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Accuracy Of Multi-Detector Computed Tomography in Assessment of Lower Limb Peripheral Arterial Diseases in Diabetic Patients

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ABSTRACT

Background: The risk of peripheral arterial disease is significantly increased among diabetic individuals, as presented through multidetector computed tomography angiography (MDCT). There are numerous benefits to choosing this path.

Objective: To evaluate the lower limb arteries by multidetector computed tomography angiography.

Patients and methods: MDCT examinations were performed on 24 diabetic patients who presented with signs and symptoms of lower limb ischemia; MDCT will be performed with PHILIPS ingenuity 128 slice CT scanner. For stenosis, occlusion, calcification, plaque structure, collaterals, transverse, maximum intensity projection, multi-planar, and volume-rendering images were used.

Results: At least 22 segments had severe stenosis, defined as luminal narrowing of more than 50% and PSV ratio of more than 2, Fifty segments were occluded, eight had no distal collateral refilling, and five had nonsignificant stenosis (luminal constriction lower than 50% of arterial diameter and PSV lower than ratio 2).

Conclusion: MDCT for evaluation of lower limb ischemia should be considered as the investigation of choice for pre-operative assessment & follow-up; being less invasive and provides angiography-like high-resolution images which are familiar to vascular surgeons.

Keywords: Multidetector computed tomography angiography, Peripheral arterial disease, Diabetic patients.

INTRODUCTION

In comparison to non-diabetic populations, the risk of arterial disease and ischemic events is much higher in diabetics who have arterial disease. The sooner a diagnosis can be made, the better [(1)]. Diabetics can have mild or moderate to severe peripheral vascular disease, depending on whether or not they can feel the dorsalis pedis and/or tibial pulses on either side of their body [(2)].

In the lower extremities, the superficial femoral artery is in the adductor canal.is the most common site of involvement in a non-diabetic patient [(2)]. Diabetic patients have a higher prevalence of arteriosclerosis of these blood vessels than non-diabetic patients [(3)].

Younger diabetics are at significantly increased risk of atherosclerosis and therefore ischemic heart disease, lower limbs ischemia, and a tendency towards cerebral thrombosis and infarction [(3)]. multidetector computed tomography angiography (MDCT). Several factors make it an attractive option, including the fact that it is non-invasive, there are shorter acquisition periods, thinner slices, and higher spatial resolution that allow scanning of the entire vascular tree in less time and with fewer contrast media. The diagnosis of PAD can be made with 98% sensitivity and 98% specificity, according to recent investigations [(4)].

The present study aimed to evaluate the lower limb arteries by multidetector computed tomography angiography.

PATIENTS AND METHODS

Twenty-four diabetic patients who presented with signs and symptoms of lower limb ischemia were included in this trial. Their ages ranged from (43) to (79) years with a mean of (66.58) years, 13 of them were males (54.17%) and 11 females (45.83%) who were referred to the Radiology Department, Faculty of

Medicine, Zagazig University Hospitals from outpatient clinics and Vascular Surgery Department.

Ethical Considerations:

The study was done after permission from the hospital's institutional review board and informed consent from patients was taken before the trial. This work has been carried out following The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Inclusion criteria: For this study, all adult diabetic patients with clinically indicated peripheral arterial insufficiency were enrolled regardless of the type of diabetes or gender.

Exclusion criteria: Patients having a history of arterial vascular trauma, those who have already undergone arterial interventions, ultrasound Doppler assessment is hindered in patients with extensive scarring or skin damage, and pregnancy.

All patients were subjected to:

All patients were subjected to a full detailed history, and clinical examination with special emphasis on the lower limb for signs of arterial insufficiency laboratory investigations (fasting blood glucose level and blood urea, serum creatinine).

Multi-Detector Computed Tomography examination:

At first, we explained the examination to the patient.

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Total immobilization of the patient during the examination is of vital importance.

Scan parameters: 128 multi-detector row CT scanner was used for the acquisition of a CT scan (PHILIPS ingenuity 128 slice CT scanner).

Patient preparation: Renal function tests, in particular, were the focus of the initial review of patient lab data.

All patients were fasting for 6– 8 hours before the examination.

It was necessary to insert a 20–22-gauge catheter into a vein in the anterior cubital foramen and administer high-flow Saline injections while the patient's arms were in the scanning position. To ensure successful vein cannulation, this was done.

Patient position: The patient's arms were resting comfortably above his head as he lay supine on the CT table in the "feet first" position.

Reference image: Anteroposterior and lateral acquisition of Scouts.

Scan:

- Examination of this Scout was planned from L1 to the soles of the feet.
- At the L1 level, a localizer section was selected. At this point in the descending aorta, we applied a zone of interest.
- When the threshold of 200 HU is crossed, the acquisition begins automatically.
- Following the injection of 150 ml of contrast media at a flow rate of 3–4 ml/s, an automatic injector injected the contrast.
- Nonionic contrast media (Omnipaque 300 mg I/ml) was employed as the contrast medium.
- A gantry rotation duration of 0.33 s and a table speed of 60 mm per rotation were used to perform helical CT with a nominal section thickness of 0.6 mm. It used 120 kV X-ray tubes with currents of 250-300 mA.
- In this case, the reconstruction of sections was done using a 1mm grid.
- Depending on the venous access, the assessment lasted anywhere from 4 to 8 minutes.
- All patients were subjected to the "late phase" acquisition in the current study's scanning methodology.

Post-processing:

- Using the right threshold level and making an effort to exclude all data from the vascular structures, we were able to construct a picture that only contained the bones.
- This image was used to subtract the bones from the original photographs, resulting in a new set of images.
- Antero-posterior views, both oblique and lateral, were used to construct three-dimensional maximum intensity projections (MIP) and volume rendering (VR) with semi-transparency.

  Based on the results of the radiology, more advanced vascular analysis software was used.

Statistical Methods

The Statistical Package of Social Services, version 20, was used to execute analyses on the data collected (SPSS). To convey the findings, tables and graphs were employed. The mean, median, standard deviation, and 95% confidence range were used to summarize the quantitative data. Qualitative data, such as the frequency and proportions, were used to illustrate the points made. Quantitative data were examined using the Student t-test (T) and the Kolmogorov-Smirnov statistic. Researchers used the Pearson Chi-Square Test and the Chi-Square for Linear Trend ($\chi 2$) to assess qualitatively independent data. Significant results were defined as those with a p-value of 0.05 or lower.

RESULTS

Twenty-four diabetic patients with a history of suspected lower-limb arterial failure were evaluated using MDCT in this investigation.

The arterial tree of lower limbs is studied in segments as follows:

Common iliac artery. External iliac artery. Common femoral artery. Superficial femoral artery. Popliteal artery. Anterior tibial artery. Posterior tibial artery, and peroneal artery.

Of these 24 patients, 54.17% were males and 45.83% were females.

Table (1): Sex distribution of patients:

Sex		
	N	%
Male	13	54.17
Female	11	45.83
Total	24	100.00

The examined cases were aged from 43 to 79 years, with an age mean of 66.125 ± 8.06.

Table (2): Age distribution of patients:

Age Groups		
	N	%
41-50 Years	1	4.17
51-60 Years	4	16.67
61-70 Years	11	45.83
71-80 Years	8	33.33
Total	24	100.00

There was a strong association between lower limb arterial-related complaints with other arterial-related diseases. 25% of patients had a history of ischemic heart disease and 37.5% had hypertension.

Table (3): Associated co-morbidities of examined patients

Co-morbidity		
	N	%
Negative	9	37.5
HTN	9	37.5
IHD	6	25.00
Total	24	100.00

During the measurement of random blood sugar samples; 18 patients (75%) had results greater than 200 mg/dL, while 6 patients (25%) have results lower than 200 mg/dL.

Table (4): DM in our patients:

Random Blood Sugar(mg/dl)	Frequency (NO.=24)	Percentage %
≥200	18	75%
<200	6	25 %

In our research, patients with foot ulcers were the most likely to seek medical attention (37.5 percent of patients). Rest discomfort and claudication were the second most common complaints.

Table (5): Symptom wise distribution of patients:

Symptoms		
	N	%
Ulcer	9	37.5
Claudication	6	25.00
Rest pain	5	20.83
Coldness	3	12.5
Color change	1	4.16
Total	24	100.00

At least 22 segments had severe stenosis, defined as luminal narrowing of more than 50% and PSV ratio of more than 2, Fifty segments were occluded, eight had no distal collateral refilling, and five had nonsignificant stenosis (luminal constriction lower than 50% of arterial diameter and PSV lower than ratio 2).

Figure (1): Pre-contrast MIP with the abdominal aorta and BIL CIA calcification.

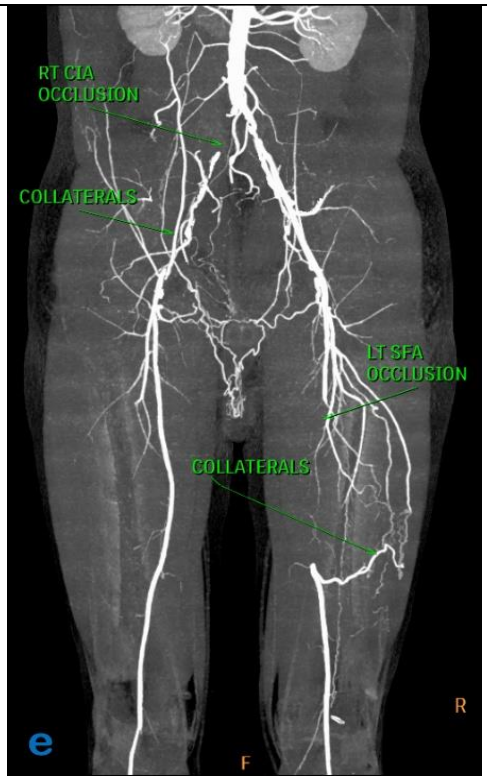

Figure (2): MIP image with RT CIA complete occlusion with collaterals and LT SFA complete occlusion with collaterals.

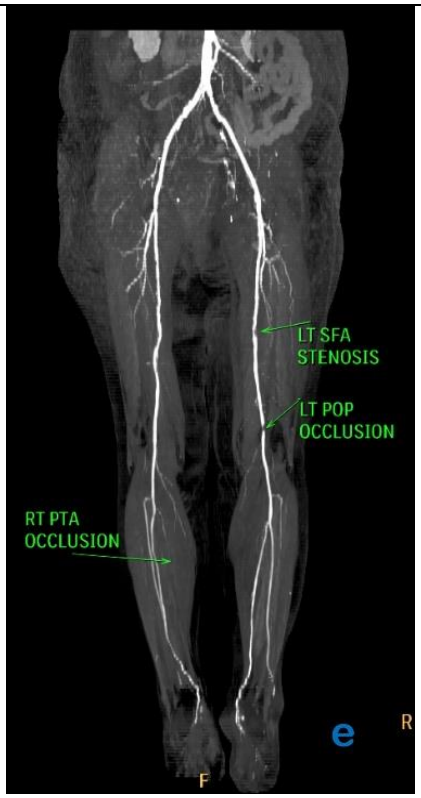

Figure (3): MIP LT SFA severe stenosis and LT POP A short segment complete occlusion.

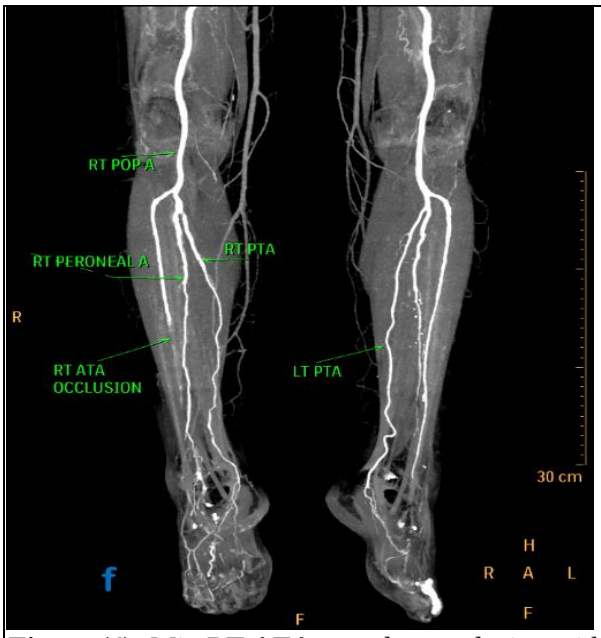

Figure (4): Mip RT ATA complete occlusion with no collaterals.

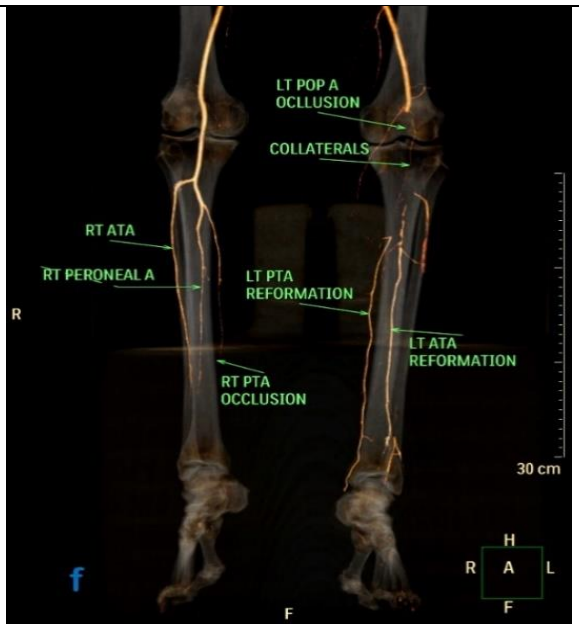

Figure (5): VR LT POP A complete occlusion with collateral and infra popliteal occlusion

The anterior tibial artery is the most affected arterial segment followed by the posterior tibial artery and the least affected is the common iliac artery.

Table (6): The affected arterial segments

Artery	by MDCT	
	Frequency	%
Common iliac	2	3%
External iliac	3	4%
Common femoral	4	5%
Superficial femoral	10	13%
Popliteal	8	10%
Anterior tibial	20	26%
Posterior tibial	19	25%
Peroneal artery	11	14%
Total	77	100%

More than one arterial segment is affected in the same patient.

Distal small arteries anterior and posterior tibial were the commonest affected occlusion was more common than Stenosis.

Table (7) Distribution of arterial segmental affection by CTA examination

Level CTA	Mild stenosis		Moderate stenosis		Severe stenosis		Occlusion		
	N	%	N	%	N	%	N	%	Total
CIA	0	0%	0	0%	1	50%	1	50%	2
EIA	0	0%	1	33%	0	0%	2	67%	3
CFA	0	0%	0	0%	1	25%	3	75%	4
SFA	1	10%	0	0%	2	20%	7	70%	10
Pop A	0	0%	1	13%	1	13%	6	75%	8
ATA	2	10%	3	15%	3	15%	12	60%	20
PTA	2	11%	3	16%	4	21%	10	53%	19
Per A	0	0%	1	9%	1	9%	9	82%	11

DISCUSSION

A rise in lower limb artery disease has been linked to diabetes, according to epidemiological studies. Lower limb arterial insufficiency is more common and more severe as diabetes progress [5].

All 24 diabetic individuals with lower limb arterial insufficiency were found to have severe lower limb arterial stenosis and/or occlusion in this investigation. 54.17 percent of diabetic arterial disease patients in the lower limbs were males, whereas 45.83 percent were females.

Gunjan Das *et al.* [6] found a similar male predominance in their prior investigation of diabetic lower limb arterial disease, in which they investigated 60 patients, 60% of whom were men and 40% of whom were women.

In **the present study,** (100%) of the patients were sort II diabetes mellitus and 75% of patients had uncontrolled hyperglycemia with a level >200 mg/dl. This is upheld by **Shahi *et al.*** [7] in an investigation of the predominance of diabetic foot ulcers and related danger elements in diabetic patients, he found that uncontrolled glucose level deferrals wound mending and results in the seriousness of ulcers and appearance of evaluation III and IV ulcers.

Our study found a clear link between diabetic arterial pathology, which affects the entire body, hypertension (37.5%), and coronary heart disease (25%).

Diabetic lower limb artery disease is strongly linked to coronary heart disease in 28% of cases, and cerebral ischemia in 33% of those instances, according to **McDermott and colleagues**[8].

The reported clinical presentation in the 24 patients incorporates ulceration in 9, irregular claudication torment in 6 patients, and rest torment in 5 patients. The clinical impacts differ with the site and the level of vascular insufficiency. This is as per the discoveries of alternate studies which demonstrated that the most well-known indication of PAD is discontinuous claudication. More compelling presentations of PAD include: rest torment, tissue misfortune, or gangrene; these appendage undermining indications of PAD are on the whole termed basic appendage ischemia. [2]

Many display formats were used in this study, including maximum intensity projection (MIP), volume rendering (VR), multiplanar reconstruction (MPR), and curved planar reformatting (CPR) techniques. Each display technique has strengthsand weaknesses.

According to **Kalra *et al.*** [9]**,** the new multidetector-row CT scanners have the greatest problem because of the "data explosion." This issue may be solved by employing 3D approaches. However, the radiologist must review the axial images. There are currently several restrictions to the MIP algorithm, one of the most common formats, which may expose the full vascular tree in a single image. To get a clear picture of the artery's true lumen, it is necessary to remove bone and dense calcifications.

Distal (below the knee) arteries were more frequently affected by diabetic lower limb arterial disease in 65% of subjects in our research. In our study, 26% of participants had severe stenosis in the anterior tibial artery; 25% had significant stenosis in the posterior tibial artery.

Anatomical characteristics and segmental distribution of diabetic lower limb artery disease have been studied previously with comparable outcomes. In a study made by **McDermott *et al.*** [8] they compared lower limb arterial disease between diabetic and non-diabetic patients by CTA and concluded that stenotic areas distribution in diabetic patients was most at the popliteal artery, anterior tibial artery, and posterior tibial artery accounting for 58% of stenotic segments.

Guo *et al.* [10] also examined 162 diabetic cases with suspected lower limb arterial insufficiency by catheter angiography and found also similar results. They found that in diabetic subjects with lower limbs.

CONCLUSION

MDCT for evaluation of lower limb ischemia should be considered as the investigation of choice for pre-operative assessment & follow-up; being less invasive and provides angiography-like high-resolution images which are familiar to vascular surgeons. MDCT angiography is considered an accurate test with a highly sensitive and specific test for the evaluation of lower limb ischemia in diabetic patients.

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Author contribution: Authors contributed equally to the study.

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