TO COMPARE CT PERIPHERAL ANGIOGRAPHY AND NON ENHANCED MAGNETIC RESONANCE PERIPHERAL ANGIOGRAPHY IN EVALUATION OF PERIPHERAL VASCULAR DISEASES

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ABSTRACT

BACKGROUND
Computed tomography Peripheral angiography (CTPA) and Non enhanced magnetic resonance angiography (NE-MRA) are accurate techniques for selecting patients with peripheral arterial disease for surgical and endovascular treatment. No studies in the literature have directly compared CTPA and NE-MRA to establish which one should be employed, in patients suitable for both techniques, before endovascular treatment.
Objective- A Prospective study of 44 Patients was performed to compare the effectiveness of CTPA and NE-MRA in the evaluation of patients with peripheral vascular diseases.

MATERIALS AND METHODS
A prospective study was conducted over a period of twenty-three months (December 2016 to September 2018) on 44 patients with clinically suspected Peripheral Vascular Disease. They were evaluated with 128 Slice CT Scanner (PHILIPS INGENUITY) and1.5 Tesla MRI (PHILIPS - ACHIEVA).

RESULTS
The results of our study have shown that unenhanced MRA is a potential alternative or complementary modality to CTA for showing clinically significant arterial disease in patients with the peripheral arterial disease with symptomatic chronic lower limb ischemia.

CONCLUSION
CTA is a compulsion over NE-MRA in case if the patient is having absolute contraindications like cardiac pacemakers, aneurysmal clips, metallic implants, or undergone prior bypass stenting for peripheral arterial disease, and in case of emergency settings like trauma. NE-MRA is an alternate modality to CTA in case if the patient is having renal insufficiency, severe diabetes who may have calcified vessels and renal complications.

KEYWORDS
CT Peripheral angiography, NE-MR Angiography, Peripheral vascular diseases.

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BACKGROUND
Peripheral vascular disease (PVD) is an occlusive disease affecting the arteries which may be acute, acute-on-chronic (where acute occlusion occurs in the presence of a previous chronic stenosis or occlusion) and chronic occlusion. Most common cause of Peripheral Vascular Disease is atherosclerosis.[1]

Characterization of PVD can be performed with noninvasive angiography using computed tomography angiography (CTA) or magnetic resonance angiography (MRA) as well as with duplex ultrasonography depending on patient specific characteristics. Invasive, digital subtraction angiography (DSA) has been the gold standard for evaluation of lower extremity atherosclerosis.

The radiologic approach to the diagnosis of PVD has changed substantially in the past few years. Duplex ultrasound is a well-established noninvasive modality with good sensitivity and specificity for PVD. The performance of this modality can be further improved by the addition of functional (color-flow) imaging. Duplex ultrasound, however, is operator-dependent and does not provide a "road map" of the vascular system that is useful for treatment planning.

CT angiography (CTA) offers the spatial resolution of catheter digital subtraction angiography (DSA) without the risks associated with the invasive procedure. The recent introduction into clinical practice of multi–detector row spiral

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CT with simultaneous acquisition of multiple channels has had a substantial effect on CT angiography by enabling high-spatial-resolution imaging of large volumes with excellent visualization of small branches and by permitting a reduction in the dose of the iodinated contrast agent. It suffers however from ionizing radiation and the risk of iodinated contrast nephropathy. Nephropathy induced by contrast medium remains one of the most clinically important complications of the use of iodinated contrast medium.

In a systematic review of the published literature, contrast-enhanced MR angiography (CEMRA) was shown to be highly accurate for the detection of stenosis greater than 50% or occlusion within the entire lower extremity arterial tree. Until evidence linking the administration of gadolinium-based contrast agents with nephrogenic systemic fibrosis (NSF) was reported.[2] Many physicians preferred MR angiography (MRA) to CTA and DSA for evaluating patients with chronic kidney disease because of the previously considered safety of these agents.

The risks of contrast-induced nephropathy and NSF associated with the prevalence of end-stage chronic renal failure and diabetes in PVD patients have renewed interest in unenhanced MRA techniques for the assessment of symptomatic PVD. Several techniques for unenhanced MRA of the peripheral arteries have been proposed, including gated 2D time of flight; 3D phase contrast; and subtractive techniques such as fresh blood imaging, native spatial and chemical-shift–encoded excitation (SPACE), and flow-sensitive dephasing.

Aims and Objectives

1. To study the diagnostic performance of non enhanced MRA when compared with CTA.
2. To compare utility of CTA and NE-MRA in terms of patient specific characteristics.

MATERIALS AND METHODS

Study Design

This is a prospective comparative meta analytic study done at Department of Radiodiagnosis Osmania institute of medical sciences, Hyderabad, Telangana State, India.

Source of Data

All patients attending the surgery OPD with complaints of claudication pain or critical limb ischemia and suspected of having PVD, who were scheduled for both CTA and NE-MRA.

Method of Collection of Data

A prospective study was conducted over a period of twenty three months (December 2016 to September 2018) on 44 patients with clinically suspected Peripheral Vascular Disease. They were evaluated with 128 Slice CT Scanner (PHILIPS INGENUITY) and1.5 Tesla MRI (PHILIPS - ACHEIVA).

Inclusion Criteria

1. All Age groups
2. All patients who were scheduled for CTA.

Exclusion Criteria

1. Renal insufficiency (creatinine> 2.5 mg/dl),
2. Known allergy to contrast media
3. Pregnant woman
4. Patients with known MRI incompatible metallic implants
5. Patients with severe disease who cannot stand long scan period of MRI

The study protocol was approved by the hospitals ethics committee and all patients gave informed consent.

Initially the CTA examination was performed and the reconstructed images were evaluated by an on staff radiologist. Then MRA examination took place. The evaluation of the MRA examination was performed by a radiologist blinded to the results of CTA. The location and extent of each diagnosed lesion was recorded separately for each modality. Finally a comparative analysis of CTA and MRA results was performed, yielding sensitivity, specificity, positive and negative predictive value of MRA compared with CTA.

MDCT Angiography

Patient Preparation

Patient consent was taken. Risks and benefits of the procedure were explained to the patient clearly. Patients were asked to fast for 6hours prior to study. Patients were also asked to avoid metformin 1day prior to study. Detailed patient history was taken, medications, routine investigations and non-invasive colour Doppler results were recorded.

MD CTA Protocol

All patients were examined with a 128 slice MDCT scanner (Philips Inguenity128 slice Netherlands) using standard peripheral angiogram CT protocol as follows-

Parameter	MDCT Angiography
Contrast agent	110ml; 350 mg /ml; 5ml/sec
Collimation	64X0.625
Gantry rotation time	1/SEC
Kv	120
mAs	210
Slice width	2mm
Increment	1MM
FOV	1200
Pitch	0.798

Table 1. 128 Slice MDCT Scan Parameters used for Peripheral Angiography

A region of interest at the bifurcation of descending aorta was marked to permit subsequent use of automated contrast bolus tracking. Iodinated contrast media.

(Omnipaque 350 mg/ml) was injected via18Gauge cannula in antecubital vein, preferably on right side. Contrast volume and rate of injection varied with patient weight from 90 to 110 ml and 5.0 to 6.0ml/second respectively. The contrast injection was immediately followed by a 40 ml saline chaser bolus at a rate of 5ml/second. Scanning was automatically triggered when contrast media in the pre-defined area of the descending aorta reached a density of 160 Hounsfield units.

Overall scan time was between 15 seconds. Post processing and reconstruction Data was reconstructed using Philips Extended Brilliance Workspace. All 44patientsunderwent NE-MRA 1 day after CTA using 1.5 tesla MRI, post processing was done using EXTENDED PHILIPS WORK STATION and images were analysed by experienced radiologist.

NE-MR Angiography

Patient Preparation

Patient consent was taken. Risks and benefits of the procedure wereexplained to the patient clearly.Detailed patient history was taken, medications, routine investigations and non-invasivecolour Doppler results were recorded.

NE-MRA protocol

All patients were examined with 1.5 Tesla MRI scanner (Philips Acheiva 1.5 T Netherlands) using standard peripheral angiogram MRA protocol as follows-

Parameter	MR Angiography
Contrast agent	NIL
Technique	2D TOF
Surface coil	Q body and Torso xl
Sequence	Gradient echo
Flip angle	60 degree
Slice thickness	5mm
Slicegap	2mm
FOV	250mm

Table 2. 1.5T NE-MRA Scan Parameters used for Peripheral Angiography

Data Evaluation and Statistics

The analysis of the data is based on the comparison of each single arterial segment seen in NE-MRA with CTA representing the standard.[3] For this purpose each artery/ arterial segment is classified as Stenosis and normal segments. The stenosed segments are divided into 4 categories according to the extent of lumen narrowing as follows - total occlusion: 100% stenosis, severe stenosis >70% of vessel lumen, moderate stenosis 50 - 70% of vessel lumen, mild<50% of vessel lumen. Each artery/arterial segment is thus categorized with both CT angiography, and NE-MRA making it possible to define the NE-MRA results for each artery/arterial segment as either true positive, false positive, true negative or false negative so that separate evaluations for total occlusion, severe stenosis, moderate stenosis and mild stenosis can be performed.

20 arteries/segments for each leg analyzed namely Comman iliac Artery (CIA), Internal iliac artery (IIA), External iliac artery (EIA), Common femoral artery (CFA), Superfiscial femoral artery-proximal (SFA-P), Superfiscial femoral artery-mid(SFA-M), Superfiscial femoral artery-distal (SFA-D), Profunda femoris artery-(PFA), Popliteal artery(POPA), Anterior tibial artery-proximal (ATA-P), Anterior tibial artery-mid (ATA-M), Anterior tibial artery-Distal(ATA-D), Tibioperoneal trunk(TPT), Posterior tibial artery-proximal (PTA-P), Posterior tibial artery-Mid (PTA-M), Posterior tibial artery-Distal (PTA-D), Peroneal artery-proximal (PER-P), Peroneal artery-mid(PER-M), Peroneal artery-Distal(PER-D), Dorsalispedis artery(DPA) with both CTA and NE-MRA and NE-MRA results were compared with CTA.

Among total of 44 cases 6 of the upperlimb cases are omitted from analysis due to inadequacy of sample as only 2 were abnormal among those 6 cases. A total of 38 remaining cases of lower extremity 7 cases were removed due to poor image quality and 31 taken into analysis and of total 31 cases 1092 arterial segments were comparable both with CTA and NE-MRA. Separate statistical evaluations were performed for:

- Lesions with 100% stenosis, >70% stenosis, 50-70% stenosis, <50% stenosis, total diseased segments and total normal segments.
- Lesions within each of the separate artery/arterial segment (CIA, IIA, EIA, CFA, SFA-P, SFA-M, SFA-D, PFA, POPA, ATA-P, ATA-M, ATA-D, TPT, PTA-P, PTA-M, PTA-D, PER-P, PER-M, PER-D, DPA).
- Total diseased segments in the arteries/segments of pelvic region, thigh region, leg & foot region.

Observations

The present study included total number of 44 cases including both male and female. Among the total of 44 cases 84.09% (n=37) are male patients and 15.90% (n=7) are female patients giving a male to female ratio of 5.6:1.

Among 44 cases the youngest patient was 30 years old and oldest was 80 years old. The highest numbers of patients were in the age group of 61-70 years.

Among total of 44 cases 86.3% (n=38) came with lower limb complaints and 13.7% (n=6) came with upper limb complaints.

Among the total of 44 cases 72.72% (n=32) are having risk factors for peripheral vascular diseases and 27.27% (n=12) are having no risk factors.

Among a total of 32 cases having risk factors 31.25% (n=10) are diabetic, 18.75% (n=06) are hypertensive, 31.25% (n=10) are smokers and18.75% (n=06) patients were having more than one risk factors among which diabetes was predominant risk factor and PVD is found more among diabetics comparatively than in smokers and hypertensives, and both smoking and hypertension found equally as a risk factor among the study group.

Among the total of 44 cases 90.9% (n=40) are abnormal and 9.1% (n=4) are found normal. Among 40 abnormal cases 90% (n=36) are diagnosed as having atherosclerotic peripheral vascular disease, 2.5% (n=1) are diagnosed as having buerger's disease, 2.5% (n=1) are diagnosed as having anatomical variant, 2.5% (n=1)) are diagnosed as having both anatomical variant and atherosclerosis and 2.5% (n=1) are diagnosed as having acute thrombotic ischeamia without prior atherosclerosis, so total cases of atherosclerosis were 92.5% (n=37) and total cases of anatomical variants are 5% (n=2).

Sl. No.	Diagnosis	No. of Patients	%
1.	Atherosclerosis	36	81.81
2.	Buerger's	1	2.27
3.	Anatomical variation	1	2.27
4.	Acute thrombosis	1	2.27
5.	Atherosclerosis and Anatomical variation	1	2.27
6.	Total	40	

Table 3. Spectrum of Diseases Diagnosed in the Present Study Population

Sl. No.	Artery/Segements	Total Segments with Disease		False Positive	False Negative
		CT Angio	MR Angio		
1.	CIA	10	7	0	3
2.	EIA	14	9	0	5
3.	IIA	15	13	0	2
4.	CFA	4	3	0	1
5.	SFA-PROXIMAL	38	27	0	11
6.	SFA-MID	40	45	5	0
7.	SFA-DISTAL	40	38	0	2
8.	PFA	9	2	0	7
9.	POP ARTERY	32	25	0	7
10.	ATA-PROXIMAL	34	25	0	9
11.	ATA-MID	35	50	15	0
12.	ATA-DISTAL	37	47	10	0
13.	TPT	24	12	0	12
14.	PTA-PROXIMAL	36	24	0	12
15.	PTA-MID	32	41	9	0
16.	PTA-DISTAL	35	44	9	0
17.	PER ARTERY-PROXIMAL	30	14	0	16
18.	PER ARTERY-MID	28	49	21	0
19.	PERARTERY-DISTAL	34	42	8	0
20.	DPA	26	51	25	0
		553	**568**	**122**	**87**

Table 4. Artery wise Distribution of Total Disease Segments Detected on CTA and NE-MRA

Of 553 total diseased segments on CTA, NE-MRA detected 568 total diseased segments, and 122 are false positive and 87 are false negative with a sensitivity and specificities of 86% and 77% for total diseased segments.

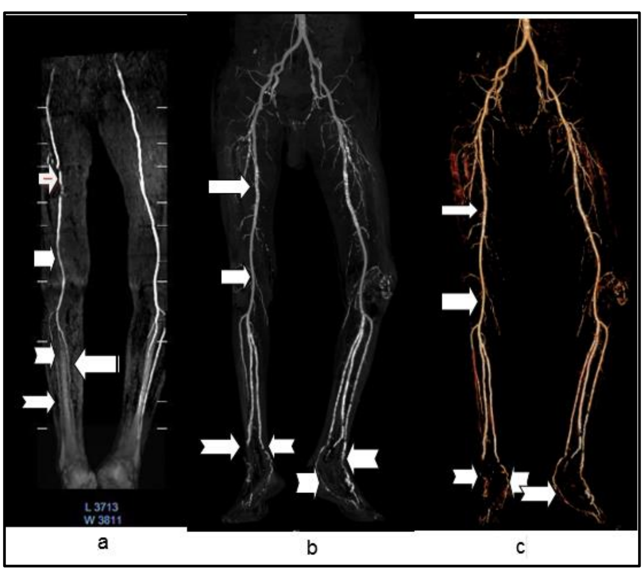

Figure 1. A) NE-MRA Image; B) & C) CTA Volume Rendered Image and MIP Image

- Circumferential calcified plaque causing mild stenosis at distal part of deep femoral artery and tibioperoneal trunk. (white arrows)
- Multiple areas of stenosis and near total occlusion noted in anterior tibial artery, posterior tibial artery, peroneal artery and dorsalispedis artery with flow in between due to collateral supply. (notched white arrows)

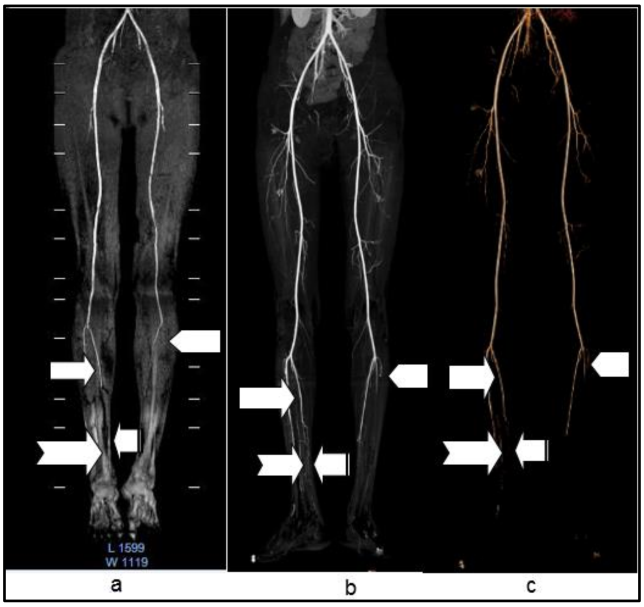

Figure 2. A) NE-MRA Image;
B) & C) CTA Volume Rendered Image and MIP Image

.RT LL:

- Multi segmental mild to moderate stenosis noted in mid 1/3rd of peronealartery (white arrow).
- Multi segmental mild stenosis noted in distal 1/3rd of peronealartery (notched white arrow).
- Moderate stenosis and focal areas of near total occlusion noted in distal half of posterior tibial artery. (striped white arrow).

LT LL:

- Severe stenosis and near total occlusion noted at multiple levels of anterior tibial artery &peroneal artery distal to their origin. (White pentagon)

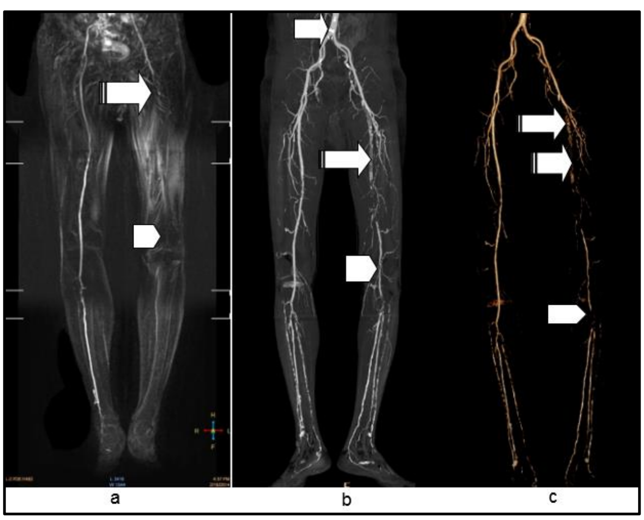

Figure 3. A) NE-MRA Image; B) & C) CTA Volume Rendered Image and MIP Image

- .Atherosclerotic changes noted in aorta and common iliac artery. (White arrow)
- Long segment thrombosis causing severe stenosis at left superificial femoral artery from its origin to throughout its length causing near total occlusion (and complete occlusion at some places) (notched white arrows).
- Moderate stenosis of left popliteal artery (white pentagon).

DISCUSSION

Imaging modality is considered based on patient's renal parameters level, diabetes status and implanted metal devices. For patients who have normal renal function and are not diabetic, initial evaluation with either CTA or MRA is done based on their diagnostic capabilities.[4,5] Overall, Duplex US is less sensitive technique for imaging native vessel stenosis than CTA or MRA,[6] however the greatest limitation of Duplex US is the time required for evaluation of two lower extremities.

In our study we analysed1092 arterial segments by both CTA and MRA

With CTA 1092 segments were evaluated. The arterial segments included in the study were found to contain a total number of 553 stenoses and a total of 539 normal segments. And among 553 stenosed segments 103 were mild degree (<50%), (figure 1) 96 were moderate degree (50 to 75%), (figure 2) 128 were severe degree (>75%) and 226 were total occlusions (100%). (Figure 3).

NE-MRA detected 568 total stenoses, and 122 are false positive and 87 are false negative; of 524 total normal segments with NE-MRA 87 are false positive and 122 are false negative.[4] Of 108 all mild stenotic segments with NE-MRA 30 are false positive and 25 are false negative. Of 119 all moderate stenotic segments with NE-MRA 46 are false positive and 23 are false negative. Of 114 all severe stenotic segments with NE-MRA 28 are false positive and 42 are false negative. Of 227 all complete occlusions with NE-MRA 50 are false positive and 48 are false negative.

The sensitivity and specificities of NE-MRA is 86% and 77% for total diseased segments; and 84% and 80% for total normal segment identified. And among the total diseased segments the sensitivity and specificity of NE-MRA to identify mild stenosis is 80%, 93%.In identifying moderate stenosis is 81%, 92%; in identifying severe stenosis is 80%, 95%; and in identifying complete occlusions is 82%, 93%.[7]

NE-MRA has overestimated 15 segments as diseased segments when compared to CTA in estimating total stenosed segments irrespective of severity of stenosis with a sensititivity and specificity of 86% and 77%.

NE-MRA has overestimated 5 segments as mild stenosed segments when compared to CTA with a sensitivity and specificity of 80% and 93%.

NE-MRA has overestimated 23 segments as moderate stenosed segments when compared to CTA with a sensitivity and specificity of 81% and 92%.

NE-MRA has underestimated 14 severe stenosed segments when compared to CTA with a sensitivity and specificity of 80% and 95%.

NE-MRA has overestimated 01 segments as complete occlusion when compared to CTA with a sensitivity and specificity of 82% and 93%.[8,9,10]

CONCLUSION

In conclusion, our results suggest that CTA can be considered as a first-line investigation in patients being candidates for endovascular procedures when clinical history or duplex sonographic evaluation are indicative of severe impairment. Unenhanced MRA is a potential alternative or complementary modality to CTA for showing clinically significant arterial disease in patients with peripheral arterial disease with symptomatic chronic lower limb ischemia.

CTA is a compulsion over NE-MRA in case if patient is having absolute contra indications like cardiac pace makers, aneurysmal clips, metallic implants, or undergone prior bypass stenting for peripheral arterial disease, and in case of emergency settings like trauma.

NE-MRA is an alternate modality to CTA in case if patient is havingrenal insufficiency, severe diabetes who may have calcified vessels and renal complications.

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