

Original research article

Comparing the Diagnostic Efficacy of Multidetector CT Angiography with Duplex Ultrasound for the Assessment of Peripheral Arterial Disease in the Lower Extremity

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Abstract

Background: A common disorder that affects the arteries in the lower leg is peripheral arterial disease (PAD). The main contributing factor to occlusive arterial disease of the lower extremities is atherosclerosis. The care of individuals with peripheral vascular disorders includes a thorough assessment of the peripheral vasculature. In the current study, we evaluate peripheral artery disease of the lower limb using duplex ultrasound (DUS) and multidetector computed tomography angiography (MDCTA), and compare their effectiveness.

Methods: A total of 50 individuals with a clinical suspicion of peripheral artery disease of the lower leg participated in this prospective correlative longitudinal investigation. The first imaging modality used was duplex ultrasonography (DUS), which was followed by MDCT angiography. From the level of the common femoral artery to the level of the dorsalis pedis artery, the arteries were scanned. According to the degree of stenosis, the length of the stenotic segments, vessel wall calcification, and collateral circulation assessment, imaging data from DUS and MDCTA were compared.

Results: Over the course of two years, 50 patients with a mean age of 55.76 ± 12.3 years (range: 36-74 years) were assessed. With a p-value <0.001 , MDCT angiography's diagnostic accuracy outperformed Duplex Ultrasonography in both the detection of hemodynamically significant stenosis and the delineation of disease extent. With a p-value of less than 0.001, MDCTA had a higher overall diagnostic accuracy than duplex ultrasonography in the examination of popliteal, anterior, posterior, and dorsalis pedis artery stenosis or thrombosis. On MDCT angiography, the extent of vessel wall calcification and collateralization was more clearly defined. Better arterial tree delineation was achieved with image reconstruction using CT angiography, giving it an edge over DUS.

Conclusion: We find MDCTA more effectively diagnoses stenotic or obstructed arteries than DUS in patients with mild PAOD clinical symptoms. MDCTA is a non-invasive, quick, and accurate alternative to DUS.

Keywords: Peripheral arterial occlusive disease Duplex ultrasonography MDCT angiography

Introduction

The atheromatous constriction or blockage of one or more arteries in the leg is known as peripheral arterial occlusive disease (PAOD). In the industrialised world, it is a prevalent vascular condition with significant incidence rates [1, 2]. In 75% of individuals, the major presentation is stable claudication, and in the remaining patients, the disease progresses and causes clinical deterioration (severe claudication or skin lesions) [3].

Because it allows for a better overall image of the artery system and permits the simultaneous application of any necessary therapies, conventional digital subtraction angiography (DSA), also known as DSA, is regarded as the gold-standard approach in PAOD diagnosis [4]. Its invasiveness by artery puncture, the requirement for hospitalisation, the high radiation dose, and the possibility of nephrotoxicity as a result of iodinated contrast agents are its downsides. Duplex ultrasonography (DUS), computed tomography angiography (CTA), and magnetic resonance angiography (MRA) are a few imaging modalities that can be used instead of DSA [5-7].

In mildly symptomatic PAOD, duplex ultrasonography (DUS) has been employed as the initial imaging technique. DUS has a lesser sensitivity than MRA and CT angiography [9], despite its widespread usage in patients with PAOD [8]. There is dispute over using it as the only diagnostic imaging approach prior to surgery because it does not immediately offer a "roadmap" of the vascular system and because it is technically challenging to examine the aortoiliac arteries due to obstruction from bowel gas and their depth.

Fortunately, improvements in CT angiography, particularly in the multidetector row approach, allow for faster scanning of larger body volumes with resolution high enough to clearly distinguish artery input and outflow [10]. This has made multidetector row CT (MDCT) a potential technology for imaging the arteries in the lower extremities [11,12]. Recent studies have demonstrated that MDCT angiography (MDCTA) is an accurate non-invasive method for determining the length, number, and degree of stenosis in PAOD patients [13–15]. Additionally, it has been demonstrated to be a reliable diagnostic tool in patients with stenosis greater than 50% [16], and in some circumstances, it has even been suggested to take the role of DSA [16,17]. In patients with mild lower extremity PAOD, the objective of this study is to prospectively compare the performance of MDCTA and DUS as diagnostic and screening techniques.

Methods

In this prospective correlative longitudinal investigation, 50 patients who had a clinical suspicion of peripheral artery disease were added in succession. The Department of Radiology received a referral to evaluate the patients using MDCT angiography and Duplex ultrasonography. The study was carried out at Big Apollo Spectra Hospital, Patna for two years. Inclusion Criteria: Patients presenting with intermittent claudication, gangrene changes, and absent peripheral pulses.

Exclusion Criteria: Polytrauma patients with suspected acute arterial injury, pregnancy, acute or chronic renal failure, and patients with contrast allergy.

Imaging Protocol: Using Philips HD11 XE equipment and a linear phased array (5-12MHz) transducer, duplex ultrasonography of the lower leg arteries was carried out from the level of the common femoral artery till the dorsalis pedis artery. The Common Femoral Artery (CFA), Superficial Femoral Artery (SFA), Deep Femoral Artery (DFA), Popliteal Artery (PA), Anterior Tibial Artery (ATA), Posterior Tibial Artery (PTA), and Dorsalis Pedis Artery were

examined as lower limb arterial segments (DPA). Peak systolic speed, PSV ratio, and luminal diameter reduction were measured metrics (stenosis).

Then, an MDCT angiography procedure was carried out using a Philips Ingenuity 128 slices MDCT scanner. These variables were applied: A table feed of 27 mm per gantry rotation, a tube voltage of 100–120 kV, a tube current–exposure time product of 225 mAs, a collimation of 0.625, and a section thickness of 1 mm are all required. The contrast agent employed was Iohexol, which contains 350 mg of iodine per millilitre and has a high iodine content but low osmolarity. After administering the contrast medium intravenously at a flow rate of 3.5 mL/sec to create a bolus period of 31 seconds with 25 mL of saline chase at a flow rate of 4.0 mL/sec for 6 seconds using a dual-head pressure injector (Medrad), axial sections were collected. Then, for 3D reconstructions, maximum intensity (MIP), and volume renderings (VRT) images, all CTA images were transmitted to a workstation. The following specifications were noted: Luminal diameter reduction (stenosis), collateral flow, the length of stenotic segments, and wall calcifications. Stenosis on duplex ultrasonography and MDCT angiography was graded as follows:

- Grade 0: normal or no stenosis
- Grade I: Mild arterial stenosis (1-49 % stenosis)
- Grade II: Moderate arterial stenosis (50-74% stenosis)
- Grade III: Severe arterial stenosis (75-99% stenosis)
- Grade IV: 100 % or complete occlusion.

Statistical analysis: Software from IBM-SPSS Statistics 22.0 was used to analyse data from a Microsoft Excel spreadsheet. Data that was categorical was displayed as frequencies and proportions. The significant test employed was the chi-square test. Mean and standard deviation were used to depict continuous data.

Results

50 patients in all, with a mean age of 55.76 ± 12.3 years (range between 36-74 years). Five patients (or 10%) were female, whereas 45 patients (or 90%) were men. 84% of research participants had atherosclerosis, and 16% had thromboangiitis obliterans (TAO). According to the clinical presentation, 20% of the patients had gangrene, while 42% had grade 2 claudication, 46% had grade 3, and 12% had grade 4 claudication. 28% of the participants had diabetes mellitus, 62% had smoked previously, and 4% of the patients had used tobacco previously. As indicated in Table 1, MDCTA was statistically significant in detecting the length of stenotic segments when compared to Duplex ultrasonography with a p value <0.001 .

Table 1: Length of stenotic segment as detected by MDCTA VS DUPLEX USG

Stenosis Length	MDCTA VS DUS		
	Diagnostic accuracy (%)	Agreement	P value
Deep femoral artery	96	0.81	<0.001
Dorsalis pedis artery	95	0.67	<0.001
Posterior tibial artery	95	0.67	<0.001
Anterior tibial artery	95	0.67	<0.001
Common femoral artery	97	0.89	<0.001
Superficial femoral artery	97	0.89	<0.001
Peroneal artery	93	0.57	<0.001
Popliteal artery	97	0.89	<0.001

With the exception of the popliteal (79%) and peroneal (76%) arteries, duplex USG exhibited an overall diagnostic accuracy of >80% in finding collateral flow. With a higher rate of thrombosis and collateral flow detection in both supra-popliteal and infra-popliteal segments, MDCT provided a more accurate depiction of the arterial tree. Particularly in the infra-popliteal small diameter arteries, DUS performed better than MDCTA at assessing flow in the calcified arterial segments. As indicated in Table 2, MDCTA was more effective at detecting vessel wall calcification than DUS.

Table 2: Diagnostic Accuracy

Characteristics	MDCTA	DUS
Collateral flow	99%	84%
Vessel wall calcification	99%	90%
Thrombosis	97%	93%

Discussion

The prevalence of peripheral vascular disease is rising as a result of numerous risk factors, including smoking, diabetes mellitus, hypertension, and hypercholesterolemia [18]. In the current investigation, which is analogous to a study by Rosamond W et al [19], TAO (16%) was the second most prevalent cause of peripheral vascular disease (84%) after atherosclerosis (84%) in terms of prevalence. As the industry standard test for assessing peripheral vascular disease, digital subtraction angiography (DSA) is used. Recent technological developments like Duplex Ultrasonography, MDCT Angiography (MDCTA), and magnetic resonance angiography have put the role of DSA under threat (MRA). The first imaging modality of preference in cases when peripheral arterial disease is suspected is duplex ultrasonography. A few restrictions include the amount of time required, operator reliance, obesity, edema, and the examination of the distal vasculature.

The lower limb arterial tree can be accurately recreated using MDCT angiography and multiplanar reconstruction techniques, which also improve the ability to detect collateral flow. Duplex ultrasonography was effective in detecting grade I and grade II stenosis, although CT angiography was more effective in detecting grade III and grade IV stenosis.

As a promising minimally invasive method for the assessment of patients with PAOD, MDCTA is being used more frequently. The diagnostic accuracy of MDCTA for identification of >50% stenosis and occlusion in the entire leg has been investigated in earlier research using 4 and 16-row MDCTA. For >50% stenosis, the median sensitivity and specificity values were determined to be 91% and 91%, and for occlusion, 97% and 99.6% [13,20-25]. In their series using 16-row MDCTA, Laswed et al. discovered that detection of severe stenosis more than 50% had a 100% overall sensitivity and specificity. In segmental analysis, distal pedal arteries were included, and the sensitivity and specificity ranged from 91 to 100% and from 81 to 100%, respectively [26]. Because DSA was not conducted in conjunction with our study's 40-row MDCTA, sensitivity and specificity values could not be determined.

MDCTA was more effective than DUS at detecting vessel wall calcification. The results below were equivalent to those of a prior study conducted by Netam SS et al [27]. In our study, we also discovered that the PSV ratio was higher prior to the degree of stenosis and that the spectral wave form pattern gradually deteriorated from the typical triphasic to biphasic in mild to moderate stenosis to monophasic in moderate to severe stenosis as the grade of the stenosis increased. Both Duplex Ultrasonography and MDCT angiography are effective at predicting

lower limb peripheral vascular disease, but the combination provides higher diagnostic precision. The combined use of DUS and MDCT angiography for the diagnosis, grading, and preoperative evaluation of lower limb peripheral artery disease is highlighted by the current investigation and the preexisting data.

Conclusion

The detection of hemodynamically significant stenosis with duplex ultrasound was found to be almost as accurate as MDCT angiography in terms of diagnostic accuracy. Compared to duplex ultrasonography, MDCT angiography more accurately defined the length of stenotic segments and collateral flow in both supra- and infra-popliteal segments. Duplex ultrasonography is a recommended imaging modality of choice for determining the flow and severity of the disease due to its close resemblance to MDCT accuracy, wide availability, affordability, lack of need for iodinated contrast material, and non-ionizing nature.

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