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Research Article

COMPARATIVE STUDY OF CT ANGIOGRAPHY VERSUS DUPLEX ULTRA SONOGRAPHY IN ASSESSMENT OF LOWER LIMB PERIPHERAL ARTERIAL OCCLUSIVE DISEASES (PAOD)

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Abstract:

Introduction: Currently, CT angiography (CTA) and Duplex ultrasonography (DUS) are widely used non-invasive imaging modalities for evaluating PAOD. CTA involves radiation exposure and the use of iodinated contrast. On the other hand, DUS is a safer, widely available, radiation-free technique, but its accuracy may vary. There is a need to evaluate whether DUS can serve as a reliable, cost-effective, and non-invasive first-line modality in the diagnostic pathway. This study will help in evaluating its potential as a non-invasive, cost-effective and safer alternative to CT angiography.

Methodology: It was a observational cross sectional study conducted at Tertiary Healthcare centre hospital over a period of 12 months.

Results: For the Infra-renal aorta (IRA) USG had poor sensitivity at only 31.3%. USG's performance for the Common Iliac Artery (CIA) was better, with a sensitivity of 61.9%. USG proved to be highly effective for the External IliacArtery (EIA), with a sensitivity of 92.3%. For the Profunda Femoris Artery (PPFA), USG showed similarly high performance with 96.2% sensitivity. In the Superficial Femoral Artery (SFA), USG achieved flaw less results with 100%. In the Popliteal Artery (PA), USG maintained high diagnostic value, with sensitivity of 94.6%. The Anterior Tibial Artery (ATA) also showed strong metrics, with sensitivity of 92.3%. The Posterior Tibial Artery (PTA) comparison revealed a sensitivity of 87.5%for Dorsalis Pedis Artery (DPA), USG's performance was less impressive (sensitivity 75.0%).

Conclusion: Duplex Ultrasound (USG) is a highly effective, non-invasive diagnostic tool for assessing peripheral arterial disease, particularly in proximal and mid-level arterial segments.

Keywords: Peripheral arteries occlusive disease, CT angiography, Duplex ultrasonography, Sensitivity, specificity, PPV, NPV.

INTRODUCTION

Peripheral arterial disease (PAD) includes disorders that cause a reduction or blockage of blood flow in the arteries, PAD can affect the extra cranial carotid, upper extremity, mesenteric and renal circulations.[1] Many PAD patients have either no symptoms or atypical complaints that do not fully adhere to the concept of claudication.[2] PAD affects nearly 200 million adults worldwide and the incidence of PAD can reach 20% in people over the age of 70. Smokers with PAD live shorter lives than nonsmokers and are more likely to develop critical limb ischaemia and amputation. Diabetes, hyperlipidaemia, hypertension, race, and ethnicity all contribute to PAD risk.[3] Peripheral arterial disease (PAD) can lead to several complications, primarily due to reduced blood flow to the limbs and an increased risk of cardiovascular events. These complications include muscle ischemia, tissue damage, and a higher risk of heart attack and stroke. More severe outcomes may involve critical limb ischemia, non-healing ulcers, and even limb amputation.[4] Intermittent claudication is typically treated conservatively, whereas limb-threatening ischaemia requires angioplasty, surgical revascularisation, or amputation.[5] Depending on how severe the disease is, the intervention may require a combination of treatments. Therefore, in order to create an appropriate treatment strategy, patients with limb-threatening ischaemia need a thorough evaluation.

The gold standard for examining lower limb arterial disease is intra-arterial contrast angiography. Its disadvantages include the possibility of iodinated contrast agent nephrotoxicity, arterial puncture, and ionising radiation. There are other alternative imaging methods, such as Duplex Ultrasonography, Computed Tomography Angiography, and Magnetic Resonance Angiography. Although there are dangers related with ionising radiation from computed tomography angiograms, contrast enhanced magnetic resonance angiograms, and computed tomography angiograms that use contrast agents, there are no risks associated with duplex ultrasound.[6]

Currently, CT angiography (CTA) and Duplex ultrasonography (DUS) are widely used non-invasive imaging modalities for evaluating PAOD. CTA offers high-resolution vascular imaging and detailed anatomical visualization, but it involves radiation exposure and the use of iodinated contrast, which carries the risk of nephrotoxicity and allergic reactions. On the other hand, DUS is a safer, widely available, radiation-free technique that can assess both arterial anatomy and blood flow dynamics, but its accuracy may vary based on operator expertise and patient factors (e.g., obesity, calcified vessels). However, despite their common usage, comparative data on the diagnostic accuracy of DUS versus CTA in detecting and grading arterial occlusive lesions are limited, particularly in specific patient populations. There is a need to evaluate whether DUS can serve as a reliable, cost-effective, and non-invasive first-line modality in the diagnostic pathway, potentially reducing the need for more expensive and invasive imaging like CTA. Therefore, this study is needed to assess the diagnostic value of Duplex ultrasonography in comparison to CT angiography for the evaluation of peripheral arterial occlusive disease. By directly comparing the two modalities, the study aims to determine whether Duplex ultrasonography can reliably detect the presence, location, and severity of arterial lesions. This study will help in evaluating its potential as a non-invasive, cost-effective and safer alternative to CT angiography, especially in settings where radiation exposure or contrast use is a concern.

METHODOLOGY

It was a observational cross sectional study conducted at Tertiary Healthcare centre hospital over a period of 12 months. Sample size calculated by using formula n=(Z^2 *p*(1-p)/d^2)*((1+(κ-1)*p)/κ). Based on various studies conducted across India and World, the agreement kappa value is around 0.90, using this, with 15% absolute error and 80% power and considering prevalence of PAD to be around 25%, we found the minimum sample size of 32 in each group (Total 62). Study participants included in the study using Convenience Sampling. Patients above 18 years of age, presenting to the Tertiary care hospital with Unilateral or Bilateral,Acute or Chronic lower limb peripheral arterial occlusive disease that consent for both duplex ultrasonography and CT angiography.

Data collection was commenced after approval from Ethical committee. Patients presenting with lower limb peripheral arterial disease in Tertiary care Hospital referred to Radiology department for evaluation, after written informed consent, first DUPLEX ULTRASONOGRAPHY was done in the patients then referred for CT Angiography. Duplex ultrasound was done with MINDRAY X insight DC-60 Ultrasound machine band width frequency transducer with a range of 9-3 MHz for lower limb arteries and 5-1 MHz probe for infra-renal aorta and iliac vessels.Patients were kept fasting for at least 6 hours, to improve visualization of the aorto-iliac region. Colour flow assisted B-mode was used to rapidly map the vessel of interest and locate lesions. Pulse Doppler was used to analyze spectral wave form and to measure peak systolic velocity. To minimize inter-observer variation, all Doppler studies was done by the same operator; three measurements for each segment were made to improve diagnostic accuracy. CT angiography was done with SEIMENS SOMATOM DEFINITION AS 128 slice Multi detector CT. Patients were placed in supine position with feet entering the gantry first. Scanogram and plain study were taken. Patients were asked to hold their breath during the first part of the scanning pass. After saline check, 100mL volume of iodinated contrast material (320 mg of iodine per milliliter), was administered through a 18-gauge cannula in an antecubital vein at a rate of 4.5mL/sec through pressure injector followed by saline chase. Scanning began when the contrast opacification of descending thoracic aorta reached 120 HU. All transverse source images were transferred to workstations for the preparation of reconstructions. Sliding maximum intensity projections was obtained with coronal, and sagittal projections of each data set.

The data was collected, compiled, and analysed using SPSS 25. The qualitative variables was expressed in terms of percentages. The quantitative variables was both categorized and expressed in terms of percentages or in terms of mean and standard deviations. Cohen's kappa was used to find agreement between the two methods. Diagnostic performance was expressed in terms of sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy.All analysis was 2 tailed and the significance level was set at 0.05.

Illustrative Cases:

Case 1: A 40 year old male patient presented with acute onset left lower limb pain since 3 days. History of smoking since 15 years was present. Patient was taken for duplex ultrasonography following preparations followed by CT lower limb angiography was done.

a.

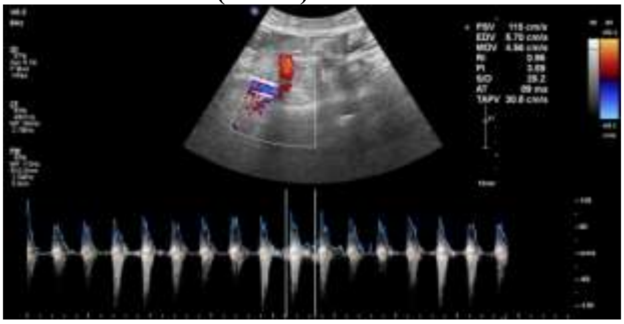


Image a. Color doppler and Spectral waveform image at the level of abdominal aorta (Visualized sections of infra-renal abdominal aorta) showing Anterograde, High velocity, Monophasic waveforms.

b.

Image b- Grey scale image of longitudinal section of visualized infra-renal abdominal aorta.

c.

Image c- Grey scale image of longitudinal section of visualized right external iliac artery with no obvious thrombosis seen.

d.

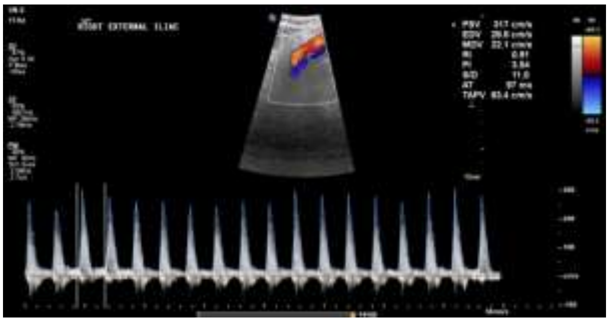


Image- d. Color doppler and Spectral waveform image at right external iliac artery showing Anterograde, High velocity, Monophasic waveforms.

e.

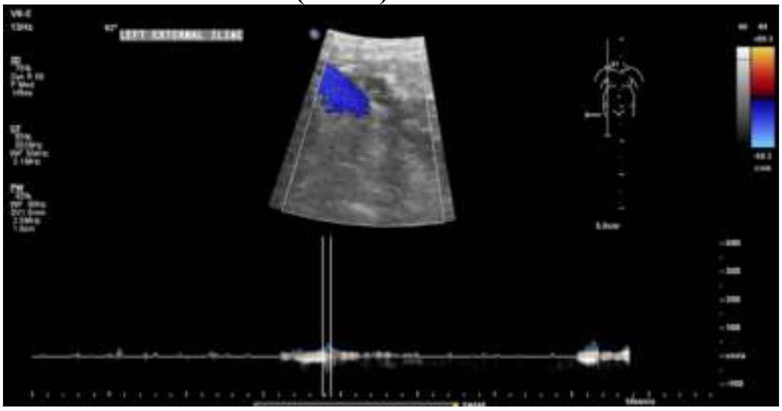


Image e. Color doppler and Spectral waveform image at left external iliac artery showing absence of color flow and spectral waveform. Echogenic content noted causing 100% stenosis - complete occlusion.

f.

Image f- Color flow images of transverse section of left proximal superficial and profunda femoris artery showing absence of color flow. Echogenic content noted causing 100% stenosis - complete occlusion.

g.

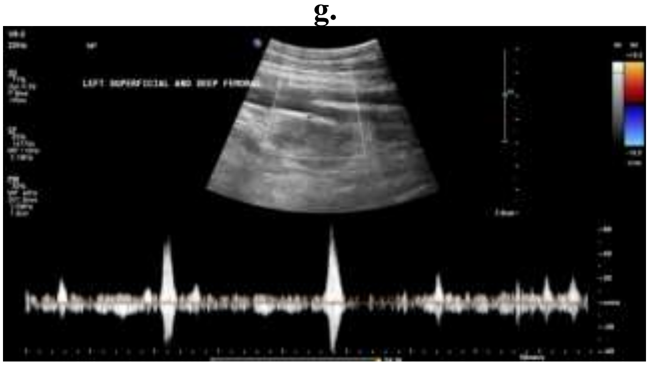
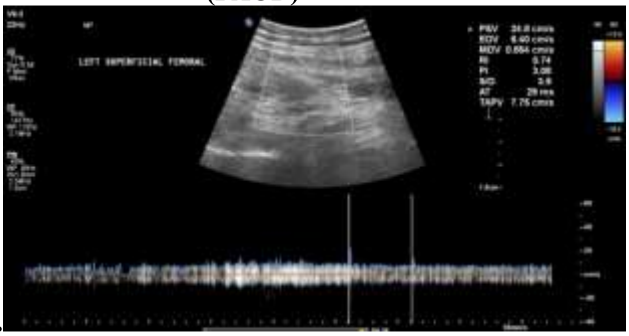


Image g- Color flow and spectral waveform images of longitudinal section of bifurcation of left common femoral artery showing absence of color flow in common femoral artery, left proximal superficial & profunda femoris artery and low velocity monophasic waveforms on spectral doppler. Echogenic content noted in the above arteries causing 80-90% luminal occlusion.



h.

i.

Image h, i-

h. Color doppler and Spectral waveform of longitudinal section of left superficial femoral artery showing complete absence of color flow and low velocity monophasic waveforms. Echogenic content in vessel causing 90% stenosis- near complete occlusion.

i. Color doppler and Spectral waveform of longitudinal section of right proximal superficial femoral artery showing complete absence of color flow and low velocity monophasic waveforms- near complete occlusion.

j.

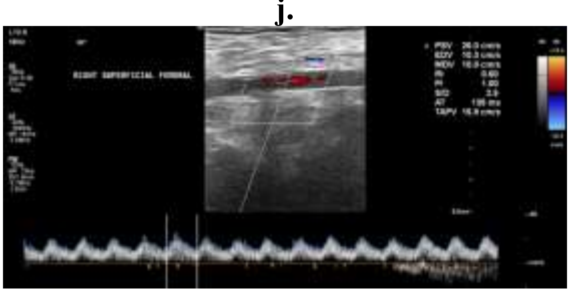
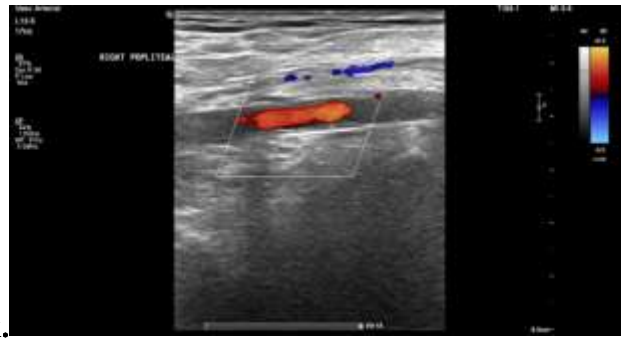


Image j. Color doppler and Spectral waveform of longitudinal section of right distal superficial femoral artery showing patchy color flow and low velocity monophasic waveforms. Echogenic content noted causing 60-70% stenosis- Partial thrombosis.



k.

Image k. Color doppler image longitudinal section of right popliteal artery showing patchy color flow. Echogenic content noted causing 20-30% stenosis - Partial thrombosis.

l.

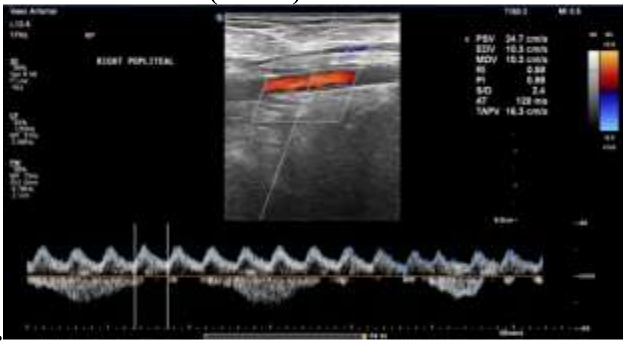


Image l. Color doppler and Spectral waveform of longitudinal section of right popliteal artery showing patchy color flow and low velocity monophasic waveforms- Partial thrombosis.

m.

Image m. Color doppler of longitudinal section of left popliteal artery showing complete absence of color flow.

n.

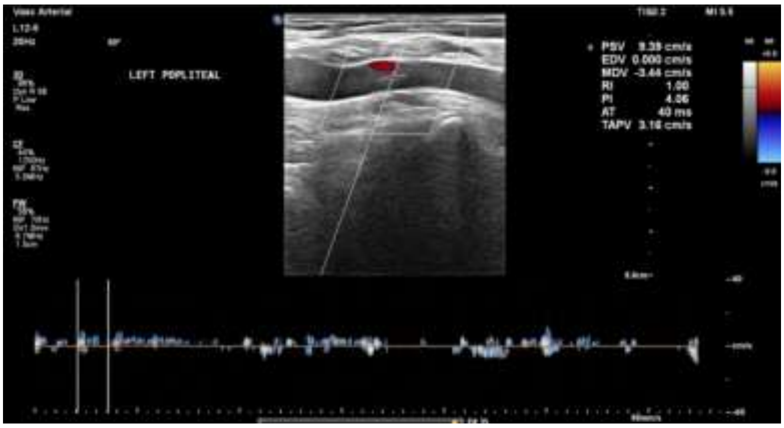
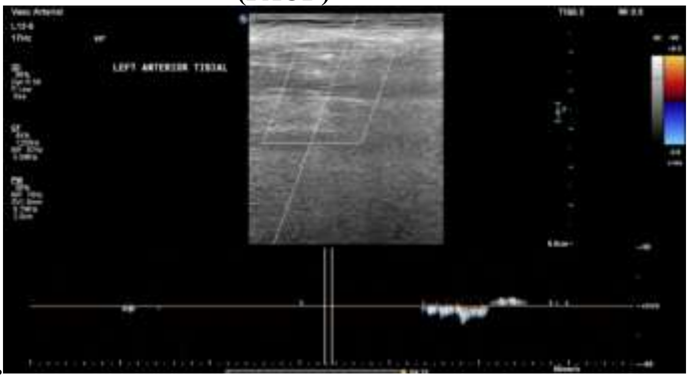
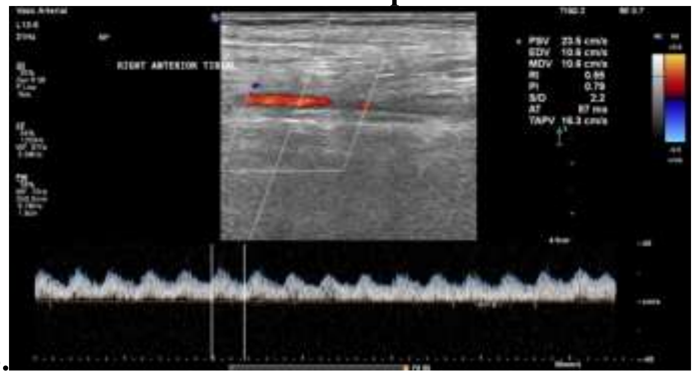


Image n. Color doppler and Spectral waveform of longitudinal section of left popliteal artery showing absent color flow and low velocity monophasic waveforms.



o.

Image o. Color doppler and Spectral waveform of longitudinal section of left anterior tibial artery showing absent color flow and absent waveforms- complete thrombosis.



p.

Image p. Color doppler and Spectral waveform of longitudinal section of right anterior tibial artery showing patchy color flow and low velocity monophasic waveforms.

q.

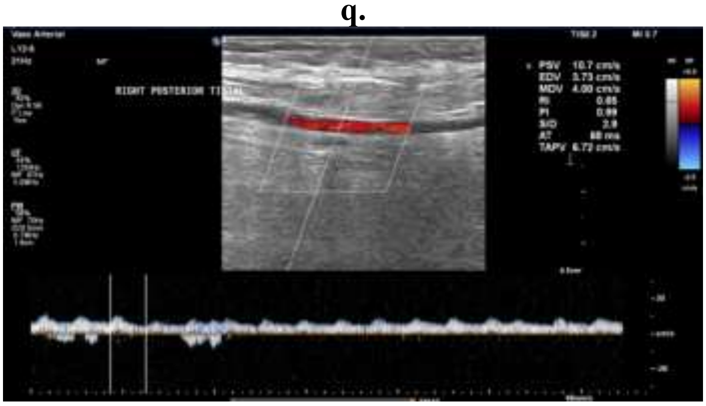


Image q. Color doppler and Spectral waveform of longitudinal section of right posterior tibial artery showing patchy color flow and low velocity monophasic waveforms.

r.

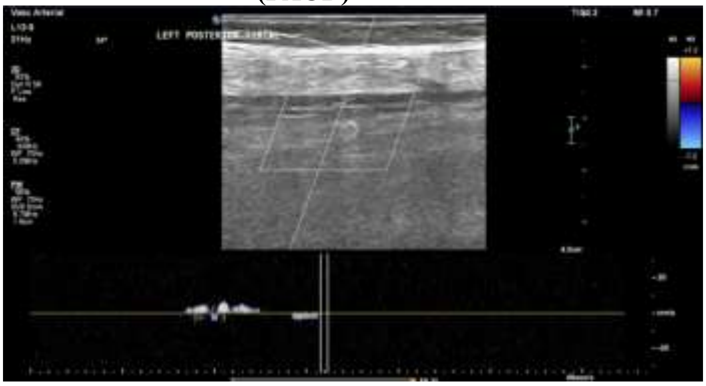
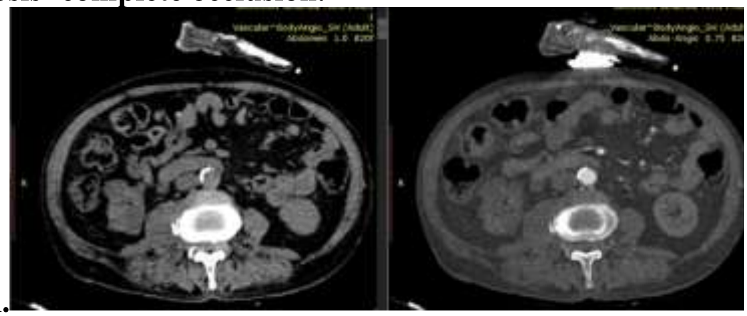
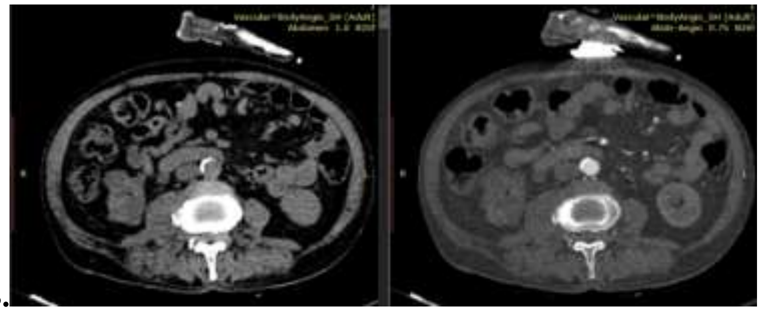


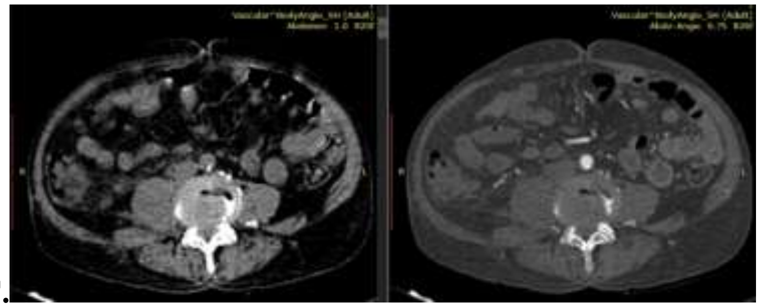
Image r. Color doppler and Spectral waveform of longitudinal section of left posterior tibial artery showing complete absence of color flow and low velocity monophasic waveforms. Echogenic content seen causing 100% stenosis- complete occlusion.



A.



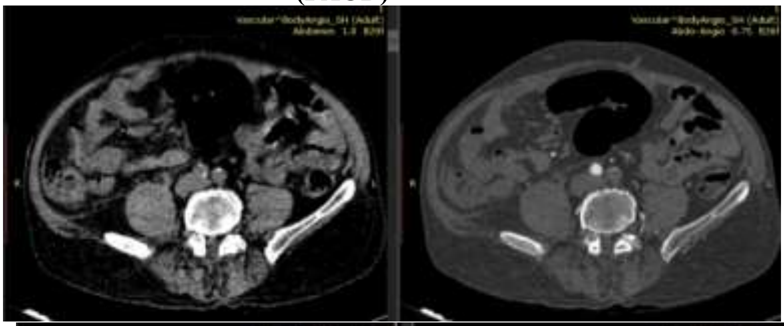
B.



C.

Image A, B, C: Axial Non-contrast(right) and post-contrast(left) images of proximal(A), Mid(B) and Distal(C) Infra-renal Aorta showing discontinuous calcific plaque and contrast opacification. Mild luminal stenosis is seen 10-20%.

D.



E.

F.

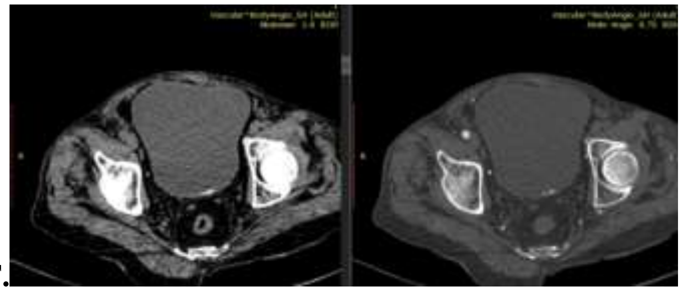


Image D, E, F: Axial Non-contrast(right) and post-contrast(left) images of Bilateral Common iliac artery just distal to bifurcation(D), Proximal(E) and Distal(F) External iliac artery showing hypodense non-enhancing content in left CIA and EIA causing 100 % stenosis- complete occlusion.

G.

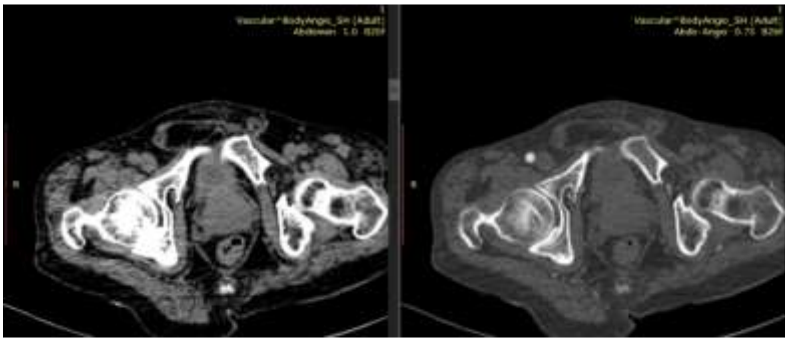
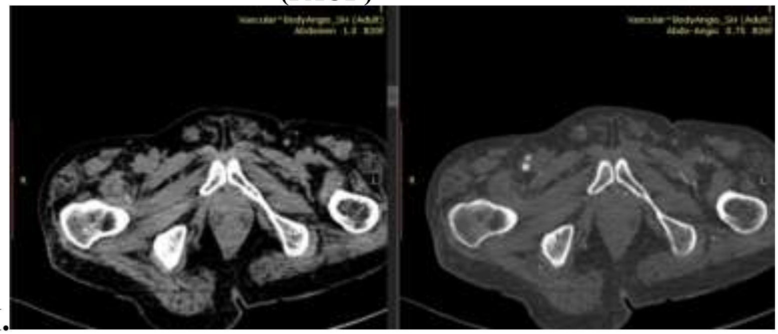
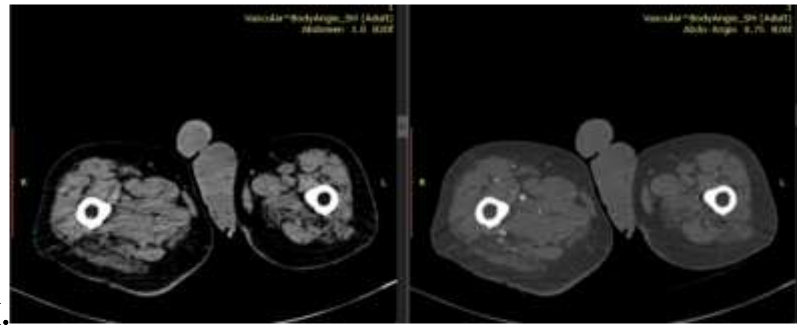


Image G. Axial Non-contrast(right) and post-contrast(left) images of bilateral common femoral artery showing hypodense non-enhancing content in left CFA causing 100 % stenosis- complete occlusion.

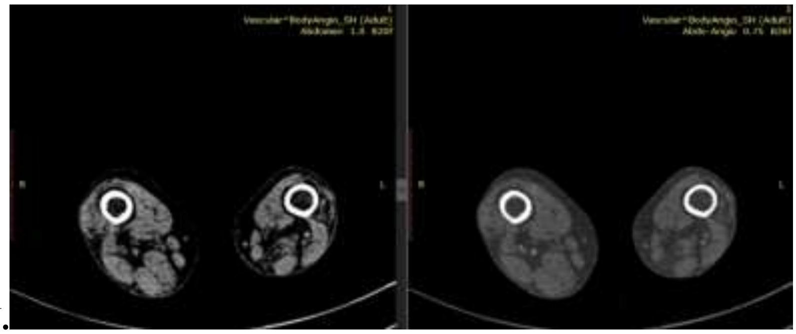


H.

Image H. Axial Non-contrast(right) and post-contrast(left) images at bifurcation of Common Femoral artery showing hypodense non-enhancing content in left proximal superficial artery and left profunda femoris artery causing 100 % stenosis- complete occlusion.



I.



J.

Image I, J: I. Axial Non-contrast(right) and post-contrast(left) images of bilateral proximal(I) and distal(J) femoral artery showing hypodense non-enhancing content in bilateral SFA causing 100 % stenosis- complete occlusion.

K.

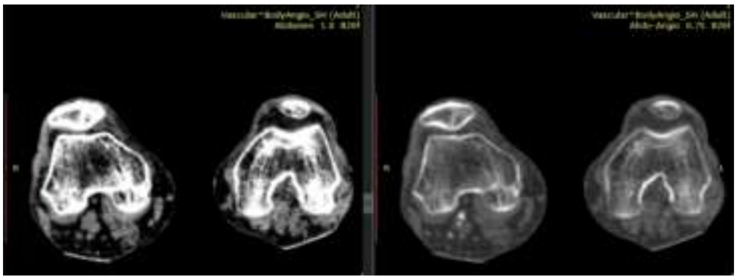
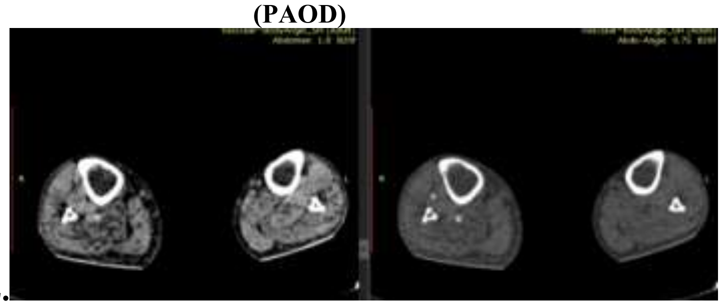
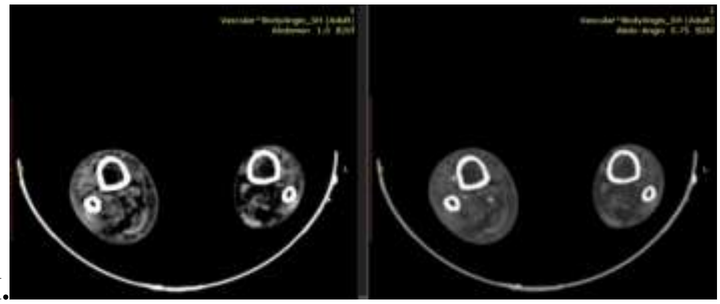


Image K: Axial Non-contrast(right) and post-contrast(left) images of bilateral popliteal artery showing hypodense non-enhancing content in left popliteal artery causing 100 % stenosis- complete occlusion.

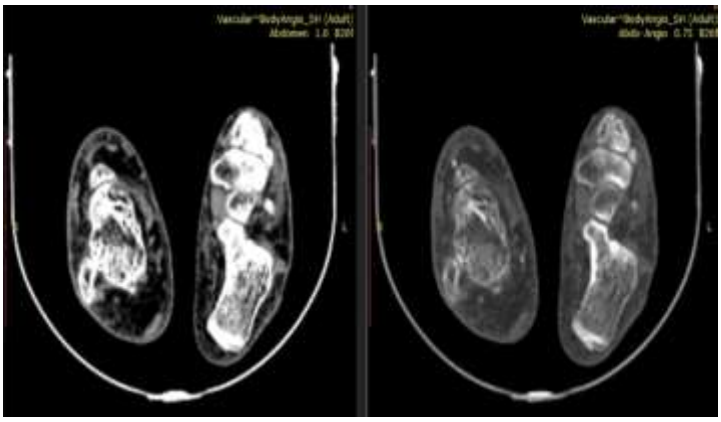


L.



M.

Image L, M,: Axial Non-contrast(right) and post-contrast(left) images of bilateral proximal(L) and distal(M) anterior and posterior tibial artery showing hypodense non-enhancing content in left ATA and PTA causing 100 % stenosis- complete occlusion.

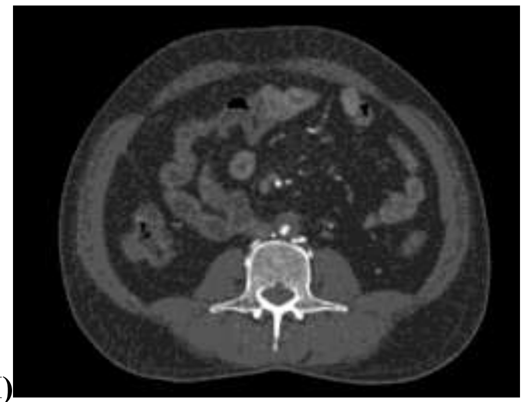


N.

Image N. Axial Non-contrast(right) and post-contrast(left) images of bilateral dorsalis pedis artery showing hypodense non-enhancing content in left dorsalis pedis artery causing 100 % stenosis- complete occlusion.

Image O. 3D- CT Angiography reconstruction images of abdominal aorta and lower limb arteries.

Case 2: A 47 year old male patient presenting with complaints of bilateral lower limb claudication since 5 days. CT lower limb angiography done to look for any thrombosis-

I)  **II)** 

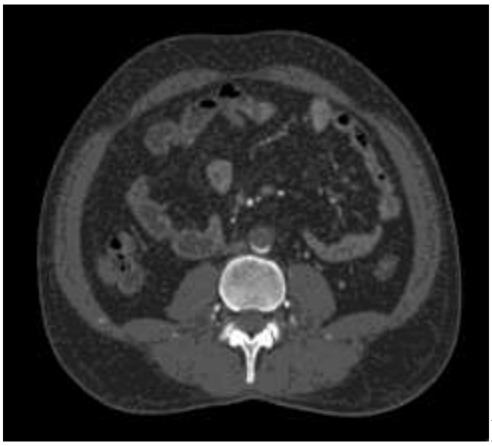
III)  IV) 

Image I to IV)- Contrast lower limb angiography images with axial sections of infra-renal abdominal aorta(I-III) and its bifurcation(IV) showing eccentric hypodense filling defect causing 40-50% luminal occlusion of IRA and 90 % luminal occlusion of bilateral common iliac arteries.

V) 

Image V)- Contrast lower limb angiography images with axial sections of bilateral external and internal iliac arteries showing normal contrast opacification.

VI) 

VII) 

Image- VI, VII)- 3-D CT contrast angiography reconstruction image- frontal and lateral view- showing partial luminal narrowing of infra- renal abdominal aorta with normal contrast filling of its branches

VIII) 

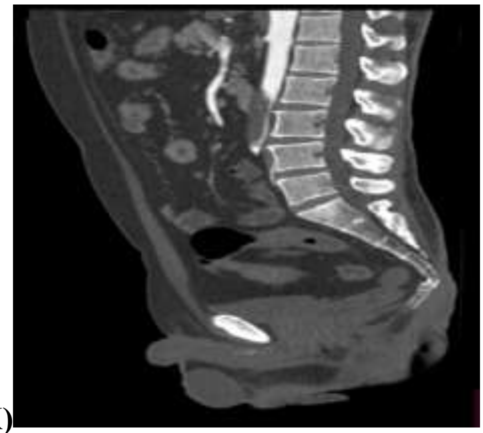
IX) 

Image VIII, IX)- Coronal(VIII) and Sagittal(IX) Multi-planar Reconstruction images of infra-renal abdominal aorta showing hypodense eccentric non-enhancing filling defects causing luminal occlusion.

RESULTS

Total 62 participants enrolled in this study. The majority of participants (25.8%) belonged to the 56–65 years followed by 20.9% aged >65 years & majority 59.6% were male. (Table 1)

Figure 1 highlights that half of the study participants (51.5%) had at least one comorbidity. Hypertension (13.0%) and diabetes mellitus (8.2%) were the most commonly reported conditions, while 13.0% had both.

Table 2 shows the duplex ultrasonography &CT angiography based assessment of peripheral arteries stenosis grading.

Table 3 shows the diagnostic accuracy of duplex ultrasonography with CT angiography to detect peripheral arterial disease.

Table1: Distribution of patients according to demographic data

Demographicparameter		Frequency	Percentage
AgeGroup	18-25	3	5
	26-35	6	9.6
	36-45	11	18
	46-55	13	20.7
	56-65	16	25.8
	>65	13	20.9
Gender	Male	37	59.6
	Female	25	40.4

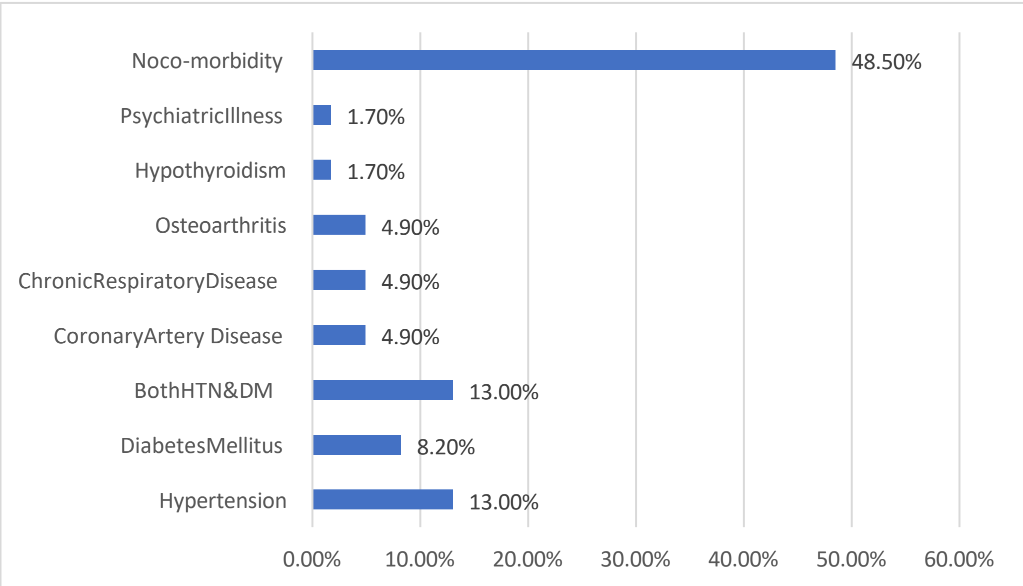


Fig 1: Distribution of patients according to co-morbidity

Table 2: Distribution of patients according to grading of stenosis of peripheral arteries in different evaluation modality

		Duplex ultrasonography		CT angiography	
		Frequency	Percentage	Frequency	Percentage
IRA Stenosis Grade	Normal	57	91.9	46	74.2
	Grade 2	2	3.2	6	9.7
	Grade 3	3	4.8	9	14.5
	Grade 4	0	0	1	1.6

CIA Stenosis Grade	**Normal**	49	79	41	66.1
	Grade 2	2	3.2	5	8.1
	Grade 3	2	3.2	11	17.7
	Grade 4	9	14.5	5	8.1
EIA Stenosis Grade	**Normal**	38	61.3	36	58.1
	Grade 2	2	3.2	5	8.1
	Grade 3	8	12.9	11	17.7
	Grade 4	14	22.6	10	16.1
CFA Stenosis Grade	**Normal**	29	46.8	28	45.2
	Grade 2	3	4.8	3	4.8
	Grade 3	15	24.2	16	25.8
	Grade 4	15	24.2	15	24.2
PLPFA Stenosis Grade	**Normal**	37	59.7	36	58.1
	Grade 2	6	9.7	7	11.3
	Grade 3	8	12.9	6	9.7
	Grade 4	11	17.7	13	21
SFA Stenosis Grade	**Normal**	20	32.3	20	32.3
	Grade 2	3	4.8	4	6.5
	Grade 3	21	33.9	22	35.5
	Grade 4	18	29	16	25.8
	Normal	27	43.5	25	40.3
	Grade 2	2	3.2	2	3.2

PA Stenosis Grade	Grade 3	17	27.4	17	27.4
	Grade 4	16	25.8	18	29
ATA Stenosis grade	Normal	37	59.7	36	58.1
	Grade 2	2	3.2	1	1.6
	Grade 3	8	12.9	9	14.5
	Grade 4	15	24.2	16	25.8
PTA Stenosis Grade	Normal	40	64.5	38	61.3
	Grade 3	11	17.7	1	1.6
	Grade 4	11	17.7	11	17.7
DPA Stenosis Grade	Normal	49	79	12	19.4
	Grade 2	2	3.2	58	93.5
	Grade 3	2	3.2	1	1.6
	Grade 4	9	14.5	3	4.8

(IRA- infrarenal aorta, CIA- common iliac artery, EIA- external iliac artery, CFA-common femoral artery, PLFA-proximal left profundafemoris artery, SFA- Superficial femoral artery, PA- popliteal artery,ATA- anterior tibial artery, PTA-posterior tibial artery, DPA-dorsalis pedisartery)

Table 3: Diagnostic accuracy of duplex ultrasonography comparison to CT angiography

Diagnostic accuracy	IRA	CIA	EIA	CFA	PPFA	SFA	PA	ATA	PTA	PDA
Sensitivity	31.30%	61.90%	92.30%	97.10%	96.20%	100%	94.60%	92.30%	87.50%	75%
Specificity	100%	100%	100%	100%	100%	100%	100%	97.20%	97.40%	82.80%
PPV	100%	100%	100%	100%	100%	100%	100%	96.00%	95.50%	23.10%
NPV	80.70%	80.70%	94.70%	96.65%	97.10%	100%	92.60%	94.60%	92.50%	98%
KAPPA Value	0.403	0.682	0.933	0.968	0.965	1	0.934	0.9	0.862	0.282
p Value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.006

(IRA- infrarenal aorta, CIA- common iliac artery, EIA- external iliac artery, CFA-common femoral artery, PLFA-proximal left profundafemoris artery, SFA- Superficial femoral artery, PA- popliteal artery,ATA- anterior tibial artery, PTA-posterior tibial artery, DPA-dorsalis pedisartery)

DISCUSSION

The comparison between USG and CT for the Infra-renal aorta (IRA) showed that USG had poor sensitivity at only 31.3%, meaning it could detect only a small fraction of true positives seen on CT. However, it showed excellent specificity at 100%, indicating no false positives. The positive predictive value (PPV) was also 100%, while the negative predictive value (NPV) was 80.7%. The moderate Kappa value of 0.403 and statistically significant p-value (<0.001) suggest moderate agreement and that the findings are not due to chance. In contrast, USG's performance for the Common Iliac Artery (CIA) was better, with a sensitivity of 61.9% and specificity of 100%. The PPV remained at 100%, and the NPV was 83.7%, indicating that USG could reliably rule in disease and had a reasonable capability to rule it out. The Kappa value of 0.682 points to substantial agreement with CT findings, further supported by a p-value < 0.001. USG proved to be highly effective for the External Iliac Artery (EIA), with a sensitivity of 92.3%, specificity of 100%, PPV and NPV of 100% and 94.7% respectively, and a near-perfect Kappa value of 0.933. Similarly, in the Common Femoral Artery (CFA), USG demonstrated exceptional accuracy with sensitivity of 97.1%, specificity of 100%, and both PPV and NPV nearing perfection. The Kappa value was 0.968, again showing almost perfect agreement with CT.

For the Profunda Femoris Artery(PPFA), USG showed similarly high performance with

96.2% sensitivity, 100% specificity, and near-perfect predictive values. The Kappa value of 0.965 reflects almost perfect agreement, making USG a very reliable tool at this level of the arterial tree. In the Superficial Femoral Artery(SFA), USG achieved flawless results with 100% across all parameters-sensitivity, specificity, PPV, NPV-and a perfect Kappa of 1, indicating complete agreement with CT. In the Popliteal Artery (PA), USG maintained high diagnostic value, with sensitivity of 94.6%, specificity of 100%, and high predictive values. The Kappa value was 0.934, again showing excellent agreement. The Anterior Tibial Artery (ATA) also showed strong metrics, with sensitivity of 92.3%, specificity of 97.2%, PPV of 96.0%, and NPV of 94.6%. The agreement was excellent (Kappa = 0.9), and results were statistically significant ($p<0.001$). The Posterior Tibial Artery (PTA) comparison revealed a sensitivity of 87.5%, specificity of 97.4%, PPV of 95.5%, and NPV of 92.5%. The Kappa value of 0.862 again suggests strong agreement between USG and CT, confirming USG's diagnostic utility at this level as well. However, in the Dorsalis PedisArtery (DPA), USG's performance was less impressive. While the sensitivity was fair at 75.0% and NPV remained high at 98.0%, the specificity dropped to 82.8% and the PPVwas very low at 23.1%. This implies a high rate of false positives. The Kappa value was 0.282, indicating only fair agreement, and although the p-value was still significant (0.006), it suggests more caution is needed when interpreting USG results in this distal segment.

Most of our findings, particularly in the external iliac, femoral, and popliteal arteries, showed substantial to almost perfect agreement, indicating a higher diagnostic consistency between USG and CT than reported by Favaretto et al.[7] In the aorto-iliac region, Favaretto et al.[8] reported a Kappa value of 0.63, with a sensitivity of 63% and specificity of 96%. Our study findings align partially in this region. For the Infra-renal aorta (IRA), USG had low sensitivity (31.3%) but perfect specificity (100%), resulting in moderate agreement (Kappa = 0.403). However, performance improved significantly in the common iliac artery (CIA) and especially in the external iliac artery (EIA), where sensitivity reached 92.3%, specificity remained 100%, and Kappa increased to 0.933. This shows that while both studies found challenges in the proximal arteries, Our study revealed improved accuracy moving distally in the aorto-iliac segment.

Martinelli et al. [8] evaluated the diagnostic accuracy of Duplex ultrasound (DUS) and computed tomography angiography (CTA) in 94 patients with peripheral arterial disease, using digital subtraction angiography (DSA) as the reference standard. Their findings highlighted that CTA demonstrated perfect agreement with DSA in the iliac segment (κ=1.0), whereas DUS showed slightly lower, but still excellent, agreement (κ = 0.91). In comparison, our study also assessed the iliac arteries-specifically the Infra-renal aorta (IRA), common iliac artery (CIA), and external iliac artery (EIA). Among these, the EIA had the highest agreement between USG and CT (κ=0.933), while the CIA also showed substantial agreement (κ= 0.682). However, the IRA demonstrated only moderate agreement (κ = 0.403), reflecting some diagnostic limitations of ultrasonography in the proximal pelvic vessels, possibly due to anatomical challenges or signal attenuation. In the femoro-popliteal region, Martinelli et al. reported high concordance for both DUS and CTA with DSA. However, in the below-knee arteries, Martinelli et al. observed a decline in diagnostic agreement, with CTAachieving a κ of 0.75, indicating only moderate concordance with DSA. This limitation of CTA in distal vessels may be attributed to vessel calcification, small caliber, and motion artifacts. In our study, ultrasonography also faced similar challenges, particularly with the dorsalis pedis artery (DPA), where the κ value dropped to 0.282, indicating only fair agreement with CT.

Chidambaram P et al.[9] found that Doppler USG had an overall sensitivity of 93.36%, specificity of 82.44%, and accuracy of 86.42%. Notably, they reported that while Doppler USG correlated well with CTAin 74% of cases, it tended to overestimate stenosis in 110 segments and underestimate it in 45, raising concerns about grading precision despite overall good diagnostic utility. In comparison, our study focused exclusively on lower limb arteries and evaluated each arterial segment individually using both USG and CTA, with detailed reporting of sensitivity, specificity, PPV, NPV, and Kappa values across regions. Our findings largely support the diagnostic reliability of USG, particularly in the mid-limb segments. For example, in the superficial femoral artery (SFA), USG showed perfect agreement with CTA (Kappa = 1.0), and in the popliteal artery (PA) and common femoral artery (CFA), both sensitivity and specificity were near 100% with Kappa values above 0.93, indicating excellent agreement and diagnostic precision. The dorsalis pedis artery (DPA) in our study showed a much lower sensitivity (75.0%) and specificity (82.8%), with a Kappa value of 0.282, reflecting only fair agreement and suggesting difficulty in precise evaluation at this level. Despite this, other infrapopliteal arteries like the ATA and PTA showed high sensitivity (>87%) and strong agreement (Kappa >0.86), suggesting better performance than reported by Chidambaram P et al.[9] in similar regions. A notable difference between the two studies lies in the grading discrepancy reported by Chidambaram et al., where Doppler USG frequently misjudged the severity of stenosis. In contrast, our study focused on detection accuracy and agreement with CT rather than grading severity, and did not report substantial over-or under estimation trends, possibly indicating better operator calibration or methodological standardization. While both studies affirm the diagnostic value of Doppler USG in evaluating PAD, our study demonstrates higher segment-specific agreement and fewer discrepancies, especially in major arterial regions.These findings support the use of USG as a reliable, non-invasive first-line modality, provided it is performed by experienced operators and interpreted with consideration of anatomical and technical limitations particularly in distal segments.

CONCLUSION

From this study we conclude that, Duplex Ultrasound (USG) is a highly effective, non-invasive diagnostic tool for assessing peripheral arterial disease, particularly in proximal and mid-level arterial segments. The modality showed excellent sensitivity, specificity, and almost perfect agreement with CT findings in major vessels such as the superficial femoral artery (SFA), common femoral artery (CFA), and popliteal artery (PA), with Kappa values nearing1. This confirms its reliability in detecting both stenosis and occlusion in these regions. However, the diagnostic performance of USG declined in more distal arteries, especially in the infra-popliteal region, with lower sensitivity, reduced positive predictive value, and only fair agreement with CT, as seen in the dorsalis pedis artery (DPA) and other distal segments. These findings are consistent with prior literature, which reports technical limitations of USG in evaluating distal vessels due to factors such as small vessel size, deep location, and operator dependence.

Limitation: Studies with a limited number of participants, such as 62, often lack the statistical power to detect small but clinically significant differences between diagnostic methods. This increases the chance of Type II errors (failing to detect a difference when one exists) and reduces the reliability and robustness of results. Additionally, findings from such a small group may not accurately reflect outcomes in the broader population, limiting generalizability.

In Addition to convenience sampling, the smaller sample sizes can inadvertently introduce bias. A small cohort may not allow for adequate control or adjustment for confounding factors such as coexisting medical conditions, differences in operator expertise (especially relevant for DUS), or previous interventions, which might skew comparative results.

Despite these limitations, USG remains a cost-effective, safe, and widely available modality that performs exceptionally well in diagnosing PAD in accessible arterial regions. It can be confidently used as a first-line imaging tool, reserving CTangiography for cases where distal involvement is suspected or when USG results are inconclusive.

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