CORRELATION OF DUPLEX SCAN AND CLINICAL PROFILE OF PERIPHERAL VASCULAR DISEASES IN DMCH

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Abstract

Background: *Duplex ultrasound is a non-invasive evaluation of blood flow in the major arteries and veins. It provides a unique spectrum of details, including the anatomical location of the lesion, accompanied by further information about flow velocity and volume. Day by day, this investigation has become popular among physicians and surgeons to evaluate peripheral arterial disease.*

Objective: *To determine duplex scans' accuracy in diagnosing peripheral arterial disease and correlate it with clinical diagnosis.*

Materials & Methods: *The cross-sectional study was conducted in the Department of General Surgery in collaboration with the Department of Radiology & Imaging, Dhaka Medical College Hospital, Dhaka from January 2011 to December 2011. A total of 100 clinically diagnosed cases of peripheral arterial disease, irrespective of age and sex, were included in the study. However, emergency cases of peripheral arterial disease and patients of peripheral arterial disease with concomitant cerebrovascular disease or venous pathology or arterio-venous malformation were excluded from the study. Based on clinical signs and symptoms, a clinical diagnosis was made, correlated with the diagnosis made by duplex scan findings.*

Result: *Peripheral arterial disease was mainly confined to the lower limb (85%). The right limb was involved in about two-thirds (64%) of the cases, the left limb in 31%, and both limbs in 5% of cases. More than 90% were a smoker. Pain and intermittent claudication were the universal complaints of the patients, followed by hair changes (85%), colour changes (86%) and wasting of the limb (65%). The most commonly involved arteries in the lower limb were arteria dorsalis pedis (96.6%), followed by the posterior tibial artery (84.2%), popliteal artery (60.6%), and femoral artery (21.3%). In the upper limb, the radial artery was involved in 100% of cases and the brachial artery in 86.7% of cases. Endarteritis obliterans and atherosclerosis were common clinical diagnoses (47% and 48%, respectively). Diagnosis based on duplex scan findings also demonstrated that endarteritis obliterans and atherosclerosis were common (40% and 39%, respectively), bearing consistency with clinical diagnosis. The strength of agreement between the two diagnoses was moderate (k = 0.743).*

Conclusion: *The study concludes that there was a moderate agreement between Clinical diagnosis and duplex diagnosis, which indicates that a duplex scan can be a valuable tool to support clinical diagnosis, suggest other diagnoses, or detect other associated pathologies.*

Keywords: *Peripheral vascular disease, Accuracy of the duplex scan, Systemic atherosclerosis, Acute or critical limb ischemia*

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Introduction

The term "Peripheral vascular disease refers to conditions affecting the whole vascular tree except the heart & coronary vessels. Atherosclerosis, however, affects the whole arterial tree, peripheral & coronary, so patient assessment must reflect this.[1] Arterial disease can be classified into two categories: occlusive & aneurysmal.[2] Although atherosclerosis is the dominant cause of occlusive disease, other etiologies, such as congenital and anatomical anomalies, arterial dissection & remote thromboembolism, can result in arterial occlusive disease.[2] The major sequelae of

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arterial obstruction are tissue ischemia & necrosis. At the same time, those of aneurysmal disease are rupture and haemorrhage in the aortic position and thrombosis and embolization in the peripheral arteries.[2] Stenosis and occlusion produce symptoms & signs that are related to the organ supplied by the artery, e.g. lower limb - claudication, rest pain & gangrene; brain- transient ischemic attack & stroke; myocardium- angina & myocardial infarction; kidney-hypertension & renal failure; intestine-abdominal pain & infarction.[3] A true aneurysm involves primary dilation of the artery, including all vessel wall layers. A false aneurysm, also called a pseudo aneurysm, is characterized by disruption of the artery wall, does not include all layers of the wall, and maybe a pulsatile hematoma not contained by the artery wall but by a fibrous capsule. False aneurysms of the femoral artery secondary to catheterization are the most numerous. Infrarenal abdominal aortic aneurysms are the most common of true aneurysms. Arterial disorders represent the most common cause of morbidity & death in western countries and Bangladesh. Peripheral arterial insufficiency is predominantly a disease of the lower extremity. Upper extremity arterial lesions are uncommon & confined mostly to the subclavian arteries. In the lower extremities, however, obstructive lesions are distributed widely, with lesions of the superficial femoral and iliac arteries the most common. Diseases affecting venous systems may be varicose veins, deep vein thrombosis, superficial thrombo-phlebitis, and chronic venous insufficiency. Continuous improvement in vascular and interventional techniques has opened various options for treating these patients. Imaging techniques have assumed a greater role in deciding whether a patient with PAD is a suitable candidate for endovascular or open-surgical revascularization. Conventional DSA is still the standard imaging technique used for the detection & assessment of PAD, although it has a complication rate of approximately 1%. The duplex scanner combines B-mode ultrasound with Doppler information in one imaging system.1 B-mode scanner converts ultrasound echoes from tissue interfaces into dots on a two-dimensional display; the brightness of each dot is proportional to the intensity of the reflected signal.[2,3,4] The second type of ultrasound, Doppler ultrasound, is then used to insonate the imaged vessels and the Doppler shift obtained is analyzed by the computer in the duplex scanner. Such a shift can give detailed knowledge of vessel blood flow and turbulence. Arteries, bypasses and veins can be scanned & any stenosis can be visualized anatomically. Doppler-shifted signals from scatters moving towards the transducer will have a higher frequency and are traditionally displayed as red on the image. Similarly, the frequency shift is displayed as blue if the reflector moves away from the beam.[5] If blood flow is turbulent, as at stenosis, the colour changes from orange to white and then turbulence is max. The blood flow velocity can be measured at different sites, as can the frequency of the reflected signal. While arteriography still plays an important role in selected cases, most interventions for carotid bifurcation stenoses rely on duplex ultrasound results alone. Measurement of carotid stenosis with B-mode imaging (BMI) is a potentially attractive modality because, in contrast to duplex-derived velocity criteria, which predict a stenosis range, BMI is a direct measure of carotid plaque dimensions may therefore minimize the limitations of velocity criteria. However, the variability in interinstitutional and interinstitutional accuracy of duplex-derived velocity criteria remains an inherent limitation of this technique. This underlines the importance of ongoing validation of existing institutional duplex criteria and the need for novel criteria, particularly in the current era when the utility of carotid arteriography as a gold standard is diminishing.[6] Duplex scanning is the most commonly used non-invasive diagnostic imaging modality for evaluating carotid artery stenosis. Duplex scanning is used more frequently as the sole preoperative diagnostic imaging modality before carotid endarterectomy.[7] There is no reported increase in the risk associated with using duplex ultrasonography alone in the preoperative planning of carotid endarterectomy.[8] Duplex scanning is frequently used in the assessment of the arteries of the lower limb. It is sometimes

difficult to obtain good views of the common iliac arteries. However, most centres would expect to visualize the external iliac, common femoral, superficial & crural arteries, accurately selecting patients with lesions amenable for PTA without referring to diagnostic angiography and further increasing the application of endovascular procedures in the management of lower limb arterial insufficiency. The accuracy of duplex scanning for predicting the performance of endovascular treatment was 88%.[9] The distal subclavian, axillary, brachial, radial & ulnar arteries are readily assessed using a duplex scan. However, the innominate and proximal subclavian arteries may be difficult to visualize. The duplex scan can visualize the aorta in most people allowing measurement of the size and location of any aneurysm present. Involvement of renal & iliac arteries can also be assessed. The technique of duplex ultrasound with an ultrasound contrast agent should become the method for stent graft surveillance. The ultrasound examination appears to provide reliable data regarding residual aneurysm size, and the addition of a contrast agent reliably detects the presence or absence of any endoleaks; an inexpensive plain abdominal radiograph can be added to the protocol for the evaluation of any stent graft migration.[10] Micro emboli can traverse collateral channels, and a proximal arterial source can lead to the signs and symptoms of artero embolism even in the presence of chronic occlusive disease. Furthermore, it is confirmed that the smallest elements of cholesterol crystal emboli pass through peripheral arteriolar-capillary shunts and return to the venous circulation to lodge in the lung. Micro embolic signals can be detected by Doppler ultrasound, which was considered to pass through the collateral circulation during percutaneous transluminal angioplasty and stenting.[11] A Duplex ultrasound is the “gold standard” for examining the venous system of the lower extremities. Duplex scanning gives essential information about the anatomy and pathophysiology of superficial, deep, and perforating veins by localizing and specifying the source of venous problems, building the basis for planning minimally invasive therapeutic interventions. Assessment of the deep veins of the lower limb by duplex scan usually involves compression manoeuvres to exclude the presence of thrombus, documenting the effects of respiration, noting spontaneous flow & evaluating the response to distal compression. Acute deep vein thrombosis is a major source of patient morbidity and presents a diagnostic challenge for healthcare providers. Venous duplex ultrasonography is the gold standard for diagnosing acute DVT, with sensitivity and specificity greater than 95%.[12] B-mode ultrasonography is a non-invasive clinical modality that can accurately detect the presence and continuity of superficial veins in surgical patients. Controversy remains, however, over whether B-mode scanning can provide accurate estimates of venous diameter and the resistive potential of the conduit in the arterial circulation. The limitations of B-mode ultrasound in evaluating the vein wall are balanced by its ability to assess its internal diameter.[13] Duplex scan of superficial veins is usually reserved for patients with recurrent varicose veins. Preoperative evaluation of veins using B-mode ultrasound is a valuable tool for planning infra-inguinal bypass. It is significantly correlated with both measures of hemodynamic function and early patency and, as such, can serve as a useful guide for conduit selection.[13] The veins in the forearm are readily evaluated using a duplex scanner. It is essential to assess the subclavian vein if the patient has had an ipsilateral central line in the past. Once the fistula is created, the duplex scan can be used to estimate the suitability of flow in a vein for hemodialysis. Then record the position and diameter of vessels suitable for cannulation and document stenosis in arterial and venous components of the fistula. Several duplex studies have demonstrated superficial reflux in more than 80% of leg ulcer patients, half associated with deep reflux. A “crossover” reflux causes every fifth venous ulcer, and another 20% shows no clinically visible varicose veins. The reflux routes can be precisely detected by starting the duplex examination in the area of ulceration and following the blood column up to its source. A positive sourcing test gives evidence for the venous origin of an ulcer.[14]

Objectives

General objectives:

To detect the accuracy of duplex scans in clinical diagnosis of peripheral arterial diseases in Dhaka Medical College Hospital.

Specific objectives:

To compare the findings of duplex scans with clinical features.

Methodology

This was a cross-sectional study. Sample was selected by purposive sampling method. The study was conducted from Jan 2011 to December 2011. All the patients were affected by peripheral vascular disease. The sample size was 100. The study was conducted in the Department of General Surgery in collaboration with the Radiology & Imaging Department. Dhaka Medical College Hospital (DMCH), Dhaka, Bangladesh.

Inclusion criteria:

Patients of peripheral arterial disease irrespective of age and sex.

Exclusion criteria: Patients with the following characteristics were excluded from the study: the emergency case of peripheral arterial disease, patients with cerebrovascular disease, patients with venous pathology and patients with an arterio-venous malformation.

Ethical consideration

Prior to the commencement of this study, the research protocol was approved. The aims, objectives of the study, procedure, risks and benefits of this study were explained to the patients in an easily understandable local language and then written informed consent from the patients, or their parents was obtained. It was assured that all information and records would be kept confidential and the procedure would be helpful for both attending physicians and patients in establishing a diagnosis of peripheral arterial disease.

Data collection & analysis

Data were collected using a structured questionnaire which included a History of clinical examination, Laboratory investigations and Duplex scans. Data were processed and analyzed using the software SPSS version 11.5. The test statistics used to analyze the data were descriptive statistics. The strength of agreement between clinical diagnosis and Duplex diagnosis in diagnosing peripheral arterial disease was calculated using kappa statistics (k-value), whereby a kappa value of < 0.4 indicated poor agreement, 0.41 - 0.60 moderate agreement, 0.61 - 0.80 good agreement and 0.81 - 1.0 perfect agreement. The significance level for consistency analysis was set at 0.05, and $p < 0.05$ was considered significant.

Results

Table - I

Distribution of patients by clinical presentation of peripheral diseases. (N=100)

Clinical presentation	Frequency (n)	Percentage (%)
Pain / intermittent claudication	100	100.0
Coldness	48	48.0
Numbness	18	18.0
Weakness	15	15.0
Ulcer	32	32.0
Swelling	45	45.0
Paresthesia	55	55.0
Gangrene	91	91.0
Hair changes	85	85.0
Color changes	86	86.0
Wasting of the limb	65	65.0

Table I showed patients by clinical presentation of peripheral diseases, pain 100%, gangrene 91%.

Table II

Distribution of patients by limbs involved. (N=100)

Limbs involved	Frequency (n)	Percentage (%)
Upper	11	11.0
Lower	85	85.0
Both	4	4.0

Table II showed peripheral arterial disease was predominantly confined to lower limb 85%, upper limb 11% and in both limbs 4%.

Table III

Distribution of patients by side limb involved. (N=100)

Side of limb involved	Frequency (n)			Percentage (%)		
	RT	LT	Both	RT	LT	Both
Lower	46	39	4	46.0	39.0	4.0
Upper	8	2	1	8.0	2.0	1.0

Table III showed in side of limb involved right lower limb was involved in 46%, left lower limb in 39% and both side of limbs in 4%. In upper cases, right limb 8%, left limb 2% and both limb 1% respectively.

Table IV

Distribution of patients by arteries involved. (N=100)

Clinical presentation	Frequency (n)	Percentage (%)
Lower limb	100	100.0
Dorsalis pedis	48	48.0
Posterior tibial	18	18.0
Popliteal	15	15.0
Femoral	32	32.0
Upper limb	45	45.0
Radial	55	55.0
Brachial	91	91.0

Table IV showed in patients by arteries involved in lower limb and upper limb.

Table V

Distribution of patients by Duplex scan findings (N=100)

Duplex scan findings	Frequency	Percentage
Percentage of stenosis		
0-29	16	16.0
30-49	12	12.0
50-69	40	40.0
70-99	20	20.0
Blood flow		
Mildly diminished	15	15.0
Moderately diminished	36	36.0
Severely diminished	37	37.0
Morphological pattern		
Atheromatous plaque	39	39.0
Wall thickening	46	46.0
Aneurysm	03	03.0
No abnormality	12	12.0
Phasicity		
Monophasic	60	60.0
Biphasic	12	12.0
Triphasic	28	28.0

Table V showed patients by Duplex scan findings.

Table VI

Distribution of patients by Duplex scan findings (N=100)

Arterial pulsation		Percentage of stenosis				
		Normal	0-29%	30-49%	50-69%	70-89%
ADP	Absent (n=74)	11	-	-	40	23
	Feeble (n-12)	1	-	11	-	-
	Normal (n=3)	-	3	-	-	-
PTA	Absent (n=53)	-	-	1	31	21
	Feeble (n-22)	6	-	14	2	-
	Normal (n=14)	6	7	1	-	-
PA	Absent (n=12)	-	-	-	12	-
	Feeble (n-42)	-	-	25	17	-
	Normal (n=35)	12	19	4	-	-
FA	Absent (n=0)	-	-	-	-	-
	Feeble (n-19)	-	-	-	19	-
	Normal (n=70)	12	22	36	-	-

Table VI demonstrated the relationship between arterial pulsation of lower limb and percentage stenosis in duplex scan.

Table-VII

Relationship between ABPI and percentage stenosis of duplex scan. (N=100)

ABPI	Percentage of stenosis of ADP/ PTA				
	Normal	0-29%	30-49%	50-69%	70-89%
>0.9 (n=17)	12	3	-	2	-
<0.9 (n=72)	-	-	11	38	23

Table demonstrates the relationship between ABPI and percentage stenosis in duplex scan. In case of abnormal ABPI (<0.9) higher percentage of stenosis was seen in duplex scan. In 2 diabetic cases percentage of stenosis was 50-69 % despite normal ABPI (>0.9).

Table-VIII

Association between capillary filling time and Duplex blood flow. (N=100)

Duplex blood flow	Capillary filling time (Second)		p-value
	< 3(n=24)	>3 (n=50)	<0.001
Normal	12(50.0)	0(0.0)	
Mildly diminished	12(50.0)	2(4.0)	
Moderately diminished	0(0.0)	26(52.0)	
Severely Diminished	0(0.0)	22(44.0)	

Table IX

Strength of agreement between Clinical and Duplex diagnosis

Modalities used	Character studied	k-value	p-value	Strength of agreement
Clinical diagnosis				
Duplex diagnosis Moderate	Peripheral arterial Disease	0.743		0.031

Table VIII showed the association between capillary filling time duplex blood flow. Patients in whom the capillary filling time was < 3 seconds, duplex blood flow was normal (50%) and mildly diminished (50%), while the patients in whom capillary filling time was 3 seconds or more, moderately diminished blood flow was 52% and severely diminished blood flow was 44%. The association was statistically significant ($p < 0.001$).

Table IX The strength of agreement between Clinical diagnosis and Duplex diagnosis in determining peripheral arterial disease was calculated using kappa statistics (k-value). A moderate agreement between the two procedures was observed (k - 0.743).

Discussion

In the present study, various clinical aspects of the patients with peripheral arterial diseases have been evaluated, and a Duplex scan was performed to judge the validity of the clinical diagnosis. The correlation of clinical findings with features of Duplex scan shows that duplex scan can be a useful aid in diagnosing peripheral arterial diseases. Peripheral arterial disease is relatively common in Bangladesh. The data generated from the study showed that peripheral arterial disease might acquire from as low as 20 years to as high as 65 years of age. Most patients are between the third and fifth decades of life. This is consistent with the findings of past studies conducted in Bangladesh. Endarteritis obliterans commonly affects the young. In another study in

Bangladesh, the largest age group was observed between 31 to 40 years[15], with the mean age of the patients being 39.5 years. In the present study, 94 cases were male, and 6 were female, which conforms to the classical observation that it is predominantly a disease of males. A study conducted in 1965 reported that 97.5% of Endarteritis obliterans patients were male.[16] Women affected with peripheral arterial disease are seen to be ten years older than men.[17] In this study, clinical presentations are almost classic for peripheral arterial diseases of the limbs. The main complaints were pain (100%) and gangrene (91%). colour change in 86%, hair change in 85% and muscle wasting in 65% of cases. In one study, pain is the chief complaint in 100% of patients with gangrene (100%), ulcer (62%), swelling (65%) etc., are other predominant features.[18] In this study, 75% of patients complained of rest pain which persists both day and night, 15% complained of intermittent claudication, and 10% of patients complained of burning pain which compares well with another study, where pain and intermittent claudication was a chief complaint among 88% patients." As a special test B-mode duplex scan is done in this study. Several features of the duplex scan are observed and correlated with those of the clinical study. in this study, blood flow was normal and of triphasic pattern in case of no arterial stenosis. It was also seen that with an increase in the percentage of stenosis, blood flow also becomes reduced, and the waveform pattern becomes biphasic or monophasic. The site and nature of pain are correlated with the percentage stenosis of different lower and upper limb vessels. It was observed that a percentage of stenosis is seen with increased severity and extent of pain, especially in distal arteries. The percentage of stenosis was seen to be lower where the pain is of intermittent claudication. Spinal claudication is an important differential diagnosis of intermittent claudication, especially in cases without gangrene.[19-22] In our study, out of 15 patients with clinical suspicion of intermittent claudication, three patients had normal duplex scans and were later diagnosed with spinal claudication. In one study, spinal claudication was diagnosed in 13 out of 31 patients with suspected intermittent claudication.19 In another study, spinal claudication was diagnosed in 21 out of 271 patients with features of peripheral arterial diseases. Gangrene was seen in 76 cases of the lower limb, 11 cases of the upper limb only and 4 cases of both upper and lower limbs. Gangrene was correlated with the percentage of stenosis of different limb vessels. An important observation was that a higher percentage of stenosis and greater affection of proximal vessels are seen with an increase in the extent of gangrene. Capillary filling time was seen in 15 cases of the upper limb and 74 cases of the lower limb. Capillary filling time could be assessed where at least one toe or finger was spared gangrene. In 15 cases, lower limb capillary filling could not be assessed due to gangrene involving all toes. There is a significant association between capillary filling time and duplex blood flow, as evidenced by a significant reduction in duplex blood flow in 50 cases of increased capillary tilling time in the lower limb. Among 24 cases where capillary tilling time was normal in lower limb duplex scan shows mildly diminished flow in 12 cases. So duplex scan can be a valuable tool in assessing blood flow in the affected limb, as suggested by the high abnormality detection rate. Arterial pulsation is an important consideration in assessing vascular supply and viability of the limb. In this study, arterial pulsation was felt in arteria dorsalis pedis, posterior tibial artery, popliteal artery and femoral artery in the case of lower limb and radial artery (RA) and brachial artery in the upper limb and correlated with the percentage of stenosis of the duplex scan. In case of absent pulsation, a duplex scan detects a higher range of stenosis 70-99% in 31% of arteries and 50- 69 % in 59% of arteries. In case of feeble pulsation in distal arteries, a duplex scan detects a lower range of stenosis, 30-49% in 73% of arteries. In this study, in 61 arteries, pulsation was present in popliteal and femoral arteries despite a significant percentage of stenosis 50-69 % in 59% of arteries and 30-49% in 41% of arteries. Arterial pulsation cannot be felt or may be feeble due to edemas, gangrene or clinical misinterpretation. In this case, a duplex scan can help detect arterial

pathology in arteritis or stenosis, as observed in this study in about 10% of arteries. No abnormality was detected in the duplex scan despite clinically absent or feeble pulsation. On the other hand, the duplex scan can detect abnormality and signify necessary intervention despite normal pulsation, as observed in this study in 75% of arteries. In one study, abnormality in arteries was detected despite normal pulsation in the right leg (82.2%) and left leg (67.6%).23 ABPI was measured in 89 cases of lower limbs and correlated with the percentage of stenosis in duplex scans. Abnormal ARP' (<0.9) was associated with stenosis in duplex scans in 100% of cases. In this study, the sensitivity of ABPI in depicting >50% stenosis was 95%. In one study, the sensitivity of ABPI in depicting >50% stenosis was 79%.[3] In another study sensitivity of ABPI <0.9 for a higher percentage of stenosis was 96%.24 In this study, ABPI was normal (>0.9) despite stenosis in duplex scans in 29% of cases. Two patients (with 50-69% stenosis) had diabetes. These findings bear consistency with the observation in another study that ABPI can be falsely elevated in patients with diabetes, and renal failure because of calcification of the arteries, which causes them to be incompressible.[34] In the present study, there was a moderate agreement between clinical diagnosis and duplex diagnosis (k=74.3%), indicating that a duplex scan can be a valuable tool to support clinical diagnosis or suggest other diagnoses or detect other associated pathologies. Clinical diagnosis was made among 100 cases as endarteritis obliterans (47%), atherosclerosis (48%), vasculitis (2%) and thoracic outlet syndrome in 3% of cases. Among 100 cases, a duplex scan showed 39 atheromatous plaques, cases of arterial wall thickening, three aneurysms, and 12 did not exhibit any abnormality. The duplex data showed that endarteritis obliterans and atherosclerosis are common. Other rare diagnoses were vasculitis and thoracic outlet syndrome.

Among 12 cases that were shown normally in the duplex scan, various nonvascular diagnoses such as osteoarthritis, spinal stenosis, neuropathy and traumatic gangrene were made later on.

Limitations

There are several limitations which are as follows: This study was done on a relatively limited scale with a small sample size, as acute cases of peripheral arterial diseases, various pathology and cerebrovascular cases were excluded. Duplex scan is highly operator-dependent. As a time-consuming procedure, patient compliance with duplex scans could be better in some cases. Duplex scan is costly, considering the economic condition of patients in Bangladesh, so financial assistance for many patients is required. The diagnostic accuracy of the duplex scan was not compared with other diagnostic modalities, such as angiogram-angiography or MRA. Despite some limitations, the strength of duplex scan is considered an available, noninvasive and easily reproducible test. Correlation of different aspects of clinical profile and duplex scan has been done to assess and judge clinical decisions. This study suggests clinical examination alone cannot make the proper judgment in all cases of peripheral arterial diseases. So duplex scans can be an adjunct to managing peripheral arterial disease considering the considerable load of patients with peripheral arterial diseases in clinical practice. In doubtful cases, the duplex scan can guide further diagnostic procedures to confirm the diagnosis, especially if operative decisions need to be taken.

Conclusion

From the study's findings, the correlation of duplex scans with various clinical presentations can be an excellent diagnostic aid to clinical judgment for peripheral vascular disease. Furthermore, the majority of the cases of peripheral arterial diseases can be detected by various observations in duplex scans, such as percentage of stenosis, blood flow and pattern of physicality. Finally, there was a moderate agreement between clinical diagnosis and duplex diagnosis, indicating that a Duplex scan can be a valuable tool to support clinical diagnosis, suggest other diagnoses, or detect other associated pathologies.

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