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Comparative Study between Role of Multi Slice Computed Tomography Angiography and Doppler Ultrasonography in Evaluation of Patients with Lower Limb Arterial Diseases

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ORIGINAL ARTICLE

Comparative Study Between Role of Multi Slice Computed Tomography Angiography and Doppler Ultrasonography in Evaluation of Patients With Lower Limb Arterial Diseases

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Abstract

Introduction: **Peripheral vascular disease is a leading global source of morbidity. According to epidemiological research, up to 5 % of males and 2.5 % of women who are 60 years or older may experience intermittent claudication.**

The purpose of the effort is to assess color-coded Doppler and multi-detector row CT angiography as less intrusive methods for evaluating patients with lower limb artery disease. The outcomes will be contrasted with digital subtraction angiography, the industry-recognized gold standard method.

Patients & approaches: **50 individuals with probable lower extremity artery disease participated in this investigation. It will be done in the radiology division of Cairo's Al-Hussein University Hospital.**

Patients accepted with suspected lower extremity arterial disease varied in age from 21 to 70 years old and included both sexes. Exclusion Criteria: Patients with renal impairment, those with acute limb ischemia, those who have had portions of their lower limbs amputated, etc. or those who are allergic to contrast agents. Patients with uncontrolled seizures, breastfeeding mothers, pregnant women, and those with mental illness have also been excluded.

Results: **For MSCT, the average difference between Doppler and multi-detector CT angiography was 3.3 %. Multi-detector CT angiography and Doppler revealed a mean difference of 7.3 %.**

Conclusion: **MDCT angiography exhibits better sensitivity (95.7 %) than the use of Doppler ultrasound for diagnosing lower extremity arterial disorders when conventional angiography is used as the gold standard.**

Keywords: Arterial diseases, Angiography, Doppler ultrasonography

1. Introduction

Around the world, peripheral vascular disease is a common source of morbidity. According to epidemiological research, up to 5 % of males and 2.5 % of women who are 60 years or older may experience intermittent claudication.[1]

Only digital subtraction angiography and catheter-directed conventional angiography, which were both developed less than 10 years ago, gave enough anatomical information to permit patients with peripheral vascular disease to schedule their surgeries.[2]

Yet, the potential problems and pain that come with these have led to the need for a more conservative means of examining the lower extremity artery system. A few disorders have been demonstrated to be accurately investigated by CT angiography, however Single-detector scanners could only conduct CT angiography on exceptionally small regions throughout the body due to extended gantry rotation durations and sluggish table speed. Imaging spanning cranio-caudal lengths more than 1.5 m is possible with multi-detector row CT scanners (MDCT). MDCT makes it

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feasible to image the whole artery supply in a single helical session to the lower extremities.[3]

This study's objective is to evaluate color-coded Doppler and multi-detector row CT angiography as less intrusive methods for evaluating patients with lower limb artery disease the results will be contrasted with those of digital subtraction angiography, the industry standard procedure.

2. Patient and method

50 individuals with probable lower extremities artery disease will participate in this trial. It will be done in the radiology division of Cairo's Al-Hussein University Hospital (also known as Al-Azhar University Hospital).

They will have color Doppler sonography and multi-detector row CT angiography of the lower limb arterial tree performed on them. These patients will also have traditional angiography examinations, making them comparably available for use with colour Doppler sonography and multi-detector row CT angiography.

2.1. Methods

2.1.1. MDCT angiography

A LightSpeed Plus CT scanner with four channels and many detector rows from GE Medical Systems in Milwaukee, Wisconsin will be used to acquire the CT scans.

Before surgery, a thorough history of the patient's physical condition, any comorbid conditions, current medicines, and any allergies will be recorded.

Initial revisions of the patient's laboratory results will be made with a focus on the findings of the renal function tests.

Prior to their examinations, all patients will be given the instruction to abstain from solid meals for six to 8 h. To maintain appropriate hydration, they will be urged to continue consuming enough simple fluids up to 3 h before the test.

To guarantee their compliance, patients will be instructed on how to hold their breath during examinations when necessary.

For post-processing, all pictures must be installed to the machine (GE medical systems, Advantage Windows 4.0).

2.1.2. Color Doppler sonography

The Toshiba Aplio 400 and Toshiba Aplio 500, which incorporate a real-time B-mode imaging system with capabilities for both pulsed and continuous wave Doppler as well as the availability of signal colour labelling will be used for colour Doppler sonography tests. The aorta, common, and external iliac branches will be examined with a 3.5 MHz probe. Starting at the aortic bifurcation. The infra inguinal arterial tree will be examined with a 7.5 or 5 MHz probe.

There is no need to get the patient ready.

2.1.3. Conventional angiography

All angiographic exams will be carried out utilising a PHILIPS Diagnostic 94 device equipped with digital imaging capabilities and the digital subtraction technique.- Depending on the patient's age and the outcomes of the kidney function tests, water soluble iodinated ionic or non-ionic contrast media (Urograffin or Omnipause) will be employed.

2.1.4. Angiography

As it is not available in our hospital, so we advised the patients to do it outside, d.t to consideration of being a gold standard for arterial diseases investigations.

2.1.5. Eligibility criteria

Patients accepted with probable lower extremity arterial disease varied in age from 21 to 70 years old and were accepted for both genders.

Patients with renal impairment, those who have acute limb ischemia, or those who have had portions of their lower limbs amputated are among the exclusion criteria, or those who are allergic to contrast agents. Patients with uncontrollable seizures, pregnant or nursing women, and those with mental impairments are also excluded.

The collected data's privacy will be protected.

All patients will have investigations.

All patients will get follow-up care following the trial.

2.2. Statistic evaluation

The numerical variables will be represented by the mean and standard deviation (SD). The continuous data will be analysed using the t-test and the Anova test. The threshold for statistical significance is a P value of 0.05 or less.

3. Results

50 Patients from the general surgery department who were sent to the radio diagnosis department between and were a part of this comparative research. The age range of the patients under study

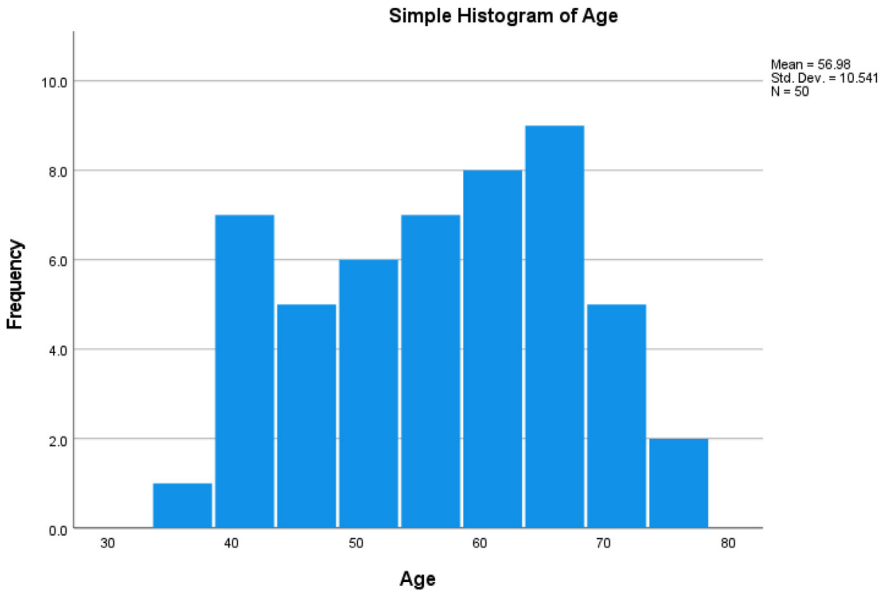

Fig. 1. Histogram of distribution of age.

was 36–76 years, with a mean of 56.98 years and a standard deviation of (± 10.5). The frequency and distribution of patient ages were displayed in the following histogram (Fig. 1).

Regarding the main complaint of the studied patients, 33 of 50 patients (66 %) complained of intermittent claudication, while 17 patients (34 %) were complained of intermittent claudication with rest pain (Fig. 2).

Regarding the site of complaint, the following (Table 1) showed the LT lower limb pain was the most dominant among patients (Fig. 3).

Regarding the morbidities of the studied patients, we found that both DM and HTN were the dominant morbidities, as 11 of 50 patients (22 %) have DM, 29 (58 %) have DM + HTN while 10 patients (20 %) have HTN (Table 2).

The extent of artery patency.

According to the degree of diameter reduction, the patency of the lower leg arteries was categorized as follows:

0 indicates a normal value.

1 denotes mild constriction (diameter decrease of 1–49 %).

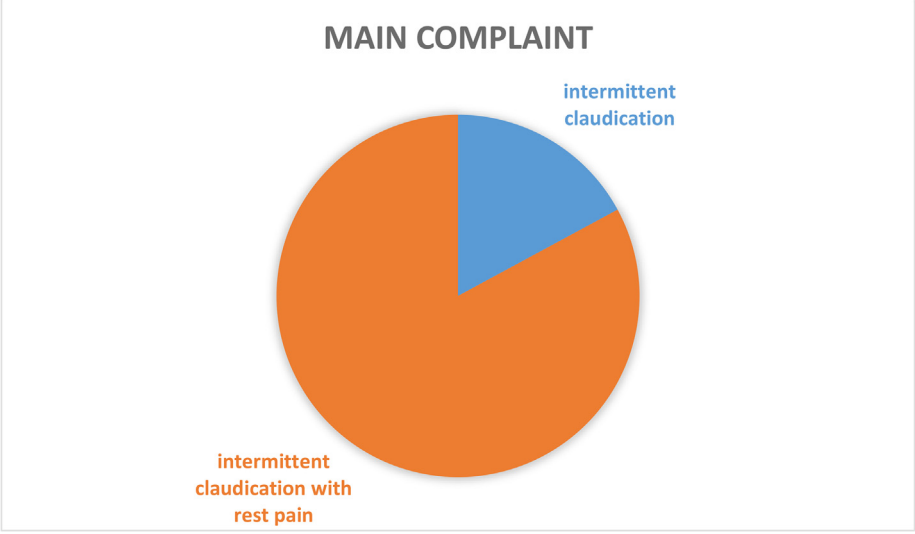

Fig. 2. Pie chart of main complaint of the patients.

Table 1. Descriptive analysis of Site of complaint.

	Frequency	Percent
Valid		
RT Lower Limb	7	14.0
LT Lower Limb	22	44.0
Both Lower Limbs' more on RT side'	11	22.0
Both Lower Limbs 'more on LT side'	5	10.0
Abdominal Pain	5	10.0
Total	50	100.0

Table 2. Descriptive analysis of morbidities.

	Frequency	Percent
Valid		
DM	11	22.0
DM + HTN	29	58.0
HTN	10	20.0
Total	50	100.0

Table 3. Distribution of stenosis detection severity.

	MSCT	Doppler	Angiography
Normal	9 (18 %)	9 (18 %)	9 (18 %)
Mild stenosis	3 (6 %)	3 (6 %)	NAD
Moderate stenosis	25 (50 %)	25 (50 %)	24 (48 %)
Severe stenosis	8 (16 %)	9 (18 %)	11 (22 %)
Occluded	5 (10 %)	4 (8 %)	6 (12 %)
Total	50 (100 %)	50 (100 %)	50 (100 %)

2 indicates moderate constriction (diameter decrease of 50–74 %).

3 = Severe constriction (diameter decrease of 75 %–99 %).

4 = Occlusion.

1- The Common Iliac Artery (Table 3) displays the results for the common iliac arteries (Fig. 4). Doppler and MSCT were not as accurate as conventional angiography in detecting severe stenosis and occlusion in CIA. However, Doppler was more effective than MSCT at detecting severe stenosis.

For MSCT, the average difference between multi-detector CT angiography and Doppler was 3.3 %.

3.1. Femoral artery

The results of femoral artery are shown in (Table 4, Fig. 5). In identifying severe stenosis and occlusion in the femoral artery, conventional angiography was comparable to doppler and MSCT. However, MSCT was more effective than doppler in detecting mild stenosis.

The average discrepancy between Doppler and multi-detector CT angiography for MSCT was 7.3 %. In this study, the sensitivity of MDCT angiography was 98.7 %, suggesting great sensitivity with no change from the gold standard of conventional angiography; however, the sensitivity of colour coded Doppler was 96.2 %, which is regarded as being fairly low in contrast to the CT angiography. Statistically speaking, this distinction is meaningless. The overall results demonstrate that CT

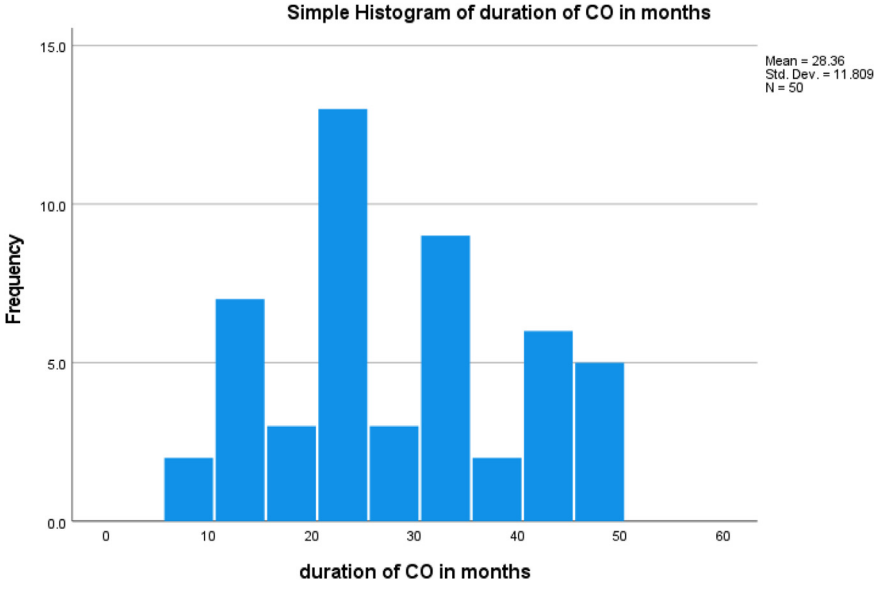

Fig. 3. Histogram showed the duration of complaint.

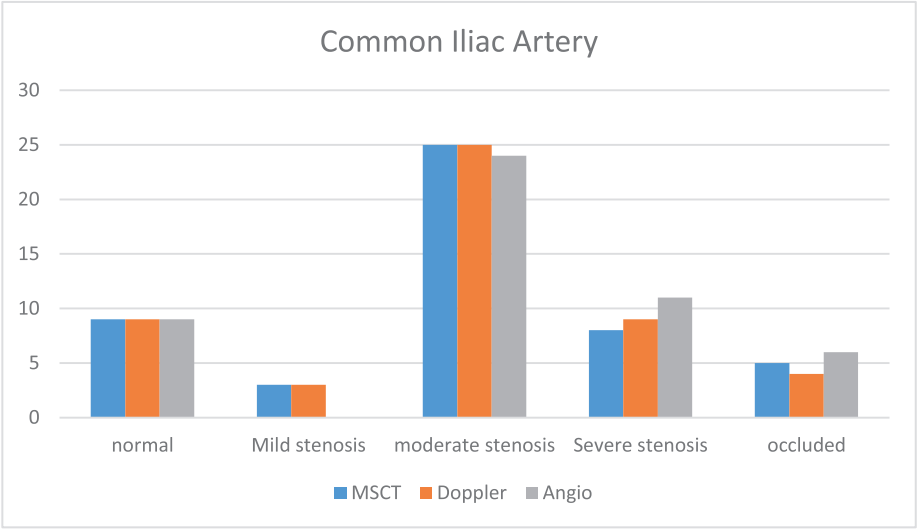

Fig. 4. The distribution of different modalities in assessment of CIA.

Table 4. Distribution of detection of degree of stenosis.

	MSCT	Doppler	Angiography
Normal	8 (16 %)	7 (14 %)	21 (42 %)
Mild stenosis	4 (8 %)	5 (10 %)	NAD
Moderate stenosis	31 (62 %)	25 (50 %)	16 (32 %)
Severe stenosis	3 (6 %)	9 (18 %)	9 (18 %)
Occluded	4 (8 %)	4 (8 %)	4 (8 %)
Total	50 (100 %)	50 (100 %)	50 (100 %)

conventional angiography is still the industry gold standard and that CT angiography just slightly behind colour Doppler in this regard.

4. Discussion

The most effective method for determining the extent of lower leg artery disease is digital subtraction angiography. High spatial resolution pictures and time data on the vascular vasculature's delayed filling are two of DSA's main benefits. Noninvasive imaging methods, however, were created as a result of the procedure's invasiveness and radiation exposure.[4] The benefits of CT angiography include the fact that it is less invasive, only requiring an intravenous injection of contrast material, and that it can image the nearby soft tissues. Asymmetrical

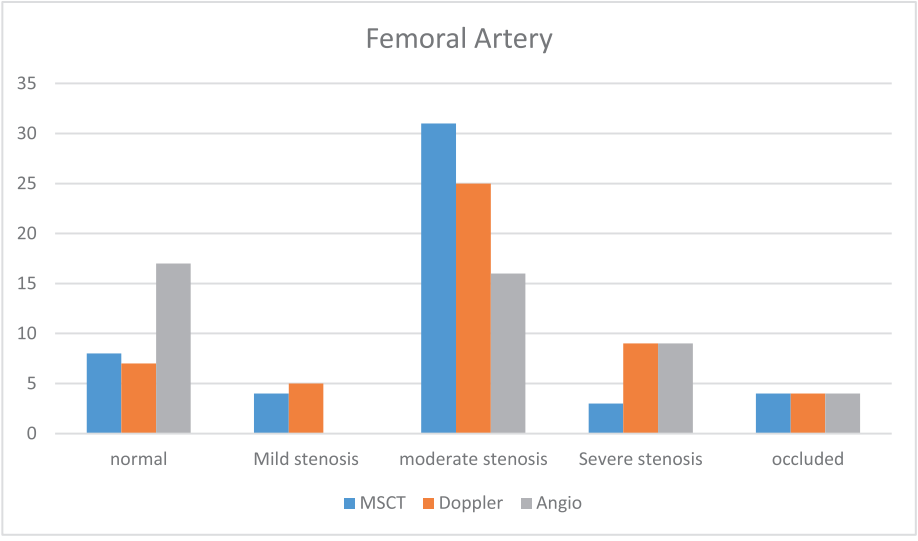

Fig. 5. The distribution of different modalities in assessment of CIA.

stenosis are easier to see with multiplanar reconstruction, and collateral blood flow is obvious.[5]

Prior to the development of MDCT, only a single IV contrast material injection over a short cranio-caudal distance could be used to produce CT angiography. It was competent for imaging the majority of systemic arteries but insufficient for studying the arterial input and outflow of the lower extremities. This restriction has been removed by MDCT, which use four channels of simultaneous acquisition. Shorter collection times, reduced contrast medium dosages, and enhanced spatial resolution provided by MDCT have significantly improved CT angiography.[6]

In 2003, two studies comparing digital subtraction angiography with multi-detector row CT angiography for peripheral vascular disease were published. Ofer *et al*. performed four-channel multi-detector row CT angiography on 18 patients with peripheral vascular disease from the level of the superior mesenteric artery to the level of the pedal arteries In 91.95 % of the instances that required treatment, the study found that digital subtraction angiography was accurate. When compared to digital subtraction angiography, CT angiography produced lesions that needed treatment with a sensitivity of 90.9 % and a specificity of 92.4 %.[7]

41 individuals with probable aortoiliac occlusive disease and ischemic legs were included in the Martin *et al*. research from 2003. They carried out digital subtraction angiography and four-channel multi-detector row CT angiography. Multi-detector row CT angiography has an 88.6 % sensitivity rate and a 97.7 % specificity rate for detecting artery occlusion, respectively, for stenosis higher than 75 %, the sensitivity and specificity were 92.2 % and 96.8 %, respectively. In 97.7 %,[8] there was a lot of inter-technique agreement.

Similar procedures were used in our investigation, which produced the following outcomes. For MSCT, the average difference was 3.3 % between multi-detector CT angiography and Doppler. Multi-detector CT angiography and Doppler revealed a mean difference of 7.3 %.

Surface shaded display, maximum intensity projection, reorganisation, and, most recently, volume rendering have all created as display formats that can be employed.[9]

The real lumen of the arteries is obscured by bones and thick calcifications, which must be removed from the projections made. It is challenging to create MIP pictures with a strong diagnostic value when there are thick calcified plaques present, especially in the distal arteries. The procedure of removing these calcifications may lead to a diagnostic mistake whereas the ongoing calcification of the artery wall may lead to a misleading diagnostic of patency, of high-grade stenosis or occlusion.[10]

The renal and internal iliac arteries are where arterial stenosis is most commonly underestimated or overestimated on CT angiograms in patients with suspected occlusive illness, according to a 2003 study by Willman *et al*.[11]

In situations of stent installation and thick calcifications, axial images should also be evaluated alongside the MIP images in order to distinguish the lumen from the stent or from calcified plaques.[12]

Visser *et al*. did a study in 2003 on the economics aims for MDCT angiography in the evaluation of patients with intermittent cramping in the US. Their study aimed to define the goal values for diagnostic accuracy in order to cost-effectively compare MDCT angiography to gadolinium-enhanced MR angiography. These factors included the cost of MDCT angiography in the work-up of patients with intermittent pain, the sensitivity for detecting substantial stenosis, and the proportion of cases requiring extra work-up with digital subtraction angiography due to unclear findings. In evaluating these individuals, they came to the conclusion that MDCT angiography had the potential to be economical.[13] as compared to the imaging techniques that are currently used in the USA, such as MR angiography.

Regarding assessing abdominal aortic artery aneurysmal dilatation, CT angiography may eventually take the position of traditional angiography in assessing the aorta and its branches, although there have not been enough prospective studies to compare the two. Spiral CT is already widely used in the assessment of aortic aneurysmal disease. By clarifying the connection between the aneurysm and the renal arteries as well as the mesenteric vessels, which is important for preoperative planning, MDCT angiography furthers this. The connection between the aortic site of dissection and branching vessels is obviously shown by scanners that can now examine the whole aortic artery and lower limbs with just one contrast material injection.[14]

Research on the X-ray dosage which the patient absorbs the investigation of CT angiography was carried out by Rubin *et al*. in 2001. They claimed that while the radiation dosage received during MSCT is greater than the amount received during a regular abdominal CT scan, it is far lower than the dose received during traditional angiography. Therefore, MDCT angiography had a radiation dose that was 3.9 times lower than traditional angiography.[15]

Doppler is most frequently used to examine patients who have lower limb ischemia symptoms in order to identify whether they might benefit from

angioplasty or a bypass graft. According to the ultrasound results, the breadth and severity of the illness may be determined, allowing any following angiogram to be arranged as either a quick mapping test before bypass grafting or a longer angioplasty operation.[16]

The prohibition of food will make the blow flow of the spleen blood flow in the basal fasting rather than dynamic postprandial, which will improve Doppler ultrasonographic scanning of the aortoiliac vessels.[17] Fasting will also make the splanchnic blood flow more visible of the aorta and its branches.

4.1. Conclusion

When conventional angiography is utilised as the gold standard, MDCT angiography shows superior sensitivity (95.7 %) than Doppler ultrasonography for the assessment of lower limb artery disease.

Ethical council

Al-Azhar University's Ethical Committee will be consulted for approval before this investigation may begin.

Patient approval

All patients who are involved will provide their informed permission.

Conflicts of interest

None declared.

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