

# Role of Doppler Ultrasound Evaluation of Peripheral Arterial Diseases of Lower Limbs

Soumitra Kumar Ghosh<sup>1</sup>, Rajatsubhra Haldar<sup>2</sup>, Kaushik Chakraborty<sup>3</sup>, Sudipta Basu<sup>4</sup>,  
Sudhish Hazra<sup>5</sup>, Ananya Mondal<sup>6</sup>, Raman Sau<sup>7</sup>, Priyadarshini Sur<sup>8</sup>

<sup>1</sup>Associate Professor, Department of Radiology, Malda Medical College and Hospital, Malda, West Bengal.

<sup>2</sup>Junior Resident, Department of Radiology, Burdwan Medical College and Hospital, Bardhaman, West Bengal.

<sup>3</sup>Junior Resident, Department of Radiology, Burdwan Medical College and Hospital, Bardhaman, West Bengal.

<sup>4</sup>Associate Professor, Department of Radiology, Nil Ratan Sircar Medical College and Hospital, Kolkata, West Bengal.

<sup>5</sup>Junior Resident, Department of Radiology, Burdwan Medical College and Hospital, Bardhaman, West Bengal.

<sup>6</sup>Junior Resident, Department of Radiology, Burdwan Medical College and Hospital, Bardhaman, West Bengal.

<sup>7</sup>Junior Resident, Department of Radiology, Burdwan Medical College and Hospital, Bardhaman, West Bengal.

<sup>8</sup>Junior Resident, Department of Radiology, Burdwan Medical College and Hospital, Bardhaman, West Bengal.

## ABSTRACT

### BACKGROUND

Peripheral arterial disease is an important cause of morbidity predominantly in males, especially of elderly age group. We wanted to evaluate the presence of peripheral arterial disease of lower limb in cases clinically indicated and referred to Department of Radio-Diagnosis and document the grey scale and Doppler features of ultrasound in cases of peripheral arterial disease of lower limbs.

### METHODS

First 50 patients of clinically diagnosed peripheral arterial disease of lower limbs have been included for colour doppler ultrasonography (CDUSG). Those patients are examined by using HD7 USG machine. 7.5 MHz frequency probe is used in most cases. For obese patients and patients with thick subcutaneous fat 3.5 MHz frequency probe is utilized.

### RESULTS

The findings of first 50 clinically diagnosed PAD patients have been evaluated. Age range of most patients were from 30 to 80 years with mean age was 58 year. Smoking followed by hypertension and diabetes mellitus appear most significant risk factors with intermittent claudication being the most common clinical presentation among the cases followed by the ulceration of lower extremities. On CDUSG an average of 36 out of 50 subjects show no obvious significant luminal stenosis. Only 5 out of 50 patients show mild to moderate stenosis of Infra-Renal Aorta. However, rest of the patients who were examined showed variable degrees of stenosis from mild to severe form with few having total luminal occlusion. Wall calcification, thickening of intima-medial layers of arterial wall, monophasic vascular flow, multiple collateral formation with decrease in resistance being the usual supportive findings.

### CONCLUSIONS

Elderly subjects with features of high-risk factors are the vulnerable group of people who are most commonly affected by the peripheral arterial disease. By using CDUSG those clinically suspected patients can be diagnosed accurately and more precisely regarding the presence of lower extremity peripheral arterial disease.

### KEYWORDS

Diabetes, Doppler Ultrasound, Peripheral Arteries

*Corresponding Author:*

*Dr. Sudipta Basu,*

*Associate Professor,*

*Department of Radiology,*

*Nil Ratan Sircar Medical College and Hospital,*

*#10, Yogipara, Byelane P.O.,*

*Beadon Street, Kolkata- 700006,*

*West Bengal.*

*E-mail: basusudipta71@rediffmail.com*

*DOI: 10.18410/jebmh/2020/216*

*Financial or Other Competing Interests:*  
*None.*

*How to Cite This Article:*

*Ghosh SK, Haldar R, Chakraborty K, et al.*

*Role of doppler ultrasound evaluation of*

*peripheral arterial diseases of lower*

*limbs. J. Evid. Based Med. Healthc. 2020;*

*7(20), 991-995. DOI:*

*10.18410/jebmh/2020/216*

*Submission 05-04-2020,*

*Peer Review 08-04-2020,*

*Acceptance 27-04-2020,*

*Published 18-05-2020.*



## BACKGROUND

Peripheral Arterial Disease (PAD) is characterised by longstanding arterial occlusive disorder due to narrowing or occlusion of arterial system predominantly involving the distal aspect of abdominal aorta and its branches. The arterial branches of lower extremities rather than the upper extremities are greatly affected by this condition which appear stenosed with decrease in vascular resistance. Elder peoples are most commonly affected who are initially presented with pain sensation leg muscles during exertion or walking some distance. The superficial femoral artery and popliteal artery of lower extremities are usually get affected frequently as a result the pain of intermittent claudication<sup>1</sup> is most commonly localized to the calf muscles which are supplied by those arteries. Similarly, when the atherosclerotic obstruction involves the distal aorta and its bifurcation into the two iliac arteries that lead to feeling of pain sensation in the buttocks, hips, thighs. It has been seen that men are most commonly affected by this condition than the women. However, women with this disorder have shown a higher prevalence of lower extremity pain following walking or exercise.

At resting state there is poorer functioning, and greater walking impairment from these leg related symptoms found in women than men with PAD.<sup>2</sup> Globally there are more than 200 million male and women are affected by PAD of whom around 8 million are from USA.<sup>3</sup> There are so many morbidities that are considered as important risk factors for PAD those include smoking, diabetes mellitus, hyperlipidaemia, and hypertension.<sup>3,4</sup> Presence of any of those risk factors are associated with development of atherosclerotic change of vessel wall which is considered as the important cause of PAD. Others fewer common causes are vasculitis like Buerger's disease, thromboembolism and trauma etc. Slower outdoor walking speed and involving more in sedentary activities are associated with rapid reduction of functional activities and grave calf muscular changes are found in PAD.<sup>4,5</sup> With disease progression those affected distal arterial lumen undergo near total occlusion that lead to compromise vascular supply to the muscles of lower limbs. In advanced stage because of lack of resting tissue metabolism, critical lower limb ischemia happens. Patients then feel pain in leg even during resting state. Longstanding vascular insufficiency leads to ulceration or even gangrenous changes of leg commonly involving the ankle, foot or toes. PAD is also seen to associated with increased incidence of cardiovascular disease as well as cerebrovascular accident.

PAD is clinically extremely significant from epidemiological study point of view. Dr Geoffrey Rose, a London epidemiologist<sup>5</sup> has described and characterised the classical leg symptoms the intermittent claudication for proper epidemiological study. He developed The Rose Claudication Questionnaire to promote the standardized measurement of the incidence, prevalence, and significance of claudication symptoms for epidemiological population studies.

The most commonly used classifications of lower extremity PAD are Fontaine (in Europe) and Rutherford (in the USA). The Rutherford classification describes stages of peripheral artery disease Stage 0: Asymptomatic. Stage 1: Mild claudication. Stage 2: Moderate claudication – the distance that delineates mild, moderate and severe claudication is not specified in the Rutherford classification, as it is in the Fontaine classification. Stage 3: Severe claudication. Stage 4: Rest pain.

Ultrasound imaging is the initial investigation of choice. It provides a measurement of blood velocity through a vessel and colour Doppler imaging. Its association with interventional endovascular procedures explains the significant development of colour Doppler these days. Thus, it allows the follow up of the arterial disease by carrying out a precise vascular mapping. Colour Doppler imaging is safe, popular, cost effective, repeatable, non-invasive procedure for investigating lower limb arteries. Ultrasound currently remains an important modality in the evaluation of peripheral arterial disease and even if MR angiography eventually becomes the pre-eminent technique in the evaluation of this disease, ultrasound will likely continue to have a role in many settings (e.g. post-angioplasty assessment, pseudo aneurysm etc).

In present study, we have made an evaluation of the colour Doppler ultrasonography in the peripheral arterial disease assessment.

## METHODS

This study was performed at the Department of Radiology in Burdwan Medical College & Hospital among first 50 referred cases of clinically diagnosed peripheral arterial disease of lower limb. US Doppler examination was performed on Philips HD7 US machine with colour Doppler.

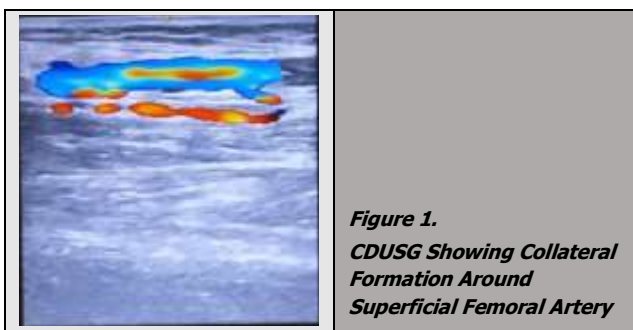
### Exclusion Criteria

1. Patients suffering from lower limb trauma or degloving injuries or burns.
2. Pregnant females

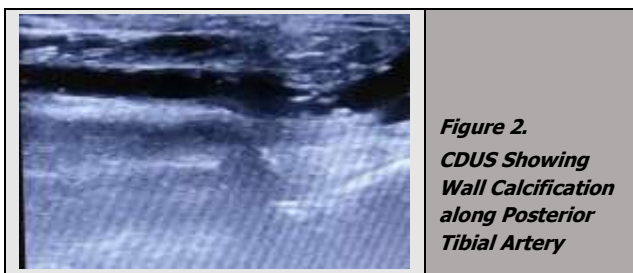
## RESULTS

The present study was conducted on first 50 patients of clinically diagnosed peripheral arterial disease of lower limbs. After clinical examination patients underwent CDUSG. Age range of the patients varied from 30-80 years with a mean age of 58 years. Majority of patients were below 60 years. Majority of the patients (72%) of our study were male with a male: female ratio of 2.57: 1. Maximum number of patients (42%) of our study were presented with the duration of symptoms of 4-8 weeks followed by 26% patients who were presented with the duration of >8-12 weeks.

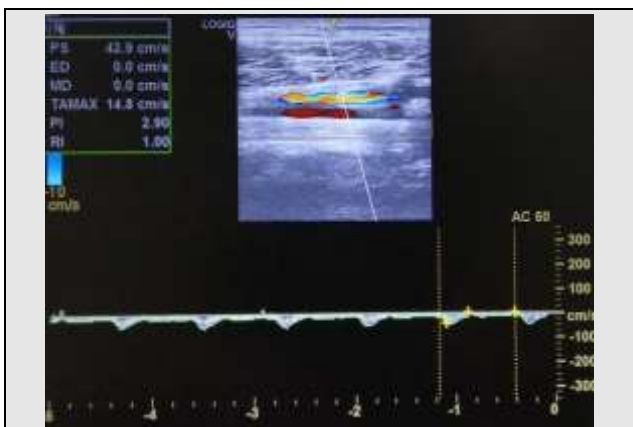
Intermittent claudication was the commonest symptoms of our study involving 46% patients followed by ulceration involving 32% patients, rest pain found in 24% patients, colour change in 10% patients, coldness involving 8% patients and gangrene in 4% patients. A majority of the patients (48%) had complaints in the left lower limb and 26% in the right lower limb in our study. 16% of the patients had bilateral lower limb pain which was more so on the left side (12%) and 4% on the right side. 10% patients were presented with abdominal pain. Smoking, hypertension, diabetes mellitus, hyperlipidaemia, alcohol intake and high BMI were the leading risk factors observed in our study involving 60%, 42%, 32%, 38%, 20% and 30% patients respectively.



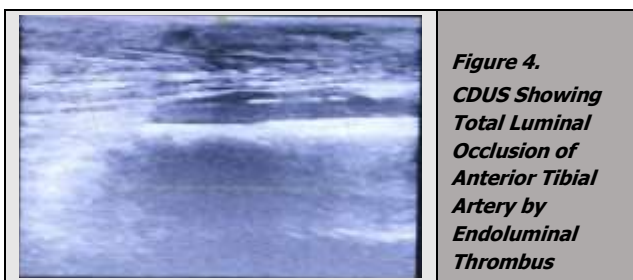
**Figure 1.**  
CDUSG Showing Collateral Formation Around Superficial Femoral Artery



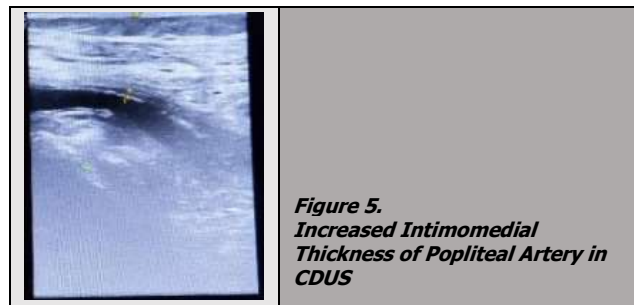
**Figure 2.**  
CDUSG Showing Wall Calcification along Posterior Tibial Artery



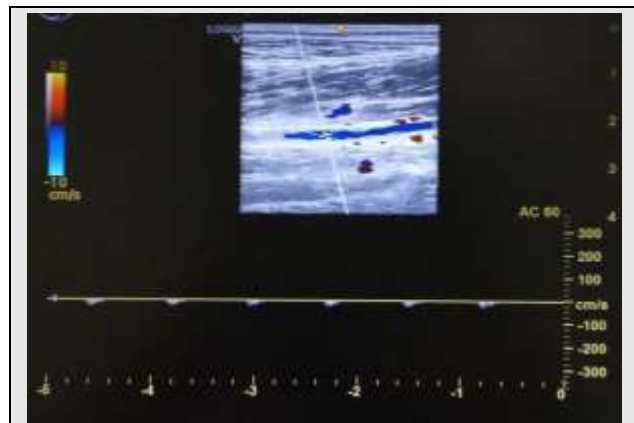
**Figure 3.** CDUSG Showing Monophasic Waveform in Anterior Tibial Artery



**Figure 4.**  
CDUSG Showing Total Luminal Occlusion of Anterior Tibial Artery by Endoluminal Thrombus



**Figure 5.**  
Increased Intimomedia Thickness of Popliteal Artery in CDUS



**Figure 6.** CDUSG Shows Monophasic Waveform, Luminal Narrowing and Collateralization around Posterior Tibial Artery

Stenosis Severity Grade	Infra Renal Aorta		Common Iliac Artery		External Iliac Artery	
	No. of Patients	%	No. of Patients	%	No. of Patients	%
Normal (0)	45	90	35	70	36	72
Mild (1)	3	6	5	10	5	10
Moderate (2)	2	4	4	8	2	4
Severe (3)	0	0	1	2	1	2
Occlusion (4)	0	0	5	10	6	12

**Table 1.** Colour Doppler USG Findings of Infra Renal Aorta, Common Iliac Artery and External Iliac Artery

Stenosis Severity Grade	Common Femoral Artery		Superficial Femoral Artery	
	No. of Patients	%	No. of Patients	%
Normal (0)	42	84	40	80
Mild (1)	3	6	4	8
Moderate (2)	1	2	2	4
Severe (3)	2	4	2	4
Occlusion (4)	2	4	2	4

**Table 2.** Colour Doppler USG Findings of Common Femoral Artery and Superficial Femoral Artery

Stenosis Severity Grade	Deep Femoral Artery		Popliteal Artery	
	No. of Patients	%	No. of Patients	%
Normal (0)	39	78	33	66
Mild (1)	5	10	4	8
Moderate (2)	3	6	6	12
Severe (3)	2	4	3	6
Occlusion (4)	1	2	4	8

**Table 3.** Colour Doppler USG Findings of Deep Femoral Artery and Popliteal Artery

Stenosis Severity Grade	Tibio-Peroneal Trunk		Peroneal Artery	
	No. of Patients	%	No. of Patients	%
Normal (0)	28	56	34	68
Mild (1)	7	14	7	14
Moderate (2)	9	18	8	16
Severe (3)	4	8	1	2
Occlusion (4)	2	4	0	0

**Table 4.** Colour Doppler USG Findings of Tibio-Peroneal Trunk and Peroneal Artery

Stenosis Severity Grade	Anterior Tibial Artery		Posterior Tibial Artery	
	No. of Patients	%	No. of Patients	%
Normal (0)	32	64	34	68
Mild (1)	6	12	5	10
Moderate (2)	7	14	7	14
Severe (3)	3	6	3	6
Occlusion (4)	2	4	1	2

**Table 5. Colour Doppler USG Findings of Anterior Tibial Artery and Posterior Tibial Artery**

The lower limb arterial system was divided into 3 anatomical regions-

1. Aorto-Iliac Region including Infra-renal aorta, common iliac arteries, external iliac arteries.
2. Femoral Region including common femoral artery, superficial femoral artery, deep femoral artery and popliteal artery.
3. Tibial Region including tibio-peroneal trunk, anterior and posterior tibial artery and peroneal artery. Each and every anatomical segment of the arterial tree was assigned a grade for the disease extent as visualized using a five point scale: 0=Normal, 1=Mild stenosis (1–19% diameter reduction), 2=Moderate stenosis (20–49% diameter reduction), 3=Severe stenosis (50–99% diameter reduction), 4=Occlusion.

## DISCUSSION

The present study was carried out on first 50 patients who were clinically diagnosed with peripheral arterial disease of lower limbs. Those first 50 patients who were subjected to Clinically examined and diagnosed with peripheral arterial disease of lower limbs have been undergone CDUSG. The CDUSG findings were assessed and compared under the following headings:

In our study, maximum number of patients (60%) were below 60 years. In a study by Rahul et al,<sup>6</sup> 10 (33.3%) out of 30 patients belonged to 61-70 years. age group, 9 patients belonged to 51-60 years. (30%), 2 patients were less than 40 years (13.3%). This is in comparison to study done by Cossman et al<sup>7</sup> show 17 out of 30 patients belonged to 61-80 yrs.

In the current study majority of patients (72%) were male with a male female ratio of 1.28: 1. In a similar study by Rezia et al<sup>8</sup> found 86.2% patients were male and 13.8% were female. This was in a comparison to study of Hughson et al. In their study, they found that 80% patients were males. Male predominance was also encountered in a previous similar study by Das et al.<sup>9</sup> Of 60 patients they examined for diabetic lower limbs arterial disease, 60% were male and 40% were female.

Intermittent claudication (46%) was the commonest symptoms followed by ulceration (32%), rest pain (24%), colour change (10%), coldness (8%) and gangrene (4%). Similar findings were observed in a study by Ali a et al<sup>10</sup> where ulceration was the commonest symptoms followed by intermittent claudication, rest pain, coldness and colour change. In a study by Vipin Kumar Choudhary et al<sup>11</sup>

majority of patients had complaints of intermittent claudication i.e. 25 out of 40 cases (62.5%), followed by rest pain (22.5%), skin discoloration (7.5%), gangrene (5%) and numbness (2.5%). This is consistent with Kannel and McGee<sup>12</sup> who showed in their study that intermittent claudication is the most common manifestation of PAD.

In the present study commonest risk factor observed among patients was hyperlipidaemia (60%), followed by hypertension (42%), smoking (38%), and diabetes mellitus (32%). The least common risk factors were alcohol intake (20%) and high BMI (30%). This observation is an association with the study by Parikh et al<sup>13</sup> where he observed smoking was the most leading risk factor involving 80% patients followed by hyperlipidaemia (60%) and diabetes mellitus (45%).

The sensitivity of Doppler in evaluating aortoiliac segments the sensitivity and specificity rate was 100% and 94.61% respectively. In evaluating aortoiliac femoropopliteal segments the sensitivity and specificity rate was 100 and 94.25%, respectively. And in evaluating tibial segments the sensitivity and specificity rate was 100% and 92.67% respectively. Similar findings were observed in the study conducted by Ali A et al.<sup>10</sup> Similar results were also found in a previous study by Kandasamy et al.,<sup>14</sup> who compared the results of Doppler ultrasonography with CTA in 34 patients.

The sensitivity of Doppler in evaluating aortoiliac segments and femoropopliteal segments was 87.5 and 100%, respectively, and the specificity in evaluating aortoiliac segments and femoropopliteal segments was 100 and 96.01%, respectively. Other studies by Chidambara et al<sup>15</sup> reported that, as regards the iliac segments, the sensitivity, specificity, and accuracy of Doppler ultrasound were 96.55, 94.79, and 95.2%, respectively. In femoropopliteal segments, the sensitivity, specificity, and accuracy of Doppler ultrasound were 88.88, 92.95, and 91.58%.

In all cases of peripheral arterial disease, Colour Doppler USG is the initial investigation of choice in PAD. This, dynamic imaging modality facilitates proper anatomical orientation of distal lower limb vascular channel, its direction of blood flow as well as assessment of its physiological properties. CDUSG along with other available imaging modalities help to evaluate more detailed PAD related changes.

## CONCLUSIONS

Elderly people are with increased risk of peripheral arterial disease. Males are more commonly affected. The common risk factors include smoking, hypertension, diabetes and hyperlipidemia. The commonest site of pathology is femoropopliteal segment and its distal branches. CDUSG which is considered as the first-line of investigation, can accurately locate the site and extent of stenosis/occlusion.

<b>REFERENCES</b>
-------------------

- [1] McDermott MM, Greenland P, Liu K, et al. Leg symptoms in peripheral arterial disease: associated clinical characteristics and functional impairment. *JAMA* 2001;286(13):1599-1606.
- [2] McDermott MM, Greenland P, Liu K, et al. Sex differences in peripheral arterial disease: leg symptoms and physical functioning. *Journal of the American Geriatrics Society* 2003;51(2):222-228.
- [3] Roger VL, Go AS, Lloyd-Jones DM, et al. Heart disease and stroke statistics--2012 update: a report from the American Heart Association. *Circulation* 2012;125(1):e2-e220.
- [4] Joosten MM, Pai JK, Bertola ML, et al. Associations between conventional cardiovascular risk factors and risk of peripheral artery disease in men. *JAMA* 2012;308(16):1660-1667.
- [5] Rose GA. The diagnosis of ischaemic heart pain and intermittent claudication in field surveys. *Bull World Health Organ* 1962;27(6):645-658.
- [6] Singh R, Sran AS, Mittal A, et al. Role of MDCT in evaluation of peripheral vascular disease of the lower limb arteries and comparison with colour Doppler. *International Journal of Scientific Research* 2019;8(1):18-21.
- [7] Cossman DV, Ellison JE, Wagner WH, et al. Comparison of contrast arteriography to arterial mapping with color-flow duplex imaging in the lower extremities. *J Vasc Surg* 1989;10(5):522-529.
- [8] Peedikayil RU, Rajendran VR, Monthampally S, et al. Multidetector CT angiography v/s colour Doppler ultrasonography in the diagnosis of peripheral arterial diseases of lower extremities. *J Evolution Med Dent Sci* 2016;5(63):4457-4461.
- [9] Das G, Gupta AK, Aggarwal A. Assessment of lower limb arteries by Doppler sonography in diabetic patients. *Int J Res Health Sci* 2015;3(1):18-23.
- [10] Ali ZA, Habib RM, Abo Hendy MA. Comparative study between Doppler ultrasound and computed tomography angiography in diabetic lower limb arterial insufficiency. *Menoufia Med J* 2018;3(3):1050-1057.
- [11] Choudhary VK, Gehlot RN, Chaturvedy K, et al. Role of Doppler ultrasonography in evaluation of peripheral arterial disease with CT angiography correlation. *JMSCR* 2019;7(6):166-174.
- [12] Kannel WB, McGee DL. Update on some epidemiologic features of intermittent claudication: the Framingham study. *J Am Geriatr Soc* 1985;33(1):13-18.
- [13] Parikh C, Brahmbhatt P, Raychaudhuri C. Efficacy of color Doppler imaging over CT angiography in peripheral arterial disease. *Journal of Integrated Health Sciences* 2017;5(2):45-52.
- [14] Kandasamy G, Maithrayee A, Kailasanathan N. Lower limb arteries assessed with Doppler angiography. A prospective comparative study with multi detector CT angiography. *Int J Latest Res Sci Tech* 2015;4(6):70-83.
- [15] Chidambaram PK, Swaminathan RK, Ganesan P, et al. Segmental comparison of peripheral arteries by Doppler ultrasound and CT angiography. *J Clin Diagn Res* 2016;10(2):TC12-TC16.