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MULTIDETECTOR COMPUTED TOMOGRAPHY ANGIOGRAPHY AND COLOUR DOPPLER FOR LOWER LIMBS

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Abstract

Background: Diagnostic imaging plays an important role in the evaluation of peripheral arterial disease.

Methods: A Cross-sectional observational study was done in 30 patients. Clinically suspected patients of peripheral arterial disease based on history, sign and symptoms and patients diagnosed with peripheral arterial disease on color doppler were included in our study. Both modalities were compared for detecting the occlusion and stenotic segments.

Results: A total of 476 vessel segments were imaged by both modalities. When all arterial segments were considered, MDCTA detected stenosis or occlusion lesions in 30% of arterial segments, versus 18.8% compared to DUS. MDCTA showed 9.8% (95% CI:[4.3%, 15.3%]) more lesions than DUS when all arterial segments were considered together, 11.2% (95% CI: [2.7%, 22.1%]) more lesions when only the iliac arteries were compared, 9.1% (95% CI: [3.2%, 17.2%]) more lesions when only the femoropopliteal arteries were compared, 8.9% (95% CI: [1.5%, 16.3%]) more lesions when only infrapopliteal arteries were compared and 13% (95% CI: [2.6%, 25.4%]) more lesions when only the upper limb arterial segments were compared, ($p < 0.05$ for all comparisons).

Conclusions: MDCTA may be used as a screening tool in patients with peripheral arterial disease as it is a non-invasive and more accurate modality when compared to DUS and plays important role in management.

Keywords: Diagnostic imaging, Doppler ultrasound, Multidetector computed tomography angiography, Peripheral arterial disease

INTRODUCTION

The term-peripheral artery disease is recommended to describe disease that affects the lower or upper-extremity arteries [1]. Peripheral artery disease is a common condition affecting 12-20% of people older than 60 years of age [2]. PAD is defined as a clinical disorder in which there is a stenosis or occlusion of aorta or arteries of the limbs. The disorder affects lower limbs eight times more than upper limbs [3]. Multilevel disease and bilateral involvement are common [4]. The disease may manifest as claudication, rest pain, ulceration, gangrene of limb [5]. Critical limb ischemia is mainly due to multi-segment plaque whereas intermittent claudication is due to single segment plaque 64]. The most common cause of PAD is atherosclerosis which is less common in younger patients. Other common causes include trauma, thrombo-embolism, acute thrombotic occlusion, micro-embolism, vasculitis

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including vasospastic disorders and Buerger's disease [7]. Imaging plays an important role in the management of PAD because it is essential to know the arterial anatomy, extent and severity of pathology. Imaging is necessary for planning interventions in patients with lower extremity PAD [8]. Those who are at highest risk for PAD are- >50 years, History of diabetes, High blood pressure, High cholesterol/lipid levels, High homocysteine levels, Obesity and Physical inactivity. Family history of vascular disease such as PAD, aneurysm, heart attack or stroke [7].

Pathologies related to PAD are atherosclerosis, diabetes, buerger's disease, athero-embolism, aneurysms, arteriovenous fistula, thoracic outlet compression syndrome, popliteal entrapment syndrome and fibromuscular dysplasia [3].

Role of doppler ultrasound

Doppler ultrasound is one of the cheapest, readily available, non-invasive technique to assess the status of peripheral arteries in symptomatic patients [9]. It has a high specificity and lower sensitivity. It is an operator dependent and time consuming, and obese patients or patients with excessive bowel gas or calcified arteries are difficult to examine [10]. Duplex US does not provide a road map equivalent to that obtained with conventional DSA, or MR or CT angiography.

Role of MDCT angiography

MDCTA is an outstanding non-invasive imaging test in the evaluation of patients with peripheral arterial disease and is currently the modality of choice in patients with intermittent claudication. It has been shown to have high diagnostic performance and reproducibility in evaluating PAD. Shorter acquisition times, thinner slices, higher spatial resolution, and improvement of MDCT scanners enable scanning of the whole vascular tree in a limited period with a decreasing amount of contrast medium [11]. It is less costly, faster and does not require team of cardiologists to perform angiography. Hence problems related to much more invasive technique like hematoma, sepsis etc. are avoided with MDCT and radiation dose given to patient is also 4 times lesser than conventional angiography. Recently, MDCT angiography has been shown to be a reliable tool in quantifying length, number, and grade of stenosis in PAD [12-14]. A decrease from 120 to 100 kVp results in a 34% reduction in radiation dose without affecting diagnostic image quality [15].

METHODS

This is a cross-sectional observational study included 30 diabetic patients who presented with diabetic foot vascular lesions in the Department of Radio Diagnosis, at Polyclinic "At Luigi

Monti" in Tirana, Albania during the year 2018. Clinically suspected patients of peripheral arterial disease based on history, sign and symptoms and patients diagnosed with PAD on color doppler were included in our study. Patients who had history of allergy to intravenous contrast agents, deranged kidney function tests and, pregnant women were excluded from our study.

RESULTS

A total of 30 cases suspected of having peripheral arterial disease on the basis of clinical profile, prior imaging profile underwent CT examination. The cases encountered in our study were in the age range of 27-76 years (Mean age-50.6). A total of 476 vessel segments were imaged by both DUS and MDCT Angiograhy in 30 patients. All arterial segments were successfully analyzed by both modalities. The number of segments with greater than 50% stenosis were 54 (11.34%) and 77 (16.17%) on DUS and MDCTA, respectively. The number of segments with occlusion were 41 (8.61%) and 65 (13.65%) by DUS and MDCTA, respectively. The total number of diseased segments found with DUS was 95 (20%) versus 142 (29.8%) identified by MDCTA.

When DUS and MDCTA are compared in identifying stenotic or occlusive lesions, MDCTA showed 9.8% (95% CI:[4.3%, 15.3%]) more lesions than DUS when all arterial segments were considered together, 11.2% (95% CI: [2.7%, 22.1%]) more lesions when only the iliac arteries were compared, 9.1% (95% CI: [3.2%, 17.2%]) more lesions when only the femoropopliteal arteries were compared, 8.9% (95% CI: [1.5%, 16.3%]) more lesions when only infrapopliteal arteries were compared and 13% (95% CI: [2.6%, 25.4%]) more lesions when only the upper limb arterial segments were compared, ($p < 0.05$ for all comparisons).

The measurement comparisons between DUS and MDCTA modalities in all arteries, iliac, femoropopliteal, infrapopliteal arteries and upper limb arteries only, are shown on (Table 1) and summarizes the McNemar test results (Table 2).

Table 1. McNemar Test Tables comparing DUS and MDCT findings of stenosis or occlusion

DUS occlusion or stenosis		MDCTA occlusion or stenosis		Total
		MDCTA-	MDCTA+	
All arterial segments	DUS-	308	73	381
	DUS+	26	69	95
	Total	334	142	476
Iliac arterial segments	DUS-	52	13	65

	DUS+	4	11	15
	Total	56	24	80
Femoro-popliteal arterial segments	DUS-	97	18	115
	DUS+	5	24	29
	Total	102	42	144
Infrapopliteal arterial segments	DUS-	121	32	153
	DUS+	15	24	39
	Total	136	56	192
Upper limb arterial segments	DUS-	38	10	48
	DUS+	2	10	12
	Total	40	30	60

Table 2: Summary of McNemar test values

Test group	McNemar's p value	MDCTA %	DUS %	Diff. %	95%CI
All arteries	0.015	29.8	20	9.8	(4.3, 5.3)
Iliac AS	0.049	30	18.8	11.2	(2.7, 22.1)
Femoro-popliteal AS	0.011	29.2	20.1	9.1	(3.2, 17.2)
Infrapopliteal AS	0.02	29.2	20.3	8.9	(1.5, 16.3)
Upper limb AS	0.039	33	20	13	(2.6, 25.5)

Discussion

Our study is comparable with many studies conducted earlier by:

Shirol et al and they found MDCTA is better than Doppler in detecting the length of stenosis, calcification and collaterals in the arterial system [7].

Netam et al performed a study of 50 patients with 550 vessels segments by colour Doppler and MDCTA and they concluded that CT angiography detected 2.7% more lesions than colour Doppler (total no. of segments with >50% stenosis were 8.7% and 11.45% by colour Doppler and CTA respectively) [16]. As regards >50% stenosis, the results of our study is comparable to that of Collins et al and Met R et al who also found CTA to be more accurate modality in assessing the presence and extent of PAD [17,18].

More number of calcified plaque are detected by CTA than Colour Doppler, as seen by Joshi et al. [19-21].

Chidambram et al in their study of 50 patients with 619 arterial segments and concluded that Doppler ultrasound overestimate the stenosis in multisegmental segments [22,23]. Peedikayil et al did a study of 29 patients with intermittent claudication and showed MDCTA (7.4%) detected more number of lesions of supra-popliteal group of vessels with total occlusion as compared to colour Doppler (6.3%) [24].

In this study we found that MDCTA is a very useful modality in detecting peripheral arterial disease of the extremities and as compared to Colour Doppler, MDCTA detected more number of disease segments, MDCTA has the advantages of being more widely available as compared to DSA which is invasive and requires more operator expertise and experience.

Conclusion

MDCT angiography is an outstanding, fast, accurate and non-invasive imaging test in the evaluation of patients with PAD. It have high diagnostic performance and reproducibility in evaluating PAD. MDCTA is able to depict whole of the arterial anatomy right from the aorto-iliac region upto distal crural vessels in lower limbs and from arch of aorta to digital vessels distally in upper limbs. It provides a complete arterial map of the limb affected and gives a bird's eye view to the surgeon before he can do any surgical intervention. The contrast and radiation dose was well tolerated by all the suitable patients and excellent image quality is obtained. MDCTA has been shown to be a reliable tool in quantifying length, number, and grade of stenosis in PAD.

Colour Doppler ultrasound though being the initial imaging modality, has certain limitations like in evaluation of aorto-iliac and femoro-popliteal arterial segments. It is an operator dependent modality with a variable learning curve and it does not provide a proper arterial map a more definite imaging modality is required especially before surgical intervention has to be offered to the patients.

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