Original Article

ISSN (O): 2347-338X; ISSN (P): 2347-3371

A Comparative Efficacy of MDCT Angiography and Colour Doppler Ultrasonography in Diagnosing Peripheral Arterial Disease in the Lower Limb

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Abstract

Background: Imaging plays a crucial role in the management of patients with peripheral arterial disease. The present study compared colour Doppler ultrasonography findings with MDCT angiography in patients with peripheral arterial disease in the lower extremity. **Subjects and Methods :** 40 patients with signs and symptoms of peripheral arterial occlusive disease referred for evaluation by imaging by colour doppler ultrasonography and MDCT angiography were studied. **Results:** There was statistically significant difference in the detection of the extent of segment involvement in DFA. There is significant difference in the detection of the extent of segment involvement in popliteal artery. There is statistically extremely significant difference in the detection of the extent of segment involvement in ATA. **Conclusion:** MDCT is better than Doppler in detecting the length of stenosis in the arterial system. MDCT is better than Doppler in detecting the presence of thrombosis especially in the infra-popliteal segment. Even though MDCT is not statistically significant than Doppler in detecting the number of collateral segments , as the arterial tree is better delineated in MDCT.

Keywords: Peripheral arterial disease, MDCT, colour Doppler ultrasonography

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Received: 25 September 2020 **Revised: 05 November 2020** **Accepted: 16 November 2020** **Published: 31 December 2020**

Introduction

Peripheral arterial disease is a very important health problem in the developing world which is increasing in its incidence due to the increase in the predisposing factors.[1] Peripheral arterial disease is diffuse in nature and contributes significantly towards the morbidity and mortality in the industrialized world.[2] Peripheral arterial disease is mostly due to atheromatous narrowing or occlusion of an artery or arteries.The first manifestation of symptomatic PVD patients is often intermittent claudication, which eventually progresses to critical limb ischemia i.e rest pain and tissue necrosis.[3]

Imaging plays a crucial role in the management of patients with peripheral arterial disease. Colour Doppler ultrasonography is the initial imaging modality of choice for PVD investigation, despite its wide use; it has lower sensitivity than MDCT angiography which is considered as an upcoming modality in the evaluation of lower extremity PVD.[4]

MDCT angiography is regarded to be a promising modality in lower extremity arterial imaging. It is a reliable non-invasive tool in quantifying the length, number and grade of stenosis.[5] It mainly 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.[6] The aim of our study was to compare colour Doppler ultrasonography findings with MDCT angiography in patients with peripheral arterial disease in the lower extremity.

Subjects and Methods

The study was a comparative study done on 40 patients with signs and symptoms of peripheral arterial occlusive disease referred for evaluation by imaging by colour doppler ultrasonography and MDCT angiography to the department of Radiodiagnosis at Father Muller Medical College Hospital were included in the study. The study was done for a period of 2 years from May 2011 to May 2013. All colour Doppler ultrasonography were performed using PHILIPS HD

11 equipment and the arterial system of the lower limb were scanned with a linear phased array (5-12MHZ) transducer. The severity of the disease was then classified using the following standard criteria mentioned in the table below.

Grade	% block	Peak systolic velocity ratio
Grade 0	0%–19% stenosis;	Equal to or less than 1.5
Grade 1	20%–49% stenosis;	Greater than or equal to 1.5 but less than 2.5
Grade II	50%–74% stenosis;	Greater than or equal to 2.5
Grade III	75%–99% stenosis;	Greater than or equal to 2.5 plus an end-diastolic velocity of greater than 60 cm/sec,
Grade IV	No doppler signal	Occlusion

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 average scan time was 15 to 30 minutes for each limb.

The data collected from the patient was classified according to the level of artherosclerotic disease present by triplex imaging. In patients whom at least one stenosis was present in the lower limbs of between 50-70% were classified as having moderate disease and placed into the moderate disease group, in patients whom at least one stenosis between 70-99% were classified as having significant disease and placed into the significant group and in patients whom an occlusion were placed in the occlusive group.

The 16 slice MDCT angiography was performed following assessment by an arterial colour Doppler The scan direction was craniocaudal from the level of infrarenal aorta to the pedal arch. The 150 ml of non-ionic contrast media was injected at a rate of 4 ml/s with a pressure injector. The images were then acquired with a slice thickness of 1.25 mm and collimation of 1.00 mm with a table feed of 27mm/s and a gantry rotation period of 0.8s. The tube voltage is 140kv with mAs between 250 and 300, and the average scan time was 30 to 40 s. Images were analyzed for plaques, extent and pattern of luminal narrowing and for the collateral flow. The grading was done.

Results

[Table 1] shows that out of these 40 patients 30 (75%) were male patients and 10 (25%) were female patients.

[Table 2] shows that out of 40 patients most of the patients belonged to the age group 61-70 years 17 (43%) patients, followed by 41-50 years with 9 (22%), patients, and 6 patients (15%), each in the age groups 51-60 years (43%), and more than 70 years. Less than 40 years age group had the least number of patients with 2 patients (5%) suggesting that peripheral vascular disease is seen rarely in the younger age group.

Table 1: Gender distribution

Sex distribution		
Sex	**No of patients**	**Percentage**
Male	30	75
Female	10	25
Total	40	100

Table 2: Age distribution

Age group	No of patients	Percentage
Less Than 40	2	5
40-50	9	22
51-60	6	15
61-70	17	43
More than 70	6	15
Total	40	100

Table 3: Assessment of parameters

Clinical features	Number	P value
Gangrene	6	-
Non-smoker	16	0.021
Smokers	22	
Tobacco chewers	2	

[Table 3] shows that 6 patients had gangrene, 16 were non-smokers, 22 were smokers and 2 were tobacco chewers.

[Table 4] shows clinically palpable pulses. 1+ is diminished; 2+ is normal and 3+ is bounding respectively.

[Table 5] shows that diabetes mellitus was the most common co-morbidity associated with PVD with 10 patients followed by hypertension with 7 patients, COPD with 3 patients. IHD, TB,RA was diagnosed, 1 patient each as the associated morbidity.

[Table 7] shows that there is statistically significant difference in the detection of the extent of segment involvement in SFA.

[Table 8] shows that there was statistically significant difference in the detection of the extent of segment involvement in DFA.

Table 4: Clinically palpable pulses

	Clinically palpable pulses				
	Femoral	Popliteal	Anterior tibial	Posterior tibial	Dorsalis pedis
0	53	41	15	21	33
1+	25	28	31	29	32
2+	2	11	33	30	15
3+	0	0	1	0	0
Total	80	80	80	80	80

Table 5: Co-morbidities

Co-Morbidities	HTN	DM	IHD	COPD	ACUTE MI	TB	Rheumatoi Arthritis	Hepatitis – B
No of Present	7	10	3	2	1	1	1	1

[Table 9] shows that there was significant difference in the detection of the extent of segment involvement in popliteal artery.

[Table 10] shows that there was statistically extremely significant difference in the detection of the extent of segment involvement in ATA.

[Table 11] shows that there is statistically extremely significant difference in the detection of the extent of segment involvement in PTA.

Discussion

Peripheral vascular disease is increasing in frequency with an increase in life expectancy and increase in its co-morbid conditions like advancing age, diabetes mellitus and hypertension. This disease is associated with a lot of morbidity due to its global involvement.[7] Following cancer and heart disease, complications of atherosclerosis causing PVD is the third leading cause of death in the world. Precise diagnosis will therefore help to obtain a better understanding of the natural history of this condition and also determine a therapeutic regimen and prognosis.[8]

Doppler ultrasound, Duplex Sonography, combining high resolution imaging and doppler spectrum analysis has proved to be popular, non-invasive, accurate and cost effective means of assessing peripheral vascular disease.[9] With the emergence of MDCT in clearly delineating the extent of arterial tree involvement in a non-invasive way and giving a result comparable to the invasive cumbersome angiography, MDCT is the present modality of choice in imaging the vascular tree before any intervention. MDCT is safe, has faster acquisition and is observer independent hence reliable.[10]

In our study of comparison of colour doppler ultrasound with MDCT 40 patients with 80 limbs were evaluated for the extent of disease in the lower limb arterial system and the data was compared with the existing studies available and the following observations were made to find an agreement between colour doppler ultrasound with MDCTA.

We studied 40 patients of peripheral vascular disease, out of these 40 patients 30 (75%) were male patients and 10 (25%) were female patients.

In a study by Bergamini et al,[11] it was concluded that PVD is a disease which affects middle aged and the elderly which is comparable with our study in which out of 40 patients studied the age group involved mostly 61-70 years 43% with 17 patients and 38 patients out of 40 were either of middle or old age.

Among the smoking group the incidence and grade of claudication was more than that of non-smokers. 100% of smokers had severe claudication, grade 3 or grade 4 as per the Boyd's classification which is statistically extremely significant indicating that in smoking worsens the progression of PVD at a faster rate. In our study we concluded that as the age advances the degree of stenosis increases which is comparable with the study by, our study also showed that with advancing age the involvement of larger arteries increases which is comparable to study by Sensier et al.[12]

We found that hypertension is a common and important risk factor for vascular disorders of hypertensives at presentation; about 2-5% has intermittent claudication, with increasing prevalence with age in the different studies by Sensier et al.[12]

In the study by Joshi et al,[13] the overall rate of helical CT was better in detecting lesions of the infrapopliteal arteries. In their study they concluded that sixteen-detector row CT angiography is an accurate and reliable noninvasive alternative to conventional DSA in the assessment of aortoiliac and lower extremity arteries in patients with peripheral arterial disease.

Table 6: Doppler USG characteristics spectral wave form

Common femoral arteries	**No of patients**	**Percentage**
Monophasic	16	20
Biphasic	25	31.2
Triiphasic	37	46.2
Cant asses	2	2.5
Total	80	100
Superficial femoral artery	**No of patients**	**Percentage**
Monophasic	17	22.2
Biphasic	25	31.2
Triiphasic	21	26.2
Cant asses	17	21.2
Total	80	100
Deep femoral artery	**No of patients**	**Percentage**
Monophasic	24	30
Biphasic	34	42.5
Triiphasic	18	22.5
Cant asses	4	5
Total	80	100
Popliteal artery	**No of patients**	**Percentage**
Monophasic	26	32.5
Biphasic	29	36.2
Triiphasic	6	7.5
Cant asses	19	23.8
Total	80	100
Anterior tibial artery	**No of patients**	**Percentage**
Monophasic	33	41.2
Biphasic	23	28.8
Triiphasic	6	7.5
Cant asses	18	22.5
Total	80	100
Posterior tibial artery	**No of patients**	**Percentage**
Monophasic	39	48.8
Biphasic	19	23.8
Triiphasic	6	7.5
Cant asses	16	20
Total	80	100
Peroneal artery	**No of patients**	**Percentage**
Monophasic	36	45
Biphasic	27	33.8
Triiphasic	6	7.5
Cant asses	11	13.8
Total	80	100

Dorsalis pedis artery	No of patients	Percentage
Monophasic	38	47.5
Biphasic	15	18.8
Triiphasic	2	2.5
Cant asses	25	31.2
Total	80	100

Table 7: MDCT versus colour doppler USG extent of involved segment in the vessel as detectedby MDCT versus colour doppler USG

		SFA-MDCT				Total	Kappa	P value
		+	-	LS				
SFA-USG	+	2	0	0	0	2	0.903	< 0.001**
	-	0	52	0	0	52		
	LS	0	0	17	1	18		
		0	0	3	5	8		
Total		2	52	20	6	80		

Table 8: Extent of Involved Segment in the Vessel As Detected By MDCT Versus Colour Doppler USG DFA

		DFA-MDCT				Total	Kappa	P value
		+	-	LS	SS			
DFA-	+	4	0	0	0	4	1.000	< 0.001**
	-	0	70	0	0	70		
	LS	0	0	3	0	3		
	SS	0	0	0	3	3		
Total		4	70	3	3	80		

Table 9: Extent of Involved Segment in the Vessel As Detected By MDCT Versus Colour Doppler USG POP

		POP-MDCT				Total	Kappa	P value
		+	-	LS	SS			
POP-	+	3	0	0	0	3	0.925	< 0.001**
	-	0	53	0	0	53		
	LS	0	0	17	3	20		
	SS	0	0	0	4	4		
Total		3	53	17	7	80		

Table 10: Extent of Involved Segment in the Vessel As Detected By MDCT Versus Colour Doppler USG ATA

		ATA-MDCT				Total	Kappa	P value
		+	-	LS	SS			
ATA-	+	2s	0	0	0	2	0.913	< 0.001**
	-	0	58	0	0	58		
	LS	0	0	15	3	18		
	SS	0	0	0	2	2		
Total		2	58	15	5	80		

Table 11: Extent of Involved Segment in the Vessel As Detected By MDCT Versus Colour Doppler USG PTA

	PTA-MDCT				Total	Kappa	P value
	+	-	LS	SS			
+	1	0	0	0	1	0.922	< 0.001**
-	0	55	0	0	55		
LS	0	0	14	0	14		
SS	0	0	3	7	10		
Total	1	55	17	7	80		

In our study when colour doppler ultrasound was compared to MDCT in detecting the infra popliteal the segment blocks MDCT was better in detecting the infra popliteal the segment blocks and the length of with a p value of < 0.001 which is statistically highly significant.

In our study when colour doppler ultrasound was compared to MDCT in detecting the femoro-popliteal region in the DFA, MDCT was better in detecting the segment block, and the length of with a p value of < 0.01 which is statistically significant, but SFA though the percentage was better there was no statistically significant significance.

In our study in comparison to colour doppler ultrasound though the number of collateral circulation recognition was not statistically significant in the lower limb arterial systems MDCTA 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, hence MDCT is needed before vascular intervention.

Romano et al,[14] compared the efficacy of multidetector computed tomography angiography and duplex ultrasonography to diagnose mild peripheral arterial occlusive disease. In their study forty-three patients with 774 segments in patients with intermittent claudication and leg pain, diagnosed as mild PAOD, had undergone DUS followed by MDCTA of lower limb. MDCTA detected obstructed or stenotic lesions in 16.8% of arteries; they concluded that MDCTA could be used as a screening tool in patients with mild lower extremity PAOD as it is a non-invasive and more accurate modality when compared to DUS.

In our study we found that MDCT is better in diagnosing the lesions in PVD. Doppler is also an effective tool which can detect the lesions to a comparable extent when no intervention is planned and only medical therapy is considered.

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 we also concluded that the PSV ratio is higher before the level of stenosis and as the grade of the stenosis increases the spectral wave form pattern progressively worsens from the normal triphasic to biphasic in mild to moderate stenosis to monophasic in moderate to severe stenosis.

Conclusion

MDCT is better than Doppler in detecting the length of stenosis in the arterial system. MDCT is better than Doppler in detecting the presence of thrombosis especially in the infra-popliteal segment. Even though MDCT is not statistically significant than Doppler in detecting the number of collateral segments , as the arterial tree is better delineated in MDCT, this modality 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 and only medical therapy is considered.

References

1. Rajpal K, Nawale A, Borde A. Role of CT Angiography & Colour Flow Imaging (USG) in Evaluation of Peripheral Arterial Diseases. Int J Sci Res. 2016;5:580–591.
2. Shirol RJ, Shetty A, K CT. Role of MDCT in Evaluation of Peripheral Vascular Disease of the Lower Limb Arteries and Comparison with Colour Doppler. J Evol Med Dent Sci. 2015;4(54):9336–9346. Available from: https://dx.doi.org/10.14260/jemds/2015/1357.
3. Catalano C, Fraioli F, Laghi A, Napoli A, Bezzi M, Pediconi F, et al. Infrarenal Aortic and Lower-Extremity Arterial Disease: Diagnostic Performance of Multi–Detector Row CT Angiography. Radiology. 2004;231(2):555–563. Available from: https://dx.doi.org/10.1148/radiol.2312020920.
4. Bueno DA, Acín F, Cañibano DC, Fernandez-Casado JL, Castillo E. Diagnostic Accuracy of Contrast-Enhanced Magnetic Resonance Angiography and Duplex Ultrasound in Patients With Peripheral Vascular Disease. Vasc Endovasc Surg. 2010;44(7):576–585. Available from: https://dx.doi.org/10.1177/1538574410377018.
5. Kohler TR, Nance DR, Cramer MM, Vandenburghe N, Jr DES. Duplex scanning for diagnosis of aortoiliac and femoropopliteal disease: A prospective study. Circulation. 1987;76:1074–8209. Available from: https://doi.org/10.1161/01.cir.76.5.1074.

6. Leiner T, Kessels AGH, Nelemans PJ, Vasbinder GBC, de Haan MW, Kitslaar PEJHM, et al. Peripheral Arterial Disease: Comparison of Color Duplex US and Contrast-enhanced MR Angiography for Diagnosis. Radiology. 2005;235(2):699–708. Available from: https://dx.doi.org/10.1148/radiol.2352040089.
7. Fishman EK, Lawler LP. CT Angiography: Principles, Techniques and Study Optimization Using 16-Slice Multidetector CT with Isotropic Datasets and 3D Volume Visualization. Crit Rev Comput Tomogr. 2004;45(5-6):355–388. Available from: https://dx.doi.org/10.3109/10408370490901356.
8. Cossman DV, Ellison JE, Wagner WH, Carroll RM, Treiman RL, Foran RF, et al. Comparison of contrast arteriography to arterial mapping with color-flow duplex imaging in the lower extremities. Ann Vasc Surg. 1989;10(5):522–529. Available from: https://dx.doi.org/10.1016/0741-5214(89)90133-x.
9. Premalatha G, Shanthirani S, Deepa R, Markovitz J, Mohan V. Prevalence and risk factors of peripheral vascular disease in a selected South Indian population: the Chennai Urban Population Study. Diabetes Care. 2000;23(9):1295–1300. Available from: https://dx.doi.org/10.2337/diacare.23.9.1295.
10. Hatsukami TS, Primozich JF, Zierler RE, Harley JD, Strandness DE. Color Doppler imaging of infrainguinal arterial occlusive disease. J Vasc Surg. 1992;16(4):527–533. Available from: https://dx.doi.org/10.1016/0741-5214(92)90160-a.
11. Bergamini TM, Tatum CM, Marshall C, Hall-Disselkamp B, Richardson JD. Effect of multilevel sequential stenosis on lower extremity arterial duplex scanning. Am J Surg. 1995;169(6):564–566. Available from: https://dx.doi.org/10.1016/s0002-9610(99)80221-9.
12. Sensier Y, Hartshorne T, Thrush A, Handford H, Nydahl S, London NJM. The effect of adjacent segment disease on the accuracy of colour duplex scanning for the diagnosis of lower limb arterial disease. Eur J Vasc Endovasc Surg. 1996;12(2):238–242. Available from: https://dx.doi.org/10.1016/s1078-5884(96)80113-4.
13. Joshi A, Nimbkar V, Merchant S, Mhashelkar Y, Talekar K. Role of CT angiography in the evaluation of peripheral vasculature using MSCT‑our initial experience. Indian J Radiol Imaging. 2004;14:309–8209.
14. Romano M, Amato B, Markabaoui K, Tamburrini O, Salvatore M. Multidetector row computed tomographic angiography of abdominal aorta and lower limb arteries. A new diagnostic tool in patients with PAOD. Minerva Cardioangiol. 2004;52(1):9–17.

How to cite this article: Raj MBN, Omprakash AR. A Comparative Efficacy of MDCT Angiography and Colour Doppler Ultrasonography in Diagnosing Peripheral Arterial Disease in the Lower Limb. Asian J. Med. Radiol. Res. 2020;8(2): 118-124.

DOI: dx.doi.org/10.47009/ajmrr.2020.8.2.19

Source of Support: Nil, **Conflict of Interest:** None declared.