis, Segmental flow analysis, Segmental length analysis, Collateral circulation, Recanalization Pre- and post-operative flow evaluation. There are few limitations as being operator dependency, time consumption, bowel gas, edema and obesity. CT angiography on the other hand is less time consuming, minimally invasive requiring only an intravenous injection of contrast medium but also involves radiation exposure and an inherent risk of allergic reactions. Multiplanar reconstruction aids in the visualization of segment length of, better appreciation of collateral circulation and better reproduction of the arterial tree. Soft tissue plaques, early recanalization, post-op flow evaluation and co-morbid conditions (renal disease) being important limitations of CT angiography. In our study Doppler sonography was better than CT angiography in the diagnosis of early onset (Grade I & II) cases and CTA was better in detecting and diagnosing grade III and IV which was comparable to study done by **Netam SS et al**[6]. Also collaterals, delineation of arterial tree and vessel wall calcification was better detected on CTA than CDUS in our study. In our study we found that CTA is better than CDUS in diagnosing the lesions in PAD.

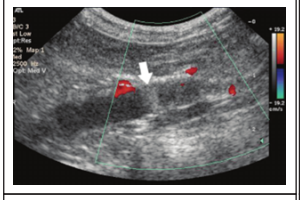


Figure 1a



Figure 1b



Figure 1c

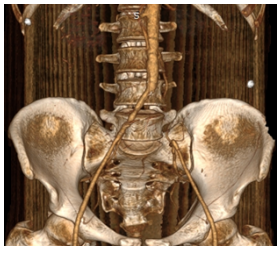


Figure 1d

Fig 1a: Colour doppler spot image shows complete block of left CIA showing absence of flow. Fig 1b: CTA Axial section at the level of bifurcation of iliac arteries showing non-opacification of left CIA s/o complete block. Fig 1c and 1d: Coronal thick MIP and VR CT angiogram image showing complete left CIA block

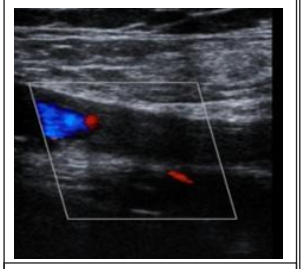


Figure 2a

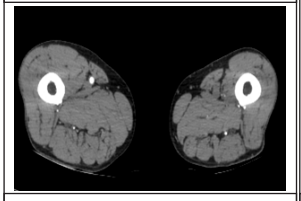


Figure 2b



Figure 2c

Fig 2a: Colour doppler spot image shows mid left SFA thrombus with absence of flow. Fig 2b: CTA axial image at mid thigh level showing non-opacification of left mid SFA with formation of collaterals. Fig 2c: CTA VR image showing long segment complete block of mid and lower left SFA with collateral formation.

TABLES

Table 1: Findings on Colour Doppler USG.

Artery	Calcification	Plaque	Thrombus	Collaterals
AORTA(n=30)	12 (40%)	10 (33.3%)	1 (3.3%)	0
CIA(n=60)	26 (43.3%)	12 (20%)	3(5%)	0
EIA(n=60)	23 (38.3%)	19(31.6%)	3(5%)	0
CFA(n=60)	43 (71.6%)	12 (20%)	4(6.6%)	0
SFA(n=60)	41 (68.3%)	22(36.6%)	12(20%)	8(13%)
POPLITEAL ARTERY(n=60)	45 (75%)	15(25%)	16(26.6%)	1 (1.6%)
ATA(n=60)	49 (81.6%)	22(36.6%)	8(13.3%)	1 (1.6%)
PTA(n=60)	46 (76.6%)	12(20%)	9(15%)	1 (1.6%)
PERONEAL ARTERY(n=60)	38 (63.3%)	16(26.6%)	8(13.3%)	2(3.3%)

Table 2: Stenosis severity grading on CDUS

ARTERY	STENOSIS SEVERITY GRADE ON CDUS				
	0	1	2	3	4
AORTA (n=30)	19 (63.3%)	7 (23%)	3 (10%)	0	1 (3.3%)
CIA(n=60)	37 (61.6%)	11 (18.3%)	7 (11.6%)	2 (3.3%)	3 (5%)
EIA(n=60)	33 (55%)	11 (18.3%)	13 (21.6%)	1 (1.6%)	2 (3.3%)
CFA(n=60)	21 (35%)	27 (45%)	8 (13.3%)	1 (1.6%)	3 (5%)
SFA(n=60)	16 (26.6%)	22 (36.6%)	9 (15%)	4 (6.6%)	9 (15%)
POPLITEAL ARTERY (n=60)	16 (26.6%)	19 (31.6%)	11 (18.3%)	7 (11.6%)	7(11.6%)
ATA(n=60)	21(35%)	19 (31.6%)	9 (15%)	5 (8.3%)	6 (10%)
PTA(n=60)	26 (43.3%)	19 (31.6%)	7 (11.6%)	6 (10%)	2 (3.3%)
PERONEAL ARTERY (n=60)	23 (38.3%)	22 (36.6%)	6 (10%)	5 (8.3%)	4 (6.6%)

Table 3: Findings on CT Angiography

Artery	Calcification	Plaque	Thrombus	Collaterals
AORTA(n=30)	18(60%)	11(36.6%)	2(6.6%)	1(3.3%)
CIA(n=60)	40(66.6%)	16(26.6%)	3(5%)	3(5%)
EIA(n=60)	48(80%)	27(45%)	3(5%)	0
CFA(n=60)	52(86.6%)	30(50%)	3(5%)	1(1.6%)
SFA(n=60)	55(91.6%)	29(48.3%)	8(13.3%)	4(6.6%)
POPLITEAL ARTERY(n=60)	56(93.3%)	21(35%)	10(16.6%)	12(20%)
ATA(n=60)	57(95%)	22(36.6%)	13(21.6%)	13(21.6%)

PTA(n=60)	55(91.6%)	15(25%)	11(18.3%)	11(18.3%)
PERONEAL ARTERY(n=60)	56(93.3%)	20(33.3%)	10(16.6%)	9(15%)

Table 4: Stenosis severity grading on CTA

ARTERY	STENOSIS SEVERITY GRADE IN CTA				
	0	1	2	3	4
AORTA (n=30)	22 (73.3%)	3 (5%)	3 (5%)	1 (1.6%)	1 (1.6%)
CIA(n=60)	45 (75%)	5 (8.3%)	5 (8.3%)	2 (3.3%)	3 (5%)
EIA(n=60)	43 (71.6%)	6 (10%)	7 (11.6%)	2 (3.3%)	2 (3.3%)
CFA(n=60)	28 (46.6%)	20 (33.3%)	7 (11.6%)	2 (3.3%)	3 (5%)
SFA(n=60)	21 (35%)	17 (28.3%)	8 (13.3%)	5 (8.3%)	9 (15%)
POPLITEL ARTERY (n=60)	20 (33.3%)	14 (23.3%)	9 (15%)	8 (13.3%)	9 (15%)
ATA(n=60)	25 (41.6%)	15 (25%)	8 (13.3%)	6 (10%)	6 (10%)
PTA(n=60)	29 (48.3%)	17 (28.3%)	5 (8.3%)	6 (10%)	3 (5%)
PERONEAL ARTERY (n=60)	26(43.3%)	17 (28.3%)	5 (8.3%)	6 (10%)	6 (10%)

REFERENCES:

1) Rahul J. Shirol, Aathish Shetty, Chethan TK. Role of MDCT in evaluation of peripheral vascular diseases of the lower limb arteries and comparison with colour Doppler. Journal of Evolution of Medical and Dental Sciences 2015; 54:9336-46.
2) Mishra A, Bhaktarahalli JN, Ehtuish EF et al. Imaging of peripheral arteries by 16 row MDCT angiography: A feasible tool. Eur J Radiol. 2007 Mar; 61 (3):528-33.
3) Met R, Bipat S, Legemate DA et al. Diagnostic performance of computed tomography angiography in peripheral arterial disease: a systematic review and meta-analysis. JAMA 2009: 415-24.
4) Collins R, Cranny G, Burch J et al. A systematic review of duplex ultrasound, magnetic resonance angiography and computed tomography angiography for the diagnosis and assessment of symptomatic, lower limb peripheral arterial disease. Health Technol Assess. May 2007; 11(20):1-184.
5) Kayhan A, Palabiyik F, Serinsoz S et al Multidetector Angiography versus arterial doppler USG in diagnosis of mild lower extremity peripheral diseases: Is a multi-detector CT a valuable screening tool? Eur J Radiol 2012; 81(3):542-6.
6) Netam SS, Singh R, Kumar S et al. CT Angiography Evaluation of Peripheral Vascular Disease and Comparison with Color Doppler Ultrasound. Journal of Evolution of Medical and Dental Sciences 2015; 4:14504-514.