ORIGINAL ARTICLE

Detection of Peripheral Arterial Disease (PAD) in Diabetics using Ankle Brachial Index (ABI)

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ABSTRACT

Objective: To evaluate the Ankle Brachial Index (ABI) in the detection of peripheral arterial disease (PAD) among diabetic patients.

Setting: Diabetic clinic of PMRC Research Centre, Fatima Jinnah Medical College, Lahore.

Study Design: Cross sectional descriptive.

Subjects & Methods: This pilot study included 95 diabetic patients with ages 40 years or above and duration of the disease was more than 5 years. Detailed history including treatment was documented. During examination systolic blood pressure in the right and left arms (Brachial Pressure) was measured & documented. Systolic Blood Pressure in both ankles was measured using ultrasound Doppler probe (Huntleigh Super Doppler – II). Left and right ABI were obtained by dividing brachial systolic pressure with ankle systolic pressure. A ratio of 0.9 or above was taken as normal.

Results: The study included 95 patients (15 males and 80 females) with mean age 51.90 ± 9.49 years and mean duration of diabetes 13.23 ± 5.83 years. Smoking was observed in 53.30%, hypertension in 57.89% and 71.57% had dyslipidemia. ABI ratio was mildly abnormal in 52.68%, moderately abnormal in 7.38% while it was normal in 38.94% cases. Duration of thedisease was negatively correlated (r = - 0.650 & 0.937) with ABI & correlation was highly significant ($p < 0.047$ & 0.008). Blood sugar and lipid levels were not significantly correlated with ABI.

Conclusions: The results conclude the detection of high percentage (60.08) of abnormal ABI in this group of patients. Ankle brachial index, a non-invasive and simple technique, may be used to screen the detection of PAD and diabetic foot.

Key words: Ankle Brachial Index, peripheral arterial disease, cardiovascular complications, diabetic foot.

INTRODUCTION

Peripheral arterial disease (PAD) is a chronic, lifestyle-limiting disease. It is an independent predictor of cardiovascular and cerebrovascular ischemic events. The risk of PAD is markedly increased among individuals with diabetes mellitus and ischemic event rates are higher in these individuals with PAD compared to non-diabetic population.[1] Peripheral arterial disease affects approximately 12 million people in the U.S; approximately 20% to 30% of these patients have diabetes.[2] The duration and severity of diabetes correlates with the incidence and extent of PAD. In a prospective cohort study, Al-Delaimy *et al*[3] found a strong positive association between the duration of diabetes and the risk of developing PAD. The association was particularly strong among men with hypertension or who were cigarette smokers. The degree of diabetic control is an independent risk factor for PAD; with every 1% increase in glycosylated hemoglobin the risk of PAD has been shown to increase by 28%.[4] The risk of PAD is associated with advancing age and the presence of peripheral neuropathy.[5]

The disorder is characterized by occlusive arterial disease of the lower extremities. Although many patients are asymptomatic or have atypical exertional symptoms, approximately one-third experience intermittent claudication, described as aching, cramping, or numbness

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in the affected limb occurring with exercise and relieved by rest.[6] Peripheral arterial disease in patients with diabetes adversely affects quality of life[7] and is associated with substantial functional impairment and mortality.[8,9] The reduced walking speed and distance associated with intermittent claudication may result in progressive loss of function and long-term disability.[3,10] With severity of the disease, critical limb ischemia (CLI) may develop, resulting in ischemic ulceration of the foot and risk of other cardiovascular events as well as amputation.

Introduction of sonography has made it possible for general physicians to diagnose asymptomatic PAD by determining the Ankle Brachial Index (ABI), which is a noninvasive technique. However, ABI is underutilized in clinical practice; thus PAD remains under diagnosed and awareness of importance of treating PAD as a coronary heart disease is low among physicians partly because determination is time consuming. Because many patients with diabetes also have PAD, the American Diabetes Association now recommends regular screening of the Patients for PAD who are over the age of 50. Diabetic Patients who are younger than 50 years should be screened if they are under-treated.[5]

This pilot study was designed to evaluate the role of ABI as a simple, non-invasive and cost effective technique in the detection of PAD in diabetics. This test may be utilized for simple screening purposes to all the diabetic population and may be a helpful tool in early detection and prevalence of diabetic foot.

METHODS

This cross sectional, descriptive study was done at the diabetic clinic of PMRC Research Centre, FJMC & Ganga Ram Hospital Lahore. All patients included in this study were taking treatment for diabetes and hypertension. In this pilot study, 95 patients suffering from Diabetes Mellitus, 40 years or above of both sexes with any duration of diabetes were included. Each patient was interviewed and the information was recorded on a performa regarding age, sex, duration of diabetes, smoking habits and any other cardiovascular disease. Blood sample was collected after an overnight fast using antiseptic measures to estimate blood sugar fasting & random (2 hours postprandial) as well as lipid profile.

During examination, systolic blood pressure was measured on both right and left arms (brachial artery) and both ankles (posterior tibial arteries). Systolic blood pressure in brachial arteries was measured by using mercury sphygnomanometer and systolic blood pressure in the ankles was measured by using ultrasound Doppler probe (Huntilegh Super Doppler-11).[20] Left and right ABI measurements were obtained by dividing mean systolic blood pressure in the left and right ankle by corresponding mean systolic brachial blood pressures. PAD was defined as an ABI less than 0.90 in either leg. Abnormal ABI ratio was graded as (a) Mild: when ratio was between 0.89-0.70 (b) Moderate: when ratio was 0.69-0.40 (c) Severe: when ratio was <0.39.[19] Total cholesterol was measured enzymatically. Hypercholesterolemia was defined as a total cholesterol level of 240 mg/dl or higher in fasting condition.[21]

STATISTICAL ANALYSIS

The data were computerized and SPSS Version "13" was used for analysis. Mean ± SD was calculated for all quantitative measures. Percentage values were calculated for various categories of ABI ratio to diagnose PAD. Pearson's correlation was used to find out any relation between ABI & blood sugar levels, lipid levels & duration of the disease.

Table1 : Demographic Chracteristics of the Study Patients of Type-2 Diabetes Mellitus

Parameters	No. of Patients (95)	Percentage (%)
Mean Age (years)	51.96 ± 9.49	-
Sex:		
Male	15	16%
Female	80	84%
Duration of diabetes (yrs)	13.23 ± 5.83	-
Smoking	8	8.42%
CAD	3	3.15%
(Coronary Artery Disease)		57.89%
Hypertension	55	57.89%
Dyslipidemia	60	71.57%
Symptoms:		
Numbness Tingling	80	84.21%
Leg pains	54	56.42%
Foot ulcers	5	5.26%
Laboratory Tests:		
Blood Sugar Fasting	112.67 ± 40.15	-
Blood Sugar Random (2 hrs P.P)*	185.53 ± 52.17	-
S. Cholesterol	193.45 ± 35.18	-
S. Triglyceride	188.64 ± 86.11	-
S. HDL	41.32 ± 33.09	-
S. LDL	116.63 ± 32.92	-

Table2 : Demographic Chracteristics of the Study Patients of Type-2 Diabetes Mellitus

ABI Ratio	No. of Cases n =95	Percentage (%)
Normal (≥ 0.90)	37	38.94 %
Mild abnormality (0.89 – 0.70) Total: Bilateral involvement Unilateral involvement	51 12(23.53%) 39(76.47%)	53.68 %
Moderate abnormality (0.69 – 0.40)	7	7.38%
Severe ≤ 0.39	-	-

Table3 : Correlation of ABI with Blood Sugar Fasting, Random, & Serum lipids

Parameters	Right ABI		Left ABI	
	Correlation	P. Value	Correlation	P. Value
Duration of Diabetes	0.650	0.047*	0.937	0.008
Blood Sugar Fasting	0.142	0.283	0.27	0.841
Blood Sugar Random (2hrs P.P)	0.069	0.661	0.272	0.76
Serum Cholesterol	0.037	0.737	0.171	0.121
Serum Triglyceride	0.013	0.904	0.087	0.429
HDL	0.006	0.956	0.027	0.810
LDL	0.014	0.901	0.126	0.254

*P Significant at 0.05. ** P.P Postprandial

RESULTS

Table 1 shows demographic & general features of the study patients which included 15 (16%) males & 80 (84%) females with mean age 51.90 ±9.46 years. Duration of diabetes was 13.23± 5.83 years. History of smoking was present in 8 (8.42%) male patients. Of the total diabetics, 55 (57.89%) had associated hypertension & 60 (71.57%) had hyperlipidemia. Symptoms included tingling and numbness (84.21%), leg pains (56.42%) and foot ulcers (5.26%). Mean values of blood sugar fasting (112.67± 40.15), blood sugar random (185.53 ± 52.17), serum cholesterol (193.45 ± 35.18), serum triglyceride (188.64 ± 86.11) and HDL cholesterol, LDL cholesterol are also shown in table 1.

Table-2 shows the results of ABI ratios in study patients Grading of ABI ratios show normal values (0.90 – 1.30) only in 38.94% cases. The ratio was mildly abnormal (0.89 to 0.70) in 52.68 % and moderately abnormal ratios (0.69 – 0.40) were observed in 7.38% diabetic patients. None of the diabetic patients was found to have severe PAD disease. Overall 61.06 % diabetics with variable duration of disease had abnormal ABI ratio and of these 4 patients foot ulcer was present. In all the disease was mild and unilateral or bilateral. Two of the patients also had associated hyperlipidaemia. One patient with foot ulcer had normal ABI with a dominant element of neuropathy.

Correlation of ABI to the duration of diabetes, blood sugar & various lipids are shown in table 3. Duration of diabetes has negative and highly significant (P = 0.047 & 0.008) correlation (r = - 0.650 & 0.937) with ABI ratio i.e the higher the duration the lower will be the ratio. However, blood sugar levels and lipids were not significantly correlated with ABI.

DISCUSSION

Peripheral Arterial Disease (PAD), an atherothrombotic syndrome associated with enhanced risk of cardio-vascular and cerebrovascular events remain under treated. Ankle-brachial index (ABI), a non-invasive and simple to apply technique provides reliable test for diagnosing PAD in practice. However, its use in clinical practice is still limited & the condition is mostly diagnosed symptomatically. In this pilot study, 95 patients suffering from diabetes mellitus with variable duration of disease were tested for ABI ratios. Ratio was abnormal (less than 0.9) in 61.06% diabetics. Abnormality was mild (ratio 0.89 – 0.70) in 53.68% and moderate (ratio 0.69 – 0.40) in 7.38% diabetic cases. In a cross sectional prevalence study of peripheral arterial disease (PAD) using ABI in general population, much higher prevalence (57% - 75%) was observed among symptomatic and high risk groups.[11]The results of this pilot study in diabetics also show a high prevalence (61%) of PAD.

Other risk factors for PAD among the study group were hypertension (57.89%), smoking (8.42%), coronary artery disease (3.15%),dyslipidaemia (71.57%) and symptoms of PAD i.e. leg pain (56.42%) and foot ulcers (5.26%). Higher prevalence rates of PAD have been documented in patients with CAD, past symptoms of PAD and smoking.[11-13] Cigarette smoking is the single most important modifiable risk factor for the development & exacerbation of PAD[12]; however, in this study 8.42%

males were smokers. Hypertension is associated with the development of atherosclerosis and with a two to three folds increased risk of claudication.[13]

The duration and severity of diabetes correlates with the incidence and extent of PAD[3,14]Adler *et al*[15] estimated the prevalence of PAD up to 18 years after the diagnosis of diabetes in 4987 subjects (United Kingdom Prospective Diabetes Study UKPDS). The results showed a high prevalence of PAD in those with longer duration of diabetes. In our study the mean duration of disease was 13.23 ± 5.83 years and there was a significant negative correlation (Rt. ABI: r = -0.65, P 0.047 & Lt. ABI: r = - 0.937 & #P value < 0.008) of ABI ratio with duration of diabetes i.e the longer the duration the lesser is the ABI ratio and therefore, the higher incidence of PAD and cardiovascular events. However, correlation of ABI with other biochemical parameters like blood sugar, cholesterol, triglyceride & HDL levels was statistically insignificant.

ABI is a simple non-invasive and rapid technique which provides reliable data for the diagnosis of PAD. The overall accuracy of ABI in the diagnosis of PAD has been well established against contrast angiography and Doppler ultrasound and is considered to have good reproducibility.[16-18] Therefore the implementation of ABI for detecting PAD would assist in early identification and treatment of the condition especially in diabetics which will also lower the risk of subsequent cardiovascular events in them. The American Diabetic Association (ADA) has, therefore, recommended regular ABI screening of diabetic patients of long duration of disease particularly if disease is under treated.[5]

The study concludes a high frequency of abnormal ABI (<0.90) indicative of high PAD among diabetics with older age, longer duration of disease & other associated risk factors. Therefore, it is recommended that ABI screening should be a routine procedure for diabetic patients with longer duration & specially for a poorly treated disease.

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REFERENCES

1. Marso SP, Hiatt WR. Peripheral Arterial Disease in patients with diabetes. J Am Coll Cardiol 2006: 47:921–9.

2. American Diabetes Association. Peripheral arterial disease in people with diabetes. Diabetes Care 2003; 26:3333–41.

3. Al-Delaimy WK, Merchant AT, Rimm EB, Willett WC, Stamperfer MJ, Hu FB. Effect of type 2 diabetes and its duration on the risk of peripheral arterial disease among men. Am J Med 2004; 116:236–40.

4. Selvin E, Marinopoulos S, Berkenblit G, Rami T, Brancati FL, Powe NR, et al. Meta-analysis: glycosylated hemoglobin and cardiovascular disease in diabetes mellitus. Ann Intern Med 2004; 141:421-31.

5. American Diabetes Association: Peripheral arterial disease in people with diabetes. Clinical Diabetes 2004; 22:181–9.

6. Schainfeld RM. Management of peripheral arterial disease and intermittent claudication. J Am Board Fam Pract 2001; 14:443–50.

7. Khaira HS, Hanger R, Shearman CP. Quality of life in patients with intermittent claudication Eur J Vasc Endovasc Surg 1996; 11:65–9.

8. Diehm C, Lange S, Darius H, Pittrow D, von Stritzky B, Tepohl G, et al. Association of low ankle brachial index with high mortality in primary care. Eur Heart J. 2006; 27:1743-9.

9. Vogt MT, Cauley JA, Kuller LH, Nevitt MC. Functional status and mobility among elderly women with lower extremity arterial disease: the study of osteoporotic fractures. J Am Geriatr Soc 1994; 42:923–29.

10. McDermott MM, Liu K, Greenland P, Guralnik JM, Criqui MH, Chan C, et al. Functional decline in peripheral arterial disease: associations with the ankle brachial index and leg symptoms. JAMA 2004; 292:453-61.

11. Cacoub P, Cambou JP, Kownator S, Belliard JP, Beregi JP, Branchereau A, et al. Prevalence of peripheral arterial disease in high-risk patients using ankle-brachial index in general practice: a cross-sectional study. Int J Clin Pract 2009; 63:63-70.

12. Lassila R, Lepantalo ML. Cigarette smoking and the outcome after lower limb arterial surgery. Acta Chir scand 1988; 154:635–40.

13. Stokes J, Kannel WB, Wolf PA, Cupples LA, Dagostino RB. The relative importance of selected risk factors for various manifestations of cardiovascular disease among men and women from 35 to 64 years old: 30 years of follow-up in the Framingham Study. Circulation 1987; 75:65–73.

14. Jude EB, Oyibo SO, Chalmers N, Boulton AJ. Peripheral arterial disease in diabetic and non-diabetic patients a comparison of severity and outcome. Diabetes Care 2001; 24:1433–7.

15. Adler Al, Stevens RJ, Neil A, Stratton IM, Boulton AJ, Holman RR. UKPDS 59, hyperglycemia and other potentially modifiable risk factors for peripheral vascular disease in type 2 diabetes. Diabetes Care 2002; 25:894–9.

16. Lijmer JG, Hunink MG, van den Dungen JJ, Loonstra J, Smit AJ. ROC analysis of noninvasive tests for peripheral arterial disease. Ultrasound Med Biol 1996; 22:391-8.

17. Feigelson HS, Criqui MH, Fronek A, Langer RD, Molgaard CA. Screening for peripheral arterial disease: the sensitivity, specificity, and predictive value of noninvasive tests in a defined population. Am J Epidemiol 1994; 140:526 – 34.

18. Baker JD, Dix DE. Variability of Doppler ankle pressures with arterial occlusive disease: an evaluation of ankle index and brachial-ankle pressure gradient. Surgery 1981; 89:134–7.

19. Parks R. Ankle-brachial index test. Web Med. Last updated October 16, 2009. Available from: (http://www.webmd.com/heart-disease/ankle-brachial-index-test).

20. Bilquis A, Saulat S, Rafiq A K, Sibgha Z Detection of atheriosclerosis by ankle brackial Index: evaluation of palpatory method versus ultrasound Doppler technique. J Ayub Med Coll Abbottabad 2009; 21:11–16.

21. Expert panel on detection evaluation and treatment of high cholesterol in adults; Summry of the third report of NCEP (Adult Treatment Panel III). JAMA 2001; 285:2486-97.