ORIGINAL ARTICLE

Examine the Diagnostic Accuracy of Handheld Doppler Ultrasound for Diagnosing Peripheral Vascular Disease

SANA SHARAFAT ALI[1], SYED TANSEER ASGHAR[2], JAVED IQBAL KHAN[3], SHAHZAD KHAN[4], MUHAMMAD KASHIF[5], ZARDAD KHAN[6]
[1]*Assistant Professor Surgery, PIMS Islamabad*
[2]*General Surgeon, Capital Hospital CDA Islamabad*
[3]*Assistant Professor Surgery, Abbottabad International Medical Institute*
[4]*Consultant Radiologist, Saidu Teaching Hospital*
[5]*Assistant Professor Surgery, Gajju Khan Medical College, Swabi*
[6]*Assistant Professor Surgery, Divisional Headquarter Teaching Hospital, Mirpur AK*
Correspondence to: Dr Sana Sharafat Ali, Email: sana_sharafat@yahoo.com, Cell No: 03215110089

ABSTRACT

Objective: To determine the diagnostic accuracy of handheld doppler ultrasound in detection of peripheral arterial disease taking Ankle Brachial Pressure Index (ABPI) as a gold standard.

Study Design: Cross-sectional study

Place and Duration: Study was conducted at Pakistan Institute of Medical Sciences, Islamabad during from 1st Dec 2019 to 31st May 2020.

Methods: Total 110 patients of both genders with ages 30 to 70 years clinically suspected with peripheral vascular diseases were enrolled in this study. Patients detailed demographics including age, sex, BMI, symptoms and co-morbidities were recorded after taking written consent. Handheld Doppler ultrasound examination was done to all the patients. Ankle brachial pressure index and toe pressure were performed. Sensitivity, specificity, PPV, NPV and diagnostic accuracy of handheld Doppler ultrasound were examined. Data was analyzed by SPSS 24.0.

Results: Out of 110 patients 60 (54.55%) were males while 50 (45.45%) were females. 42 (38.18%) patients were ages <40 years and 68 (61.82%) patients had ages >40 years. 68 (61.82%) patients had peripheral vascular disease by handheld Doppler ultrasound examination and by ankle brachial pressure index 72 (65.45%) patients had peripheral vascular disease. Sensitivity, specificity, PPV, NPV and diagnostic accuracy of handheld Doppler ultrasound were 88.89%, 90.70%, 94.12%, 82.98% and 89.57%.

Conclusion: It is concluded that handheld Doppler ultrasound is very useful tool for detection of peripheral vascular disease.

Keywords: Handheld Doppler Ultrasound, Ankle Brachia Pressure Index, Peripheral Vascular Disease, Diagnostic Accuracy.

INTRODUCTION

Peripheral arterial disease (PAD) is an age-dependent manifestation of atherosclerosis, which is highly prevalent in Western countries. Uncommon before the age of 50, its rates increase to about 20% by the age of 80. Moreover, PAD has proved to be an independent risk factor for coronary artery and cerebrovascular disease, and all-cause mortality [1-2].

However, this condition remains both underdiagnosed and undertreated, with no consensus regarding on whom and when screening should be performed [3-5]. Underdiagnosis can be attributed to the fact that only one out of three patients suffering from PAD are symptomatic [6]. and because invasive catheter digital subtraction angiography, which is considered the gold standard for PAD diagnosis, is an invasive test that requires both iodinated contrast and ionising radiation. Nevertheless, patients with PAD but without claudication are also at increased risk of cardiovascular disease and mortality [7].

Although non-invasive and simple diagnostic tests are readily available, PAD remains significantly underestimated and untreated [8], mostly because of the paucity of symptoms and underutilization of screening tools. The accuracy of the ABI is controversial when used to evaluate calcified and poorly compressible vessels in elderly patients with medial sclerosis. The ABI may also be falsely negative in symptomatic patients with moderate aortoiliac stenosis or extensive collaterals [9]. Therefore, various imaging tools, such as color Doppler ultrasonography, magnetic resonance angiography (MRA), and computed tomography angiography (CTA) have been used to diagnose suspicious PAD despite a normal ABI [10]. Although all of these tests are non-invasive, color Doppler ultrasonography provides renal protection because contrast dye is not used, compared with MRA or CTA. A previous study also reported that hand-held Doppler has the greatest diagnostic accuracy in patients with PAD, while clinical findings including claudication, femoral bruit, and pulse abnormalities are insufficient to diagnose PAD [11].

The present study was conducted aimed to determine the diagnostic accuracy of handheld Doppler ultrasonography for diagnosing peripheral arterial disease taking Ankle Brachial Pressure Index as a gold standard.

MATERIALS AND METHODS

This cross-sectional/observational study was conducted at Pakistan Institute of Medical Sciences, Islamabad during from 1st Dec 2019 to 31st May 2020. A total 110 patients of both genders with ages 30 to 70 years clinically suspected with peripheral vascular diseases were enrolled in this study. Patients detailed demographics including age, sex, BMI, symptoms and co-morbidities were recorded after

taking written consent. Patients with vascular surgery, already diagnosed patients and those with no consent were excluded from this study.

We use handheld Doppler to assess blood flow. Begin by applying gel in the expected area of the artery being investigated. Placed the Doppler over the artery at a 45 degree angle to the skin, pointing cephalad. If the Doppler signal is not detected, slowly move the Doppler probe medially and laterally, as occasionally, the path of distal arteries can vary. If a signal is encountered, we noted the character of the sound wave produced. While some HHD have a screen or can print out the waveform to view, the shape can also be determined by listening. Based on the audio and visual waveforms produced by their own Doppler assessments, presence of peripheral arterial disease was recorded. Ankle Brachial pressure index and toe pressure were performed and taking as gold standard for diagnosing peripheral arterial disease. ABI calculation was done according to the below criteria.

ABPI of leg A = Higher pedal pressure of leg A / Higher brachial pressure (A or B)	
Value	Interpretation
>1.4	Non-compressible, calcified arteries
1.0-1.4	Normal range
0.91-0.99	Borderline
0.41-0.90	Mild to moderate peripheral arterial disease
<0.4	Severe peripheral arterial disease

Sensitivity, specificity, PPV, NPV and diagnostic accuracy of handheld Doppler ultrasound were examined. All the data was analyzed by SPSS 24.0. Frequency and percentages were recorded in tabulation form.

RESULTS

Out of 110 patients 60 (54.55%) were males while 50 (45.45%) were females. 42 (38.18%) patients were ages <40 years and 68 (61.82%) patients had ages >40 years.

Table No 1: Demographics of all the included patients

Characteristics	Frequency No.	%age
Gender		
Male	60	54.55
Female	50	45.45
Age		
<40 years	42	38.18
>40 years	68	61.82
Mean BMI (kg/m)	24.68±3.25	-
Co-morbidities		
Diabetes Mellitus	48	43.63
Hypertension	30	27.27
Smoking	26	23.64
Symptoms		
Pain in hip, Thighs and muscles	50	45.45
Claudication	45	40.91
Leg Numbness	15	13.64

Table No 2: Comparison of HDD with ABI

Handheld Doppler	ABI		Total
	Positive	Negative	
Positive	TP 64	FP 4	68
Negative	FN 8	TN 34	42
Total	72	38	110

Mean BMI was 24.68±3.25 kg/m^2. Diabetes mellitus was most frequent co-morbidity found in 48 (43.63%) patients followed by hypertension in 30 (27.27%) patients, and smoking in 26 (23.64%) patients. 50 (45.45%) patients had pain, 45 (40.91%) had claudication and 15 (13.64%) patients had leg numbness. (Table 1)

68 (61.82%) patients had peripheral vascular disease by handheld Doppler ultrasound examination and by ankle brachial pressure index 72 (65.45%) patients had peripheral vascular disease. The sensitivity, specificity, PPV, NPV and diagnostic accuracy of handheld Doppler ultrasound were 88.89%, 90.70%, 94.12%, 82.98% and 89.57%. Positive likelihood ratio was 9.56 (3.74 to 24.39) and negative likelihood ratio was 0.12 ranges 0.06 to 0.24. (Table 2)

Statistic	Value	95% CI
Sensitivity	88.89%	79.28% to 95.08%
Specificity	90.70%	77.86% to 97.41%
Positive Likelihood Ratio	9.56	3.74 to 24.39
Negative Likelihood Ratio	0.12	0.06 to 0.24
Disease prevalence (*)	62.61%	53.10% to 71.45%
Positive Predictive Value (*)	94.12%	86.24% to 97.61%
Negative Predictive Value (*)	82.98%	71.58% to 90.42%
Accuracy (*)	89.57%	82.48% to 94.49%

DISCUSSION

Peripheral vascular disease is one of the most common vascular disorder found all over the world with higher rate of complications and these complications effects quality of life of patients. Accurate and proper diagnosis is very essential for the management of peripheral arterial disease. Many of studies have been conducted to examine the diagnostic accuracy of different diagnostic modalities for diagnosing peripheral vascular disease, in which ultrasound imaging, MRI, angiography, and ankle brachial pressure index were performing most frequently because of their higher accuracy rate [12-13]. We conducted present study to examine the handheld Doppler ultrasound in detection of peripheral arterial disease and taking ankle brachial pressure as a gold standard. In this regard 110 patients clinically suspected to have peripheral arterial disease were enrolled. 60 (54.55%) were males while 50 (45.45%) were females. 42 (38.18%) patients were ages <40 years and 68 (61.82%) patients had ages >40 years. Mean BMI was 24.68±3.25 kg/m^2. These results showed similarity to many of previous studies in which males were on high risk for developing peripheral arterial disease as compared to females. Patients with ages above 45 years had a high incidence rate of peripheral arterial disease [14-15].

In present study we found that diabetes mellitus was the most frequent co-morbidities found in 48 (43.63%) patients followed by hypertension in 30 (27.27%) patients, and smoking in 26 (23.64%) patients. Previous studies demonstrated that diabetes mellitus was the most frequent

cause of peripheral arterial disease accounted 40 to 60% patients followed by hypertension, obesity and smoking [15-16].

In our study 68 (61.82%) patients had peripheral vascular disease while 42 (38.18%) had negative findings by handheld Doppler ultrasound examination and by ankle brachial pressure index 72 (65.45%) patients had peripheral vascular disease <0.4 severity score while 38 (34.55%) had negative findings or mild disease. A systematic review by Song P et al [17] reported that a total of 236·62 million people aged 25 years and older were living with peripheral artery disease in 2015, among whom 72·91% were in LMICs. A prospective observational study conducted in India reported that out of 1148 suspected cases the prevalence of peripheral artrial disease was 26.7% [18]. Another study conducted by Tummala R et al [19] reported that out of 100 patients PVD was found in 57% patients.

In present study we found that the sensitivity, specificity, PPV, NPV and diagnostic accuracy of handheld Doppler ultrasound were 88.89%, 90.70%, 94.12%, 82.98% and 89.57%. Positive likelihood ratio was 9.56 (3.74 to 24.39) and negative likelihood ratio was 0.12 ranges 0.06 to 0.24. A study conducted by Nabavizadeh et al [20] reported that the audible handheld Doppler ultrasound had sensitivity of 42.8%, a specificity of 97.5%, negative predictive value of 94.10%, positive predictive value of 65.22%, positive likelihood ratio of 17.52, and negative likelihood ratio of 0.59. Jane EA Lewis et al [21] reported in their study that the sensitivity of ankle brachial index was 79%, specificity 91% and overall accuracy 88%. Pulse volume waveform sensitivity was 97%, specificity 81% and overall accuracy 85%. The combined sensitivity of ankle brachial index and pulse volume waveform was 100%, specificity 76% and overall accuracy 85%. Some other studies findings were comparable to our study in which diagnostic accuracy of HHD was 85% to 94% [22-23].

CONCLUSION

We concluded that handheld Doppler ultrasound is very useful diagnostic tool for detection of peripheral vascular disease with higher accuracy rate and could be used as an alternate to the ankle brachial index.

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