

Evaluation of Peripheral Arterial Disease of Lower Extremity by Doppler Imaging

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Abstract

Background: Doppler ultrasonography has earned recognition as the optimal screening technique for the detection of peripheral arterial disease (PAD). Doppler using color Doppler, pulse wave Doppler, and power Doppler combined with baseline grayscale ultrasound has proved to be very useful, sensitive, and cheap tool to identify and characterize lesions of PAD.

Materials and Methods: A total of 50 patients with symptoms of PAD were subjected to Doppler examination, and the pathoanatomy of the lesions of PAD was mapped along with a study of their risk factors during the period from December 2011 to December 2013.

Results: The risk factors and Doppler features of 60 limbs affected with PAD were reviewed. 90% cases were above the age of 40 years with mean age of presentation being 52.12 years. Among all patients of PAD male to female ratio was around 2:1. Symptomatically intermittent claudication was the most common symptom seen in 62% cases followed by color and temperature changes (COLD), gangrene (GG), and rest pain. Evaluation of risk factors identified 60% were having hypertension while 52% had diabetes mellitus. Nearly 50% patients had the habit of smoking. The other risk factors found in our study were hyperlipidemia, alcohol intake (ALC), and ischemic heart disease. Femoral segments were most commonly affected with 43.33% in superficial femoral artery followed by 30% in popliteal artery and 20% in the common femoral artery. Below knee involvement was seen in 21 cases. Hemodynamically significant stenosis 74.25% had involvement of the femoropopliteal segment, 7% in the iliac segment, and 18.59% of infrapopliteal segments. 34 cases had plaques identified in them, low echogenicity plaque was seen in 23.68% cases while moderate to severely echogenic plaques that are seen as the disease progresses were seen in 76.32% cases. Peak systolic velocity ratios of <2 were obtained in 21.6%, 2-4 in 30%, >4 in 11.66%, and total block in 36.66%.

Conclusion: Doppler examination proves to be a valuable modality of imaging in evaluating the characteristics, distribution, localizing, and assessing the extent of lesions of PAD.

Key words: Claudication, Doppler, Ischemia, Peripheral arterial disease

INTRODUCTION

Lifestyle diseases such as diabetes mellitus (DM), hypertension (HTN), and obesity predispose the individual peripheral arterial diseases (PAD) of the lower limb.^{1,2} PAD is the most common disease affecting lower limb arteries and

causes a reduction in arterial supply secondary to stenosis and occlusion. PAD can be asymptomatic or have symptoms such as claudication, rest pain (RP), local ulcerations, and gangrene (GG). In late stages, it can even necessitate limb amputation. Atherosclerosis is the most common cause of PAD. Other causes include thromboembolism, inflammation of vessel walls, micro embolism, and trauma.³ Initial luminal narrowing by the deposition of atheromatous plaques is compensated by dilatation of vessel lumen. The plaque may rupture with the formation of thrombus and embolism phenomenon downstream; the ruptured plaque heals by fibrosis causing permanent stenosis of the lumen. This hemodynamic compromise is the cause of the clinical manifestations of PAD.⁴

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Invasive contrast-based investigations, such as arteriography and ankle-brachial index computed tomography angiography, are the various modalities used for PAD. Ultrasonography combined with Doppler imaging has been found to be useful in the mapping of the vascular anatomy of lower limbs. Advantages are it is very sensitive to identify thrombus, stenosis, and provide a dynamic assessment of the hemodynamic status of the vessel. It is radiation free, portable, cheap, and easily available. The Doppler findings in PAD are helpful for planning surgical versus medical management and for post procedure surveillance.^{5,6} This study aims to study the risk factors and evaluate the role of Doppler ultrasound (US) examination to study characterization, classification, distribution of lower limb PAD.

MATERIALS AND METHODS

A hospital-based descriptive study was conducted on 50 patients with clinical diagnosis of PAD. This study was done in the Department of Radio-diagnosis and Imaging of Dr. Vaishampayan Memorial Government Medical College, Solapur in a period of 2-year from December 2011 to December 2013. Patients who were pregnant, suffering from lower limb trauma or degloving injuries or burns were excluded from the study. The US Doppler examination was performed on Siemens Acuson X300 US machine with color Doppler. Patient demographic and clinical history was noted, and images were evaluated for location, plaque characterization, degree of stenosis, peak systolic velocity (PSV) ratio, and sites of significant stenosis.

RESULTS

The data were entered in the master chart and analyzed using Statistical Package. The results were converted in the form of graphs and pie diagrams for easy understanding and comparison. The results are displayed from Figures 1-8.

In our study of 50 patients, 10 patients had bilateral disease so in total 60 limbs affected with PAD were evaluated. The range of presenting age was 13-82 years (Figure 1). 90% cases were above the age of 40 years with mean age of presentation being 52.12 years. It is a known fact that prevalence of PAD increases with increasing age and is in correlation with the studies done by Hughson *et al.*,⁷ Fowkes,⁸ and Vogt *et al.*⁹ 72% patients were males while only 28% were females (Figure 2). Hughson *et al.*⁷ in their study found that 2% males and 1% females had symptoms of PAD in the community. Our findings also show a male to female ratio of around 2:1. Symptomatically, we found

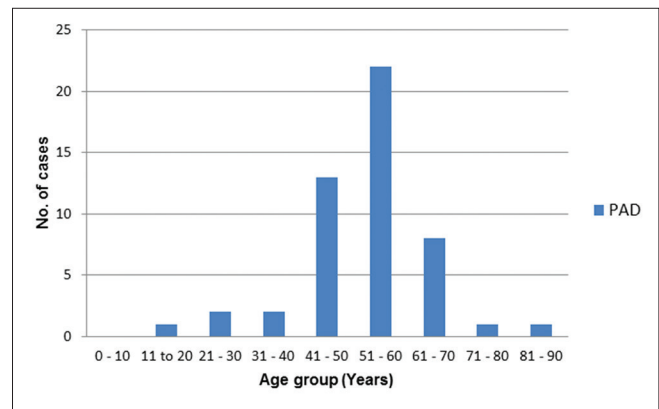


Figure 1: The age wise distribution of patients affected with peripheral arterial disease

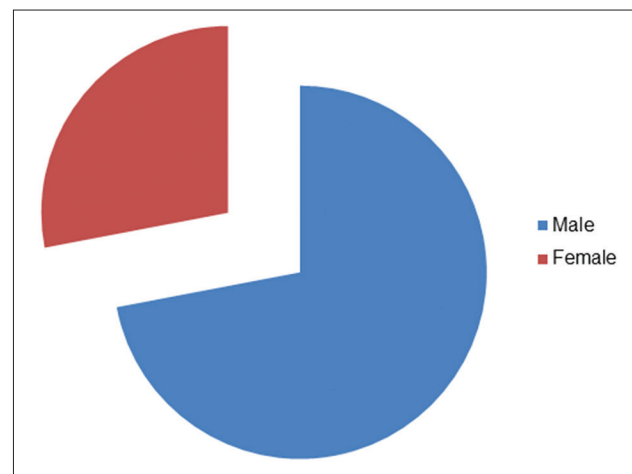


Figure 2: Sex wise distribution of peripheral arterial disease

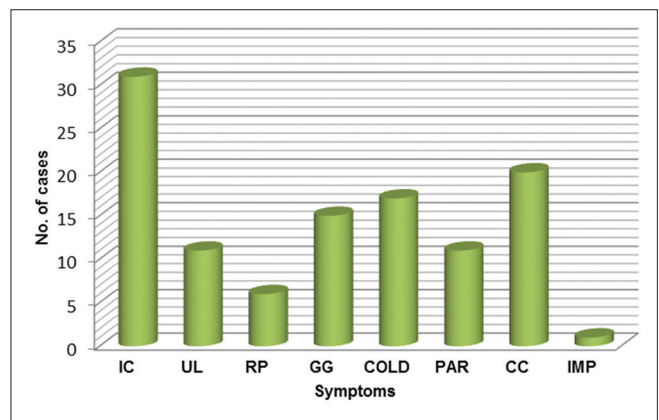


Figure 3: Symptom wise distribution of peripheral arterial disease

intermittent claudication (62%) being the most common symptoms. Color and temperature changes, GG, and RP were the other common presentations. Impotence was found in a single case, and it was associated with DM (Figure 3). Kannel and McGee¹⁰ in their study stated that IC is the most common manifestation of PAD. Rajan¹¹

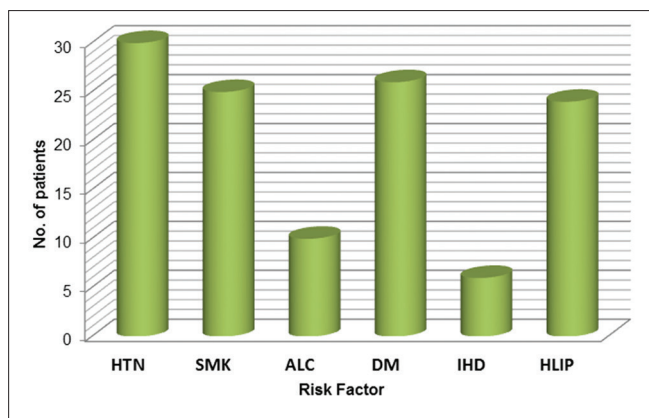


Figure 4: Risk factor wise distribution of peripheral arterial disease

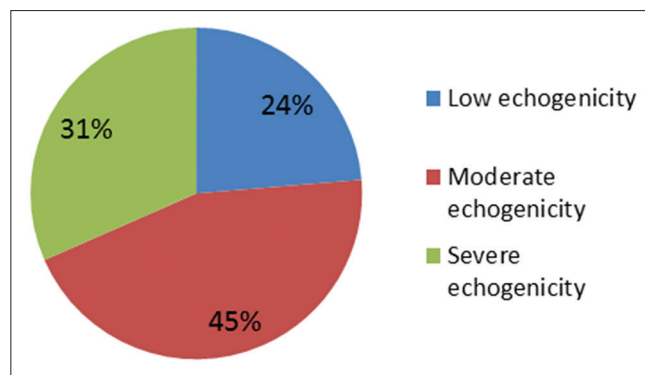


Figure 7: Echogenicity wise distribution of plaques

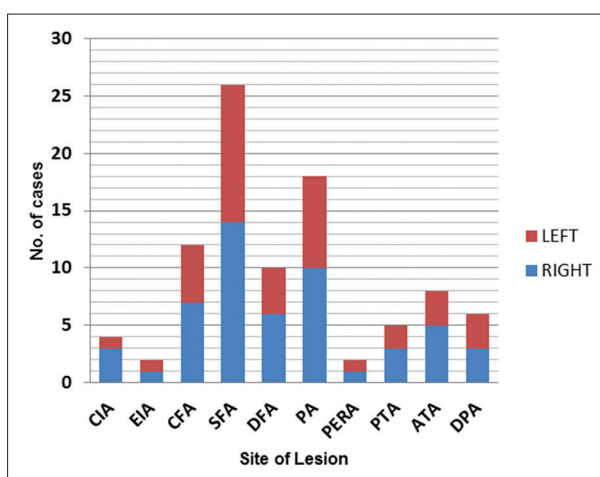


Figure 5: Anatomic segment wise distribution of peripheral arterial disease

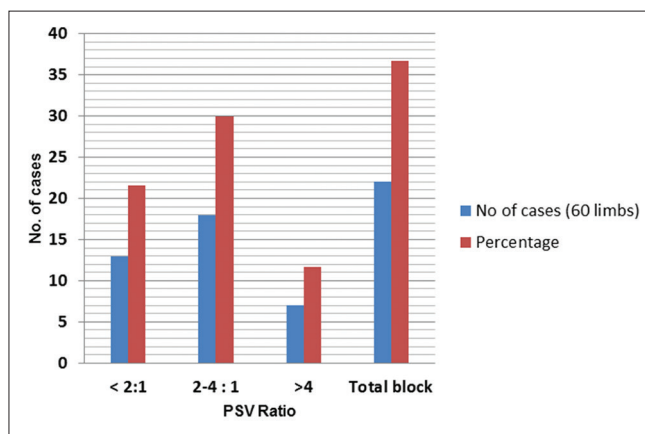


Figure 8: Distribution based on peak systolic velocity ratio

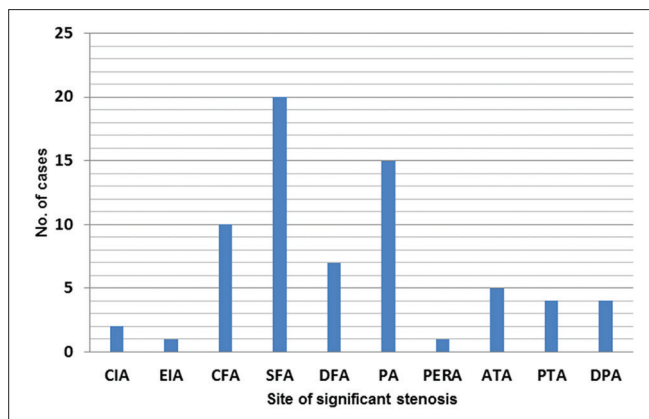


Figure 6: Distribution based on site of significant stenosis

in his study of 188 cases of PAD reported 32% had GG while it was found in 30% patients of our study. Evaluation of risk factors identified 60% were having HTN while 52% had DM. Nearly 50% patients had the habit of smoking (SMK) with half of them smoking more than 20-30 cigarettes daily for more than two

decades. The other risk factors found in our study were hyperlipidemia (HLIP), alcohol intake and ischemic heart disease (IHD) (Figure 4). Krishnaswamy *et al.*¹² in their study found HTN in around 29.3% and DM in 30.3% of patients with PAD. In their study, Gordon and Kannel¹³ found the relative risks of developing PAD in smokers being 1.7-7.5 times. The other risk factors found in their study were HLIP, alcohol intake, and IHD. Similar findings were observed in the study of Hughson *et al.*⁷ where they also found that when present together these factors had a multiplicative effect. In our study, the majority of the lesions were involving the femoral segments with most of them (43.33%) in superficial femoral artery followed by 30% in popliteal artery and 20% in the common femoral artery. Below knee involvement was seen in 21 cases (Figure 5). Among patients with hemodynamically significant stenosis, 74.25% had involvement of the femoropopliteal segment, 7% in the iliac segment, and 18.59% of infrapopliteal segments (Figure 6). Ahchong *et al.*¹⁴ in their study of severely stenosed cases of PAD found 76% had femoropopliteal involvement. In patients with complete occlusion who had significant collaterals had the severest symptoms. This is in correlation with the study of Suzuki *et al.*,¹⁵ who stated poor prognosis in cases with collaterals and absence of flow in the main trunk. 34 cases

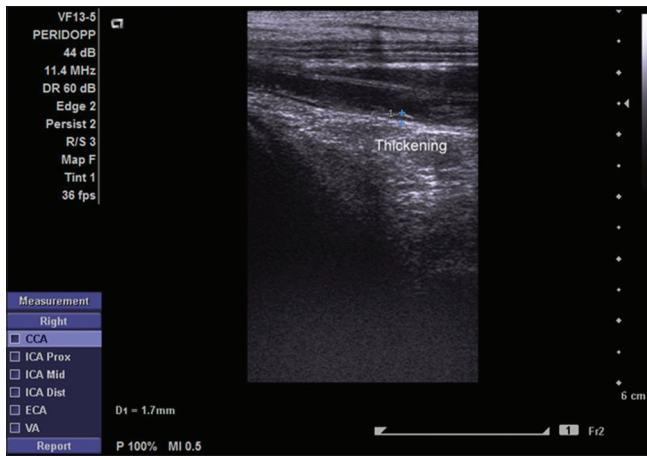


Image 1: Longitudinal grayscale image showing intimal thickening involving Dorsalis pedis artery

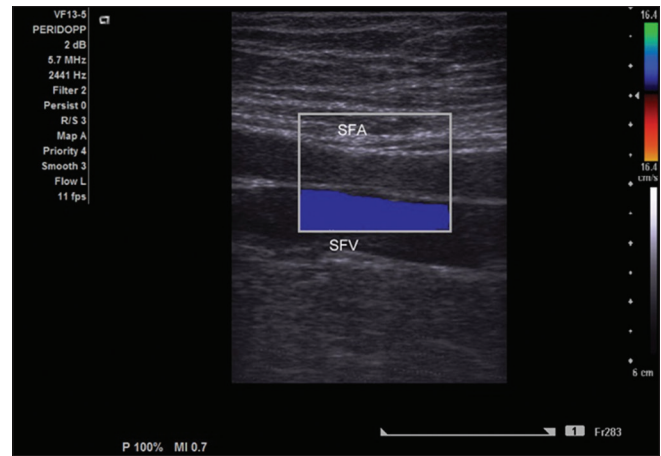


Image 4: Longitudinal color Doppler image of chronic thrombosis of superficial femoral artery with thickened walls

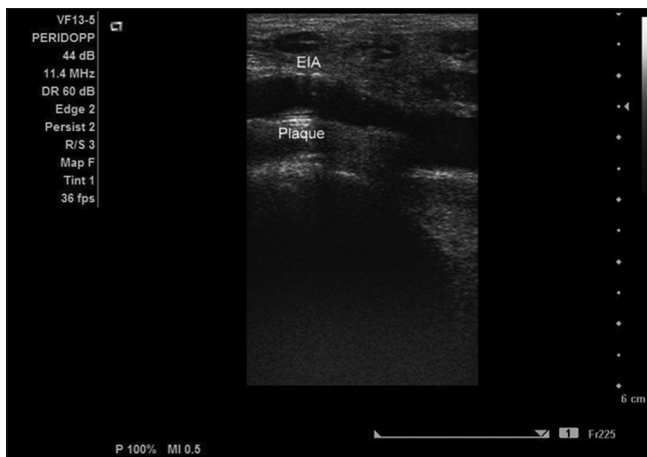


Image 2: Longitudinal grayscale image showing chronic calcified plaque in external iliac artery

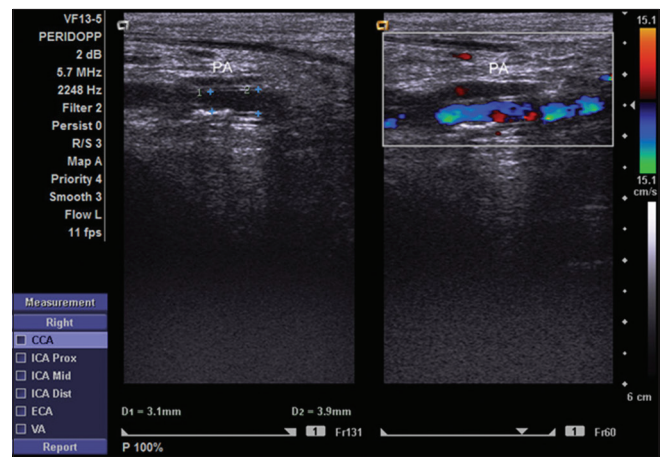


Image 5: Longitudinal grayscale and color Doppler images of popliteal artery with mild stenosis showing turbulent color flow at site of stenosis

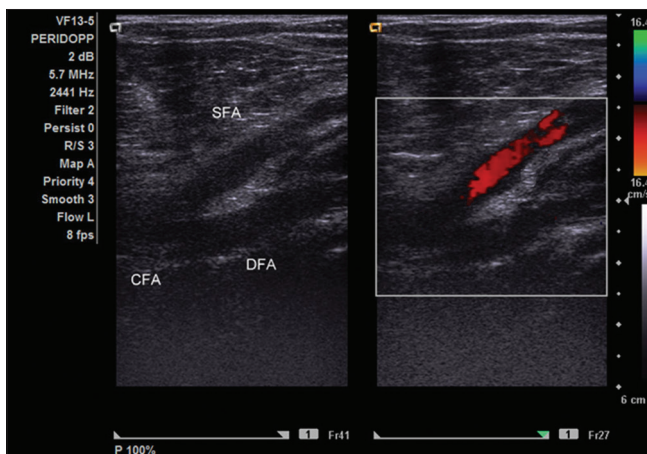


Image 3: Longitudinal grayscale and color Doppler images of acute thrombosis of common femoral artery and deep femoral artery with normal color flow in superficial femoral artery



Image 6: Transverse grayscale and color Doppler images showing thrombosed popliteal artery with collateral formation

had plaques identified in them; low echogenicity plaque was seen in 23.68% cases while moderate to severely echogenic plaques that are seen as the disease progresses

were seen in 76.32% cases (Figure 7). Hughson *et al.*⁷ found atherosclerosis to be a most important factor associated in IC and subsequently with PAD. Thus, the atherosclerotic

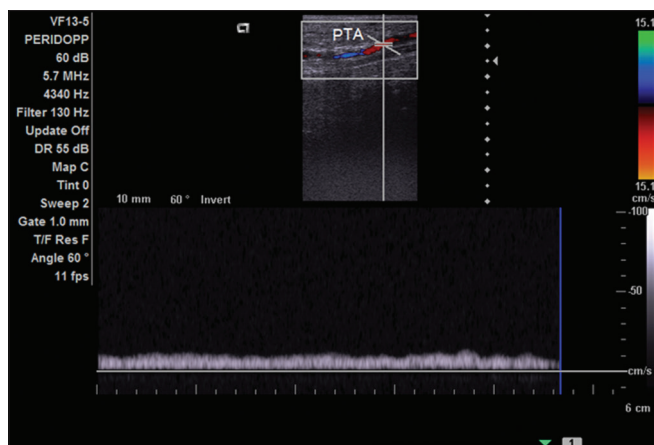


Image 7: Longitudinal color Doppler image of post-thrombotic posterior tibial artery showing monophasic waveform

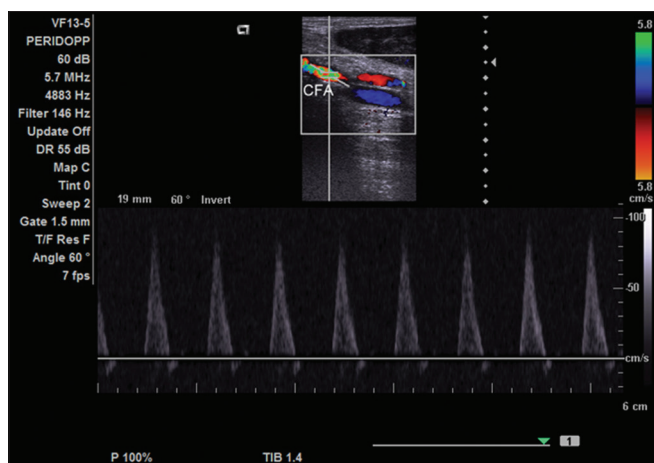


Image 8: Longitudinal color Doppler image showing moderately stenotic common femoral artery with biphasic waveforms

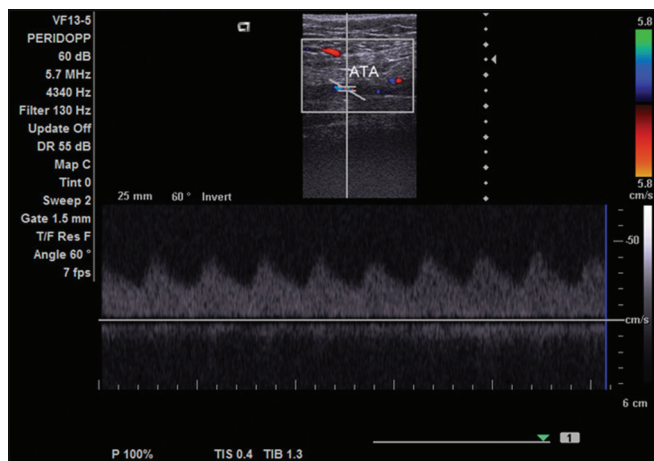


Image 9: Longitudinal color Doppler image of post-stenotic segment of anterior tibial artery showing low resistance flow pattern

lesions of PAD are mostly chronic and this is similar to the study of Maseri and Fuster,¹⁶ who found chronic plaques to predominate in settings of PAD. Out of the 50 patients of PAD, PSV ratios of <2 were obtained in 21.6%, 2-4 in

30%, >4 in 11.66%, and total block in 36.66% (Figure 8). In our study, among the 25 patients who had PSV ratio more than 2, 60% had hemodynamically significant stenosis. As per the study done by Cossman *et al.*,¹⁷ a PSV ratio more than 2 is seen in hemodynamically significant lesions and severity of stenosis is proportional to the PSV ratio. Using PSV ratio in Doppler reports is easy to remember, provides standardization, and clinically comparable.

Images (1-9) explain the various findings that can be demonstrated using doppler imaging.

CONCLUSION

In this study using Doppler examination, it was possible to categorize the diseases as PAD along with their pathoanatomy mapping. The lesions could be also classified as acute versus chronic, significant versus non-significant stenotic. We also studied the age and sex wise distribution of the lower limb vascular diseases with the underlying risk factors for them. Thus, color Doppler imaging is an excellent modality for PAD of lower limbs. Finally, the findings of this study correlate well with many other studies reported in the literature.

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