


Original Research Article

Comparison of colour duplex ultrasound, ankle-brachial pressure measurement in peripheral vascular disease in type 2 diabetes patients with foot infections

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Abstract

Introduction: Peripheral vascular disease is diagnosed by a definitive history of intermittent claudication or if one or more peripheral pulses are absent in one or both lower limbs. Diagnostic testing for peripheral vascular disease must be accurate, inexpensive, widely accessible, easy to perform, and preferably non-invasive. A variety of non-invasive techniques are available to detect the presence of peripheral vascular disease as well as to localize areas of stenosis, assess the severity of disease, and follow patients for disease progression or response to therapy.

Aim of the study: In this study, we compare the specificity and sensitivity of ankle-brachial pressure index with color Doppler ultrasound for the diagnosis of peripheral vascular disease in type 2 diabetes.

Materials and methods: This was the study done in our Hospital Government Kilpauk Medical College in collaboration with the Department of General Surgery and Radiology. The following study was a prospective study, for which ethical clearance was obtained. No. of patients studied were 50, and consent was taken from all the patients. The patients studied were diabetic, which included all types of type IIDM patients on treatment and with foot infections. No individuals with rest pain or signs suggestive of lower limb critical ischemia and other causes of peripheral neuropathy or history of reconstructive vascular surgery were taken into consideration. The study period was from January 2019 to December 2020. After doing thorough history taking and clinical examination, including Proprioception, capillary blood glucose, arterial color duplex imaging (CDU), and ankle-brachial pressure index (ABPI) were done in all the patients.

Results: Out of 33 individuals diagnosed to have PAD based on CDU, only 24 individuals were categorized as PAD by the ABI. Thus 9 individuals remain undiagnosed if ABI alone were used for diagnosis of PAD. Sensitivity of ABI was 72.72%. Conversely, only 2 patients out of 26 subjects diagnosed as having PAD according to ABI were classified as normal by CDU. Specificity of ABI was 85.71%. The positive predictive value of ABI was 92.30% and the negative predictive value of ABI was 57.14%.

Conclusion: The sensitivity and specificity of ABPI were compared with CDU. We concluded that ABPI has high specificity (85.71%) and Low sensitivity (72.72%) has compared to CDU. The overall agreement of ABPI with CDU was poor.

Key words

Color duplex ultrasound, Ankle brachial pressure measurement, Peripheral vascular disease, Type 2 diabetes, Foot infection.

Introduction

Diabetes is known for its micro and macrovascular complications like retinopathy, neuropathy, nephropathy, cardiovascular and peripheral vascular diseases, and infections. The major risk factor leading to diabetic foot ulcers is poor diabetes control, which results in neuropathic and vascular changes [1]. Currently, foot problems are an important cause of morbidity in diabetes. Foot ulceration precedes the majority of amputation in diabetics [2]. Diabetes accounts for up to 50% of non-traumatic leg amputations and 1% of diabetic people have undergone amputation. Prevention and early treatment of foot ulcers require multidisciplinary teamwork from nurses, chiropodiatrists, and doctors, preferably at the primary care level. Rapid assessment and timely intervention can make the difference between limbs salvage and limb loss [3]. The diabetic foot is mainly because of peripheral neuropathy, arteriopathy, and superimposed infection. Peripheral vascular diseases are a group of common degenerative (organic) and vasospastic (functional) disease processes that result in significant morbidity and are strong predictors of subsequent mortality [4]. Gangrene of the lower extremities as a result of advanced vascular disease is about 100 times more common in diabetics than non-diabetics [5]. The primary cause of mortality in patients with PVD is myocardial infarction (60%), stroke (12%), and other complications of diabetes. A significant

cause of morbidity in patients with peripheral vascular disease in diabetics is ischemic limb loss. Approximately 2% of non-diabetic patients with intermittent claudication require amputation. This rate increases to 7% for patients with diabetes mellitus [6].

Materials and methods

This was the study done in the Government Kilpauk Medical College in collaboration with the Department of General Surgery and Radiology. The following study was a prospective study, for which ethical clearance was obtained. No. of patients studied were 50, and consent was taken from all the patients. The Patients studied were diabetic, which included all types of Type IIDM patients on treatment and with foot infections. No individual with rest pain or signs suggestive of lower limb critical ischemia and other causes of peripheral neuropathy or history of reconstructive vascular surgery were taken into consideration. The study period was from January 2019 to December 2020. After admission, thorough history taking was done which included age, sex, history of smoking, duration of disease, and treatment taken by the patient for diabetes (oral hypoglycemic drugs insulin, diet, or a combination of either of these) clinical examination including, General examination that includes blood pressure measurement, Systemic examination local examination includes measurement of ABPI. ABPI was measured in

both the limbs, by the bedside of the patient by using Hand held Doppler and measuring the ratio between highest pressure measured in the ankle (signifying Tibial artery pressure) divided by highest pressure measured in the arm (signifying brachial artery pressure), Routine blood investigations, Including fasting blood sugar, HbA1c, and other relevant blood investigations. Wound pus swab culture and sensitivity were done. Radiological investigation includes color Doppler of both the lower limbs and the arteries included external iliac, femoral (proximal and distal), popliteal (anterior and posterior), tibial (anterior and posterior), and dorsalis pedis artery. Following components were looked for Mean arterial diameter, Peak systolic flow velocity Spectral wave form patterns, based on the above-mentioned components obstruction of the arteries, was calculated. Blood sugar values, fasting blood levels were checked in all patients. Both oral and intravenous antibiotics were given according to the pus culture and sensitivity report. Regular, surgical debridement was done. Daily dressings were done.

- All Type-IIDM patients, on treatment or diet control with a foot infection.
- The age group of 35 years to 80 years.

Exclusion Criteria:

- Individuals with rest pain.
- Individuals with signs suggestive of lower limb critical ischemia.
- Other causes of peripheral neuropathy.
- Any history of reconstructive vascular surgery.

Results

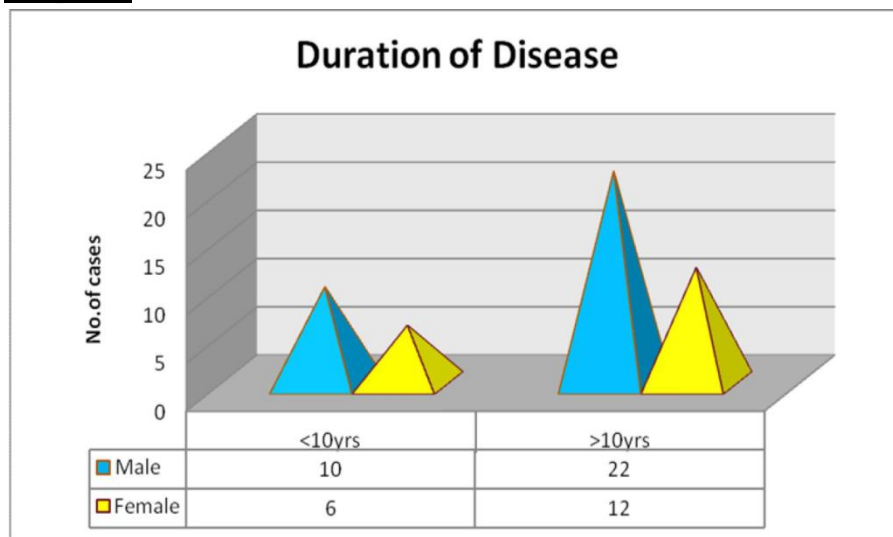
Patients distribution done based on age, 13 were of age <50 years, 22 were of age between 50 to 60 years and 16 were of age >60 years. The age of the youngest patient was 35 years and the oldest patient 80 years. The distributions were shown in the **Table - 1**. In this study, 32 patients (64%) were males and 18 patients (36%) were females. The Mean age was 59.5 ± 10.1 years. Out of 50 patients, 28 were having BMI between 20 to 25, and 22 were having BMI between 25 to 30. Mean Body mass index was 24.2 ± 3.5.

Inclusion Criteria:

Table – 1: Observations.

Age	Male	Female	Total	%
<50yr	10	3	13	26%
50-60	16	6	22	44%
>60yrs	6	10	16	32%

Graph – 1: Duration of disease.



Graph – 2: Overall sensitivity and specificity.

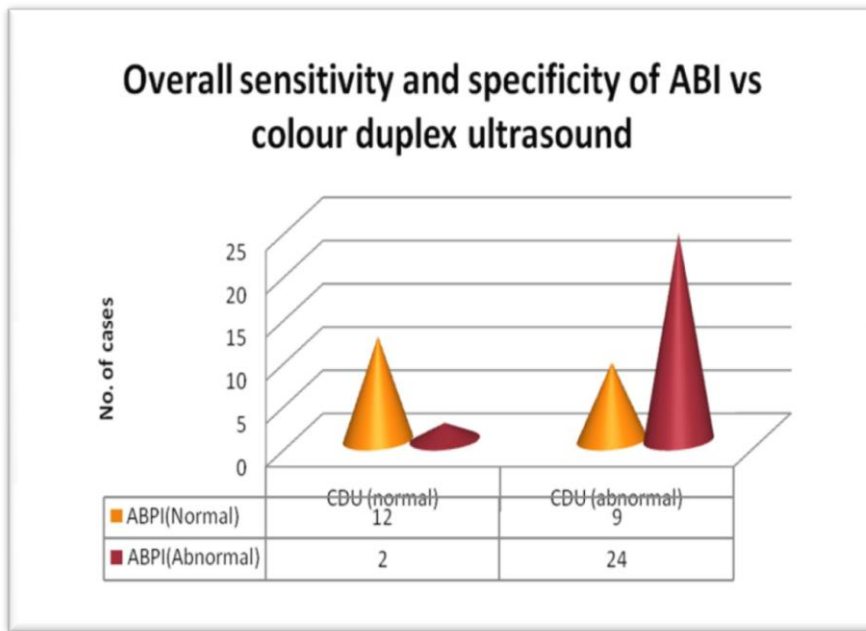
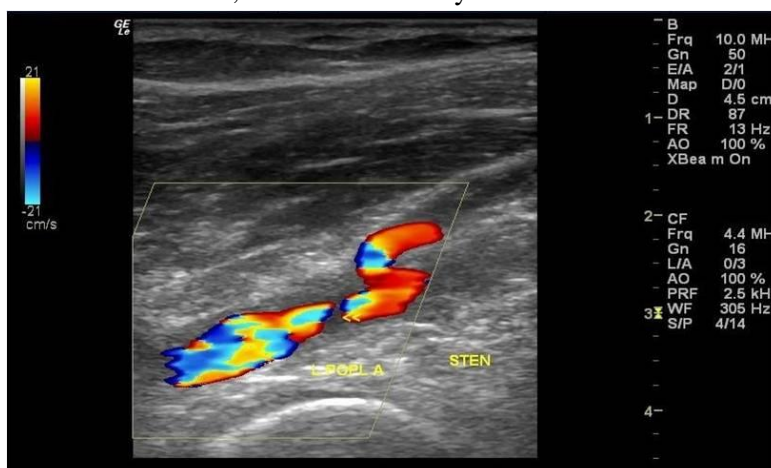


Photo – 1: Photographs showing colour duplex of left femoral artery complete stenosis in diabetic patients with foot infections, taken for our study admitted in ward.



Photo – 2: Photographs showing colour duplex of left popliteal artery stenosis in diabetic patients with foot infections, taken for our study admitted in ward.



Graph - 1 shows the distribution of the patients based on the duration of disease (diabetes mellitus). Mean duration of diabetes in the study population 11.7 ± 8.1 years. The fasting blood sugar value ranges from 132 to 240 mg%. Minimum value is 132 mg/dL presentation and the maximum value 240 mg/dL. The mean fasting blood sugar of the study population is 186 ± 76 mg/dL. **Graph - 1** showed the distribution of the study population based on HbA1C. The minimum HbA1C of the study was 7% and the maximum was 11.2%. The mean HbA1c of the study population was $9.5 \pm 2\%$. Patients based on the type of treatment were taken by the patients. 22% of patients were on OHA, 20% patients were on insulin treatment, 8% were on both combined insulin and OHA therapy and 50% patients were only on diet control.

Of the total 50 subjects, 3 patients had detected calcification of peripheral vessels on color Doppler ultrasound and they were not included while calculating sensitivity and specificity of ABI (**Photo - 1, 2**). ABI < 0.9 was cut off used for the diagnosis of peripheral arterial disease. In CDU $> 50\%$ block considered as abnormal. Out of 33 individuals diagnosed to have PAD based on CDU, only 24 individuals were categorized as PAD by the ABI. Thus 9 individuals remain undiagnosed if ABI alone were used for diagnosis of PAD. Sensitivity of ABI was 72.72%. Conversely, only 2 patients out of 26 subjects diagnosed as having PAD according to ABI were classified as normal by CDU. Specificity of ABI was 85.71%. The positive predictive value of ABI was 92.30% and the negative predictive value of ABI was 57.14% (**Graph - 2**).

Discussion

By the recent projection from WHO identified that by 2025, $> 20\%$ of the diabetic population in the world will be contributed by India that is over 57 million diabetic patients. This will cause a tremendous health burden on our nation. That's why the accurate estimate of the morbidity

caused by diabetes is therefore of great importance [7]. We had used ABI in our study to assess PAD, as it is difficult to do CDU in a population-based study. To get a good pick up of PAD, we took to study a group of type 2 DM patients admitted to our hospital with a severe foot infection. Earlier studies suggested ABI as a reliable method for diagnosis of PAD and an ABI value of < 0.9 has 95% sensitivity compared to angiography. ABI in our population was a poor predictor of peripheral artery disease. With the recent development of the scanning technique, Colour Doppler scanning is used for the diagnosis of PAD [8]. It has many clinical applications like blood flow sensing, wave form analysis, localizing blood flow, and two-dimensional mapping of the flow of blood. CDU is very effective in detecting and grading atherosclerotic plaque in the arteries. Comparative study of CDU and ABPI in the Rancho Bernardo study revealed that an Ankle-brachial index < 0.8 had optimum sensitivity and specificity. This study also revealed that peripheral Doppler is ideal for detecting the majority of the subject with PAD [9]. In our study Age of the youngest patient are 35 years and the oldest patient 80 years. In this study 32 patients (64%) were males and 18 patients (36%) were females. Mean duration of diabetes in the study population 11.7 ± 8.1 years [10]. This indicates the development of PAD in a diabetic patient requires a time-lapse. It is along term complication of diabetes [11]. The fasting blood sugar value in our study ranges from 132 to 240 mg%. Minimum value is 132 mg/dL and the maximum value 240 mg/dL. The mean fasting blood sugar of our study population is 186 ± 76 mg/dL. The mean HbA1c of the study population is 9.5 ± 2 . This indicates glycemic control in diabetic patients is a very important factor for the development of PAD [12]. Mean systolic blood pressure is 136 ± 19 mmHg and mean diastolic blood pressure of the study population is 86 ± 11 mmHg indicates our study inference is not affected by atherosclerotic changes caused by hypertension. After analyzing the results of our study conducted from January 2013 to December 2013 we observed. ABI has good specificity

(85.71%) and low sensitivity (72.72%). Low sensitivity indicates it may miss some cases with PAD. An ideal screening test must have very few false negative means high sensitivity [13]. ABI <0.5 showed very well (100%) agreement with CDU. As ABI increases agreement with CDU decreases. Overall agreement between these two methods is very poor. Around 42.85% of patients diagnosed to be normal by ABI had significant (>50%) obstruction when examined by CDU [14]. The reason for high ABI despite significant stenosis probably may be due to collateral circulation that maintains blood circulation beyond the point of obstruction in the limb. And higher ABI in the stenosed vessel may be due to calcification of the vessel wall. Support for our study comes from a study from the UK done by Hiatt W, et al. which assessed the agreement between both the tests in non-diabetic population result was that the ABI technique detects only those patients who have a significant or serious disease with increasing the value of ABI agreement become poor. Even by adding post-exercise ABI value agreement for significant obstruction increases by 2% [15].

Conclusion

In our study, we concluded that ABI has high specificity but low sensitivity compared to CDU. (ABI has good specificity (85.71%) and sensitivity (72.72%)). Low sensitivity indicates it may miss some cases with PAD. If ABI is used alone many patients with stenosis will be diagnosed as normal. But because of the ease of performing and its low cost, ABI would be still a good screening test. If ABI is abnormal diagnosis is almost certain but if normal and the patient is asymptomatic indicates no further evaluation but in case the patient is symptomatic and ABI is normal means go for CDU before concluding the patient is normal.

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