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Diagnostic Value Of CTA And MRA In Peripheral Artery Disease.

Nouraldin Alhag Musa Mukhtar[1],Bushra Hussein Ahmed[2],Hussein Ahmed Hassan[2],Asma Ebrahim Mohammed [1],*Caroline Edward Ayad[1]
[1](Sudan University of Science and Technology –Khartoum-Sudan)
[2](Hail University –Saudi Arabia)
Corresponding Author: Caroline Edward Ayad

Abstract : *Computerized Tomography Angiography (CTA) and Magnetic Resonance Angiography (MRA) have both now evolved into noninvasive techniques for imaging the lower limb vasculature.*
The purpose of the current study was to evaluate the diagnostic value of MRA at 1.5 T versus CTA for evaluation of lower extremity peripheral arterial disease (PAD). In this study, cases were maintained at King Fahad Hospital during the period from 2014-2017.

100 consecutive patients (52 were males, 48 were females) were enrolled. Their ages ranged between 34–83 years old, average age was 62.3 years with clinically suspected lower extremity PAD underwent MRA and CTA under the standard protocol of examinations. The diagnosis was compared in both modalities by two radiologists with 8 and 10 years of experience. In the evaluation of those diagnostic tests; the study of agreement for their results was obtained. The selected arteries to be evaluated were: common iliac artery, external iliac, internal iliac, femoral, femoral profound, popliteal, anterior tibial, posterior tibial, peroneal artery and distal abdominal aorta.

The results showed the consistency in the findings between the CTA and MRA in the selected arteries were as follows: Common Iliac Artery was found to be normal in 96 /100 patients, 2 arteries were affected with aneurysm. External iliac artery was normal in 95 cases and 2 with aneurysm. Internal iliac artery was normal in 94 cases and 4 with aneurysm. Femoral artery was normal in 98 cases and 5 were affected by aneurysm. Femoral profound artery was normal in 90 cases and 2 with aneurysm. Popliteal artery was normal in 86 cases, and aneurysm was found in 3 cases. Anterior tibial artery was normal in 84 cases, aneurysm in 3 cases. Posterior tibial artery was normal in 82 cases and aneurysm in 4 cases. Peroneal tibial artery was normal in 79 patients, 3 were affected with aneurysm. Most of the cases diagnosed as stenosis in CTA was found to be totally occluded in MRA .The distal abdominal aorta was found to be normal in all patients100%.

There are no significant differences in the results found in the CTA and MRA in the diagnosis of the selected arteries. All the occluded cases were well diagnosed by MRA. Interpretation of MRA and CTA for PAD has an excellent agreement, with significant correlation between the two modalities at p=0.000 in the diagnosis of the normal arteries, aneurysm stenosis and occlusion in the selected peripheral arteries. The results support the increasing use of both MRA and CTA in the diagnostic imaging of patients with PAD
Keywords - *PAD, CTA, MRA, Occlusive disease*

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I. Introduction

Peripheral arterial disease (PAD) is an expression of atherosclerosis in the lower limb distal to the aortic bifurcation, which is a major problem in the population of 55 years and older .[1](PAD) is characterized by atheromatous narrowing or occlusion of one or more of the arteries of the leg. Symptoms include intermittent claudication , ischaemic rest pain, ulceration and gangrene [2]

Diagnostic imaging development is performed when PAD becomes lifestyle limiting. Severity of stenoses shows significant variation that carries the medical decision-making [3,4]. Digital subtraction angiography (DSA) has traditionally been used for anatomic assessment of PAD it provides a precise road map for planning treatment,but due to its invasiveness, DSA is associated with a risk of morbidity and mortality [5].Therefore, non-invasive imaging tests including duplex ultrasound (DUS), multi-detector computed tomographic angiography (CTA), and contrast-enhanced magnetic resonance angiography (MRA) are increasingly used for the initial evaluation of patients with PAD.

MRA became available for non-invasive imaging of the peripheral arteries in the early nineties [6,7]. Then, the introduction of contrast-enhanced MRA offered the widespread usage for imaging peripheral arterial disease [8,9]. Disadvantages of MRA include the higher cost ,and also contraindications like having a pacemaker and being claustrophobic [10]

More recently, in the late nineties multi-detector row CT scanners have been introduced for the non-invasive diagnostic imaging of PAD. The use of multi-detector row technology has resulted in shorter acquisition time, increased volume coverage, lower dose of contrast medium, and improved spatial resolution [11]. Results of several studies have shown that multi-detector row CTA is accurate for imaging peripheral arteries [12-15]. The main disadvantages of CTA is the use of radiation ,[16] the use of nephrotoxic iodinated contrast medium, the time-consuming reconstruction techniques, and the difficulty in assessing arterial luminal stenosis in the presence of vessel wall calcifications .[17,18] as well, several disadvantages compared with magnetic resonance angiography (MRA), including uncertainties in contrast bolus timing which may result in images obtained too early with poor arterial opacification or too late ,poor opacification and venous contamination.For this reason, time-resolved MRA may be a better examination for evaluating peripheral arteries below-the-knee overflow.[19]

This research was carried out to examine the evidence on effectiveness regarding the value of magnetic resonance angiography and computed tomographic angiography,as well to identify which technique is more acceptable to patients for the assessment of symptomatic peripheral arterial disease. The scientific base of diagnostic performance of CTA or MRA in diagnosing of peripheral artery disease were highlighted and the current study was intended to serve ready source of information and to determine the protocols for physician about the most suitable method of diagnosing peripheral artery diseases.

II. Materials And Methods

In this study, cases were maintained at King Fahad Hospital regarding the diagnostic of MRA magnetic resonance angiography for lower extremity peripheral arterial disease; in comparison to CT angiography.The purpose of the current study is to evaluate the diagnostic performance Magnetic Resonance Angiography at 1.5 T versus CT angiography for evaluation of lower extremity Peripheral Arterial Disease (PAD).

100 consecutive patients (52 males, 48 were females, age range 34–83 years, average age 62.3 years) with clinically suspected lower extremity PAD underwent MRA and CTA. The diagnosis was compared in both modalities by two radiologists with 10 and 8 years' experience.

Patients

Main symptoms of the patients were limb pain and claudication, with an average duration of 11.5 months. Mean Creatinine level was from 41 to 228 μmol/ with an average of 76.3 μmol/L. Main pertinent medical history was smoking (n = 30), diabetes (n = 45), hypertension (n = 25). Permission was obtained from all patients before the examinations. MRA and CTA examinations were performed on the same day. MRA was performed prior to CTA in 70 cases and after CTA in 30 cases.

Magnetic Resonance Angiography-(MRA)-:

All MRA examinations were performed on a 1.5 T whole-body MR system GE. Patients were placed on the scanner in feet-first supine position. A dedicated peripheral coil and two eight-element body array coils were used to cover the lower extremity and lower abdomen, and were combined with the posterior integrated multi-channel spine coil. Electrocardiographic triggering was used to ensure proper synchronization between the arterial inflow events and data sampling. Initially a scout image was performed of the whole lower extremity and abdomen for localization purposes using the following parameters: TR/TE, 2.56/1.44 ms; FOV, 48 cm × 149 cm; slice thickness, 5 mm. MRA was performed in the transverse plane with the following parameters: TR = 1 heart beat; TE = 1.68 ms; flip angle, 90, or reduced according to SAR limitation; bandwidth, 700Hz; FOV, 400 mm × 260 mm; matrix, 400 × 261; number of slices, 40; slice thickness, 3 mm. The data acquisition was performed in approximately 6.5 min, given an average heart rate of 80/min. Coronal Maximum Intensity Projection (MIP) images of each station were generated by the scanner software, and all the MIP images were automatically spliced into a composite image including the entire region of interest.

Computerized Angiography- (CTA)-:

All CTA examinations were performed at a 128-row CT scanner (Discovery HD 750, GE medical, America), with the following parameters: tube voltage, 100 Kv; tube current, 150 mA; pitch, 0.984:1; table speed, 55 mm/s; slice thickness, 0.625 mm; FOV, 50 cm. Iodinated contrast agent (Ultravist, Bayer, Germany, 1.2 ml/kg body weight) was administered via an electronic power injector (Stellant, MEDRAD, America) through an 18 gauge intravenous line placed in the right cubital vein, at a rate of 3 ml/s. The bolus-tracking technique was used whereby a region of interest (ROI) was positioned at the aortic bifurcation. Image acquisition automatically started 5.5 s after the attenuation in the ROI reached the predefined threshold of 120 Hounsfield Units (HU).Post-processing procedures and measurement were performed on a dedicated General Electric MRI machine. CTA MIP images were reconstructed with a window setting of 600/300 (window width/window level).

III. Results

Table 1 : Cross tabulation between the diagnosis /findings of Common Iliac Artery in Both MRA and CTA

Common iliac artery * MRA -Common iliac artery Cross tabulation							
P-value = 0.000			MRA -Common iliac artery				Total
			Normal	Aneurysm	Stenosis	occlusion	
Common iliac artery	Normal	Count	96	0	0	0	96
		%	96.0%	0.0%	0.0%	0.0%	96.0%
	Aneurysm	Count	0	2	0	0	2
		%	0.0%	2.0%	0.0%	0.0%	2.0%
	Stenosis	Count	0	0	1	1	2
		%	0.0%	0.0%	1.0%	1.0%	2.0%
Total		Count	96	2	1	1	100
		%	96.0%	2.0%	1.0%	1.0%	100.0%

Table 2 : Cross Tabulation Between The Diagnosis /Findings Of External Iliac Artery In Both MRA And CTA

External iliac artery * MRA -External iliac artery Cross tabulation							
P-value = 0.000			MRA -External iliac artery				Total
			Normal	Aneurysm	Stenosis	occlusion	
External iliac artery	Normal	Count	95	0	0	0	95
		%	95.0%	0.0%	0.0%	0.0%	95.0%
	Aneurysm	Count	0	2	0	0	2
		%	0.0%	2.0%	0.0%	0.0%	2.0%
	Stenosis	Count	0	0	1	2	3
		%	0.0%	0.0%	1.0%	2.0%	3.0%
Total		Count	95	2	1	2	100
		%	95.0%	2.0%	1.0%	2.0%	100.0%

Table 3 : Cross tabulation between the diagnosis /findings of Internal iliac artery in Both MRA and CTA

Internal iliac artery * MRA -Internal iliac artery Cross tabulation						
P-value = 0.000			MRA -Internal iliac artery			Total
			Normal	Aneurysm	Stenosis	
Internal iliac artery	Normal	Count	94	0	0	94
		% of Total	94.0%	0.0%	0.0%	94.0%
	Aneurysm	Count	0	4	0	4
		% of Total	0.0%	4.0%	0.0%	4.0%
	Stenosis	Count	0	0	2	2
		% of Total	0.0%	0.0%	2.0%	2.0%
Total		Count	94	4	2	100
		% of Total	94.0%	4.0%	2.0%	100.0%

Table 4 : Cross tabulation between the diagnosis /findings of Femoral artery in Both MRA and CTA

Femoral artery * MRA -Femoral artery Cross tabulation							
P-value = 0.000			MRA -Femoral artery				Total
			Normal	Aneurysm	Stenosis	occlusion	
Femoral artery	Normal	Count	89	0	0	0	89
		%	89.0%	0.0%	0.0%	0.0%	89.0%
	Aneurysm	Count	0	5	0	0	5
		%	0.0%	5.0%	0.0%	0.0%	5.0%
	Stenosis	Count	0	0	3	3	6
		%	0.0%	0.0%	3.0%	3.0%	6.0%
Total		Count	89	5	3	3	100
		%	89.0%	5.0%	3.0%	3.0%	100.0%

Table 5 : Cross tabulation between the diagnosis /findings of Femoral Profound artery in Both MRA and CTA

Femoral profound artery * MRA -Femoral profound artery Cross tabulation							
P-value = 0.000			MRA -Femoral profound artery				Total
			Normal	Aneurysm	Stenosis	occlusion	
Femoral profound artery	Normal	Count	90	0	0	0	90
		%	90.0%	0.0%	0.0%	0.0%	90.0%
	Aneurysm	Count	0	2	0	0	2
		%	0.0%	2.0%	0.0%	0.0%	2.0%
	Stenosis	Count	0	0	3	5	8
		%	0.0%	0.0%	3.0%	5.0%	8.0%
Total		Count	90	2	3	5	100
		%	90.0%	2.0%	3.0%	5.0%	100.0%

Table 6 : Cross tabulation between the diagnosis /findings of popliteal artery in Both MRA and CTA

Popliteal artery * MRA -Popliteal artery Cross tabulation							
P-value = 0.000			MRA -Popliteal artery				Total
			Normal	Aneurysm	Stenosis	occlusion	
Popliteal artery	Normal	Count	86	0	0	0	86
		%	86.0%	0.0%	0.0%	0.0%	86.0%
	Aneurysm	Count	0	3	0	0	3
		%	0.0%	3.0%	0.0%	0.0%	3.0%
	Stenosis	Count	0	0	5	6	11
		%	0.0%	0.0%	5.0%	6.0%	11.0%
Total		Count	86	3	5	6	100
		%	86.0%	3.0%	5.0%	6.0%	100.0%

Table 7 : Cross tabulation between the diagnosis /findings of anterior tibial artery in Both MRA and CTA

Anterior tibial artery * MRA -Anterior tibial artery Cross tabulation							
P-value = 0.000			MRA -Anterior tibial artery				Total
			Normal	Aneurysm	Stenosis	occlusion	
Anterior tibial artery	Normal	Count	84	3	9	0	96
		%	84.0%	3.0%	9.0%	0.0%	96.0%
	Stenosis	Count	0	0	1	3	4
		%	0.0%	0.0%	1.0%	3.0%	4.0%
Total		Count	84	3	10	3	100
		%	84.0%	3.0%	10.0%	3.0%	100.0%

Table 8 : Cross tabulation between the diagnosis /findings of posterior tibial artery in Both MRA and CTA

Posterior tibial artery * MRA -Posterior tibial artery Cross tabulation							
P-value = 0.000			MRA -Posterior tibial artery				Total
			Normal	Aneurysm	Stenosis	occlusion	
Posterior tibial artery	Normal	Count	82	4	10	1	97
		%	82.0%	4.0%	10.0%	1.0%	97.0%
	Stenosis	Count	0	0	0	3	3
		%	0.0%	0.0%	0.0%	3.0%	3.0%
Total		Count	82	4	10	4	100
		%	82.0%	4.0%	10.0%	4.0%	100.0%

Table 9 : Cross tabulation between the diagnosis /findings of peroneal tibial artery in Both MRA and CTA

Peroneal artery * MRA -Peroneal artery Cross tabulation							
P-value = 0.000			MRA -Peroneal artery				Total
			Normal	Aneurysm	Stenosis	occlusion	
Peroneal artery	Normal	Count	79	3	10	0	92
		%	79.0%	3.0%	10.0%	0.0%	92.0%
	Stenosis	Count	0	0	0	8	8
		%	0.0%	0.0%	0.0%	8.0%	8.0%
Total		Count	79	3	10	8	100
		%	79.0%	3.0%	10.0%	8.0%	100.0%

Table 10 : Cross tabulation between the diagnosis /findings of Distal abdominal aorta in Both MRA and CTA

P-value = 0.000			MRA -Distal abdominal aorta	Total
			Normal	
Distal abdominal aorta	Normal	Count	100	100
		%	100.0%	100.0%
Total		Count	100	100
		%	100.0%	100.0%

IV. Discussion

Lower-extremity peripheral CTA and MRA are increasingly used as non invasive techniques to evaluate patients with peripheral arterial disease.MRA have gained widespread use for imaging peripheral arterial disease [20, 21, 22]. Disadvantages of MRA include the limited spatial resolution [23].The recently introduced multi-detector row CT scanners has resulted in shorter acquisition time, increased volume coverage, and improved spatial resolution [24,25]. Results of several studies have shown that multi-detector row CTA is accurate for imaging peripheral arteries [26-31]. It is therefore increasingly important for all vascular specialists to become familiar with the strengths and limitations of these techniques and which one is suitable in diagnosis of each artery. In the evaluation of those diagnostic tests the study of agreement for their results were obtained. The selected arteries to be evaluated were: common iliac artery, external iliac, internal iliac, femoral, femoral profound, popliteal, anterior tibial, posterior tibial, peroneal artery and distal abdominal aorta.

Table (1) cross tabulated the diagnosis /findings of common iliac artery in both MRA and CTA ,96 out of 100 were found to be normal in both techniques and 2 cases as aneurysm .One negative case was detected ,it was diagnosed as stenosis in CTA but was found to be totally occluded in MRA . In 2 cases; the external iliac arteries were diagnosed better in MRA to be occluded while it was diagnosed as stenosis in the CTA examination, as presented in Table (2).

Stenosis and aneurysm of the internal iliac artery, table (3) based on MRA showed significant agreement with CTA. 4% of the cases were found to have aneurysm and 2% were with stenosis indicating that MRA can potentially be used for stenosis assessment and aneurysm diagnosis at the internal iliac arteries, similar results was mentioned by Akos Varga-Szemes et al 2017[32]

In 6 cases, the femoral arteries were diagnosed as stenosis by CTA while MRA showed that only 3 arteries were with stenosis and the rest have totally occluded table (4).The mismatch noticed in the diagnosis of such cases to be confused between stenosois or totally occluded because the presence of the vessel wall calcifications appears on CTA[32] .This justification have also been exposed to affect image interpretation in several studies [33,34,]. In our experience, extensive arterial wall calcifications found in common iliac artery, external iliac arteries, internal iliac artery and femoral arteries, are frequently seen in patients with peripheral arterial disease and interfered with the image interpretation/diagnosis. The vessel diameter combined with vessel wall calcifications may have contributed to the lowest harmony between the two modalities occurring in those arteries.

Femoral profound artery showed similar results as normal and aneurysm in 90 and 2 patients in respectively in both MRA and CTA, while 8 patients were diagnosed as stenosis ,however 5 of them were found to be completely occluded when they are investigated by MRA. As well 6 cases were found to have total occlusion in the popliteal artery and also were diagnosed by MRA, Table (5,6).

Popliteal aneurysm is the most common peripheral arterial aneurysm and 50% of aneurysms are bilateral, [35] however in our cases we found it unilateral .Studies have mentioned that 80% of the popliteal aneurysm are associated with aneurysm elsewhere[35] as well we diagnosed it in common iliac artery, external iliac, internal iliac, femoral, femoral profound, popliteal, we referred the findings to the atherosclerotic disease .Anterior tibial artery was also been evaluated in both imaging methods, 96 cases were diagnosed as normal in CTA however MRA showed 3 out of 96 have aneurysm and 9 have stenosis,as well 4 were diagnosed to have stenosis but the MRI showed 3 cases are totally occluded, as well the posterior tibial artery in both MRA and CTA was also been evaluated, 97 cases were diagnosed to be as normal but 15 cases were found to have aneurysm (4;4%) stenosis (10;10%) and total occlusion (1;1%).3 cases were diagnosed to have stenosis by CTA but total occlusion was found in all of those cases when were examined by MRA, table(7,8)

In peroneal artery the aneurysm and stenosis were found in 15 cases which were diagnosed as normal in the CTA examination as well 8 cases were diagnosed to be totally occluded in MRA and were diagnosed as stenosis in the CTA, table (9).The distal abdominal aorta was found to be normal in all the cases and are equally diagnosed in MRA and CTA, table (10)

Statistically; the study showed that there are no significant difference in the results found in the CTA and MRA in the diagnosis of the common iliac artery, external iliac, internal iliac, femoral, femoral profound, popliteal, anterior tibial, posterior tibial, peroneal artery and distal abdominal aorta.All the occlude cases were well diagnosed by MRA, The literature have mentioned that MRA is a widely used modality for imaging of peripheral artery occlusion diseases [36-40]. It is noninvasive and low-risk and can image the entire vascular system, including tibial arteries [41-43]. Moreover, in a patient with total occlusion, MRA more reliably defines the reconstituted vessels.[44]When comparing the two modalities; both MRA and CTA assume a greater role in patient evaluation. MRA is excellent in a better visualization of vascular system [45]on the other hand CTA used the ionizing radiation, potentially nephrotoxic iodinated contrast medium, and it was difficult to assess the arterial luminal stenosis in the presence of vessel wall calcifications [18]which made it to give false positive results about stenosis or whether the vessels were totally occluded.

Several studies have demonstrated the excellent diagnostic value of CTA in evaluating aortoiliac and peripheral arteries.[46,47,48-50] CTA is particularly useful for evaluating the vascular disease however; CTA is still somewhat limited in its ability to grade the severity of stenotic lesions accurately when the volume of calcified plaque in a vessel is high with respect to the diameter of the vessel which is an important limitation when using CTA in the calf. [51, 52, 53] Those findings were also been noticed in our results that there were cases diagnosed as stenosis and were found to be totally occluded.

V. Conclusion

Interpretation of MRA and CTA for peripheral arterial disease has an excellent agreement,with significant correlation between the two modalities at p=0.000 in the diagnosis the normal and aneurysm ,stenosis and occlusion in the peripheral arteries including common iliac artery, external iliac, internal iliac, femoral, femoral profound, popliteal, anterior tibial, posterior tibial, peroneal artery and distal abdominal aorta.The results support the increasing use of both MRA and CTA in the diagnostic imaging work-up of patients with peripheral arterial disease.

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