RESEARCH ARTICLE

ANKLE BRACHIAL PRESSURE INDEX: AS A PREDICTOR OF PERIPHERAL ARTERIAL DISEASE IN DIABETIC & NON DIABETIC SUBJECTS

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ABSTRACT

Background: Peripheral arterial disease is known to be associated with the diabetes and ankle-brachial pressure index (ABPI) can be used to screen such patients having PAD.

Aims & Objective: To highlight the application of ankle brachial pressure index as a routine procedure and to assess the feasibility of using ABPI in detecting PAD in the patients of diabetes mellitus.

Material and Methods: 30 Diabetic and 30 Non diabetic patients were recruited. Details regarding anthropometric measurements, blood sugar levels, lipid profile, Edinburgh questionnaire, peripheral pulse examinations etc. were filled in preformed questionnaire. Ankle-brachial pressure index (ABPI) was measured with the help of Handheld Doppler machine. Descriptive statistics in the form of frequency and percentage is used for description of data. Chi-square test was used for comparison of events in two groups.

Results: PAD was more common in old age but found not to be associated with gender. Body mass index, surface area and wait hip ration was significant more in PAD group as compared to non-PAD. All blood sugar parameters [Fasting blood sugar (FBS), postprandial blood sugar after 2 hours (PP2BS) and Glycosylated haemoglobin (HB1AC)] were significantly more in PAD group as compared to non-PAD. High density lipoprotein was significantly less in PAD group as compared to non-PAD. Triglyceride, Total Cholesterol and Low density lipoprotein was significantly more in PAD group as compared to non-PAD. ABPI was significantly less in diabetics as compared to non-diabetics. More diabetics were in having PAD as compared to non-diabetics.

Conclusion: PAD is found to be associated with more weight, adverse lipid profile and diabetes. ABPI can be used to screen the PAD in diabetic patients.

KEY-WORDS: Peripheral Arterial Disease; Diabetes; Ankle- Brachial Pressure Index; Lipid Profile

Introduction

Epidemiologists have paid less attention to peripheral arterial disease (PAD) than coronary and cerebrovascular disease. Prevalence and incidence data typically shows that peripheral arterial disease increases with age, is more common in men than women and that symptomatic disease is only the tip of the iceberg. Although much is known regarding PAD in the general population, assessment and management of PAD in those with diabetes is less clear and poses some special issues. Data from the Framingham Heart Study revealed that 20% of symptomatic patients with PAD had diabetes, but this probably greatly underestimates the preva-lence, given that many more people with PAD are asymptomatic rather than symptomatic.[1,2]

At present, there are no established guidelines regarding the care of patients with both diabetes and PAD. Studies concerning the prevalence of peripheral arterial disease rely mainly on the Edinburgh questionnaire, which is used to screen for intermittent claudication, and on the ankle/brachial pressure index, used to detect asymptomatic disease.

The ankle-brachial pressure index (ABPI) is a, simple, most reliable, accurate, rapid, inexpensive, non-invasive, quantitative measurement & the initial test for screening and diagnosing peripheral arterial disease. The Ankle Brachial Pressure Index (ABPI) can accurately identify peripheral vascular disease but is grossly underutilized by medical practitioners outside of the vascular surgical arena. It can be used in clinical practice as

the standard reference in primary care of PAD and to establish the presence or absence of lower extremity atherosclerotic vascular disease.[3] The ABPI can also predict how severe an individual's atherosclerosis is and the risk of future leg problems such as development of future leg rest pain, poor healing of foot wounds, need for leg bypass surgery or amputation. A high ankle brachial pressure index is associated with increased cardiovascular disease morbidity and lower quality of life because it suggests calcification of arteries.[4] A low ankle brachial pressure index is associated with impaired lower extremity functioning, slower walking velocity, fewer blocks walked per week, lower hip abduction force and lower knee extension force.

A high ABPI values have significantly higher odds for congestive heart failure, stroke, foot ulcers and neuropathy. The ankle-brachial pressure index also has prognostic significance because of the association with arterial disease elsewhere, especially coronary heart disease. Recent studies indicate an association of elevated ankle-brachial index levels with increased cardiovascular mortality.[5]

Ankle-brachial pressure index has 92.85% sensitivity and 100% specificity (Daphne Pereira, et al. 2007). However, a normal ABPI value does not absolutely rule out the possibility of PAD for a few individuals. Some patients with a normal or near normal ABPI results may have few symptoms suggesting PAD. A treadmill exercise or reactive hyperaemia test may be recommended to test further for the disease and the cause of pain. ABPI does not specifically identify which arteries are blocked. A very abnormal ABPI test may require more testing to determine the exact location and severity of PAD that might be present. Hence this study was designed to highlight the application of ankle brachial pressure index as a routine procedure and to assess the feasibility of using ABPI in detecting PAD in the patients of diabetes mellitus also to assess the vascular supply to the lower legs in the control and diabetic groups.

Materials and Methods

The present study consisted of diabetic (n=30) and non-diabetic (n=30) subjects. Diabetic subjects were taken for the study from the diabetic clinic, OPD and from the patients admitted in the wards of SSG Hospital, Vadodara.

All diabetic patients were under the anti-diabetic treatment at least for 5 years and more. None of the patients had CNS disorders or organ damage. Subjects of both the groups were in between the age group of 40 to 70 yrs. Some of the subjects not suffering from PAD had the habit of doing mild to moderate type of physical activity e.g. long distance walking, jogging and cycling while the subjects with PAD had the problem of intermittent claudication and hence they were reluctant to go for physical activity.

Detailed history of subjects of both the groups was taken and their Standard anthropometric measurements like height, weight, waist and hip circumference, BMI, body surface area were registered. Name, age, physical activity, any past/family history of illness etc. were noted. History of diabetic subjects was taken with respect to total duration and medical treatment. History of intermittent claudication and history of pain during walking, standing, walking uphill (Edinburgh questionnaire) was taken. Examination of peripheral pulses in lower limb was done and legs were examined for any skin changes or presence of ulcer.   Ankle Brachial Pressure Index Measurement was done with the help of - Handheld Doppler machine (emco meditec India, model no. D- 580).

The ABI is calculated by dividing ankle systolic pressure by brachial systolic pressure:
ABI=ankle systolic pressure/ brachial systolic pressure

In a normal subject the pressure at the ankle pulses is slightly higher than pressure at the brachial pulses. ABPI value from 0.9 to 1.3 is considered normal (Free from significant PAD). An ABPI value greater than 1.3 suggests calcification of the walls of the arteries and incompressible vessels, reflecting severe peripheral vascular disease.

The data regarding routine blood investigation like FBS, PP2BS, HBA1c, lipid profile and haematocrit were also collected from the

investigation sheets of the patients and registered in the pro-forma.

Statistical Analysis

Descriptive statistics in the form of frequency and percentage is used for description of data. Chi-square test was used for comparison of events in two groups.

Results

Out of 27 subjects in age group of 40-55 years 8 (29.62%) had PAD while out of 33 (69.69%) subjects of 56-70 years age group 23 had PAD (P < 0.01). Out of 14 female subjects 6 (42.85%) were suffering from PAD while out of 46 male subjects 25 (54.34%) were suffering from PAD (P >0.05).

Table-1: Comparison of Standard Anthropometric Measurements between PAD and NON-PAD Subjects

Parameters	PAD Subjects		NON-PAD Subjects	
	Mean	SD	Mean	SD
Height (cm)	164.61	7.36	165	8.26
Weight (kg)	76.87	11.15	65.72	8.14
BMI (kg/sq.m)	28.85	5.42	24.28	3.87
Body surface area (sq.m.)	1.86	0.13	1.72	0.12
Waist circumference (cm)	96.58	9.64	88.68	5.86
Hip circumference (cm)	95.54	5.72	92.31	3.88
Waist hip ratio	1.00	0.05	0.95	0.04

The mean BMI in subjects with PAD was 28.85 with SD of 5.42 and the mean BMI in non-PAD subjects was 24.28 with SD value of 3.87 (P < 0.01). In this study while measuring the body surface area, the mean in PAD subjects was 1.86 and in non-PAD subjects the mean was 1.72 with P value of < 0.05. The mean waist hip ratio was 1.00 in PAD subjects and 0.95 in non- PAD subjects (P < 0.001).

Table-2: Comparison of Blood Sugar and Glycosylated Haemoglobin between PAD and NON-PAD Subjects

Investigations	PAD Subjects		NON-PAD Subjects	
	Mean	SD	Mean	SD
FBS in mg/dl	172.87	64.26	119.55	43.05
PP2BS in mg/dl	235.35	76.94	155.34	49.12
HBA1c	9.23	3.28	6.43	1.77

The mean FBS in PAD subjects was 172.87 while in non-PAD subjects was 119.55 (P <0.01). In the case of PP2BS, the mean was 235.35 in PAD subjects and 155.34 in non-PAD subjects with P value of <0.001. The mean HBA1c in PAD subjects was 9.23 and in non-PAD subjects the mean was 6.43. (P <0.001).

Table-3: Comparison of Lipid Profile between PAD and NON-PAD Subjects

Investigations	PAD Subjects		NON-PAD Subjects	
	Mean	SD	Mean	SD
HDL (mg/dl)	37.45	6.50	45.27	5.82
LDL (mg/dl)	134.48	31.61	102.83	30.27
Total cholesterol (mg/dl)	219.64	37.55	175.41	38.53
Triglycderides (mg/dl)	233.22	103.96	141.65	63.77

The mean HDL in PAD subjects was 37.45 and in non-PAD subjects was 45.57 (P <0.001). The mean LDL in PAD subjects was 134.48 and in non-PAD subjects 102.83 and has P value <0.001. The mean total cholesterol in PAD subject was 219.64 and in non-PAD subjects 175.41 (P <0.001). The mean triglyceride in PAD subjects was 233.22 and in non-PAD subjects 141.65 (P<0.001).

Table-4: ABPI in Diabetic and Non-Diabetic Groups

Investigations	PAD Subjects		NON-PAD Subjects		p value
	Mean	SD	Mean	SD	
ABPI left side	0.87	0.16	1.01	0.10	< 0.01
ABPI right side	0.85	0.15	1.00	0.09	< 0.01

ABPI was significantly different between diabetic and non-diabetic patients (Table 4).

Table-5: Relation between PAD and Diabetes Mellitus

	PAD Subjects	NON-PAD Subjects	Total
Diabetic Subjects	22	8	30
Non-diabetic Subjects	9	21	30

Out of 30 diabetic subjects 22 (73.33%) were having PAD and out of 30 non-diabetic 9 (30%) were having PAD (P <0.001).

Table-6: Comparison of Anthropometric Measurements, Symptoms, Signs and Investigations between PAD and Non PAD Subjects.

Parameters	PAD Subjects (N=31) N (%)	Non-PAD Subjects (N=29) N (%)
Anthropometric Measurements		
BMI > 25 kg/sq.m.	19(61.29%)	7 (24.13%)
Body surface area > 1.72 sq.m.	26 (83.87%)	17 (58.62%)
Waist-hip ratio > 1	20 (64.51%)	4 (13.79%)
Symptoms		
Intermittent claudication	29 (93.54%)	0
Signs		
Peripheral pulses absent	22 (70.96%)	0
Blackening of Skin present	23 (74.19%)	0
Ulcer/gangrene	18 (56.25%)	0
Investigations		
ABPI <0.9	27 (87.09%)	0
HBA1c >7.0	21 (67.74%)	5 (17.24%)
HDL < 40 mg/dl	21 (67.74%)	4 (13.79%)
LDL ≥ 130 mg/dl	20 (64.51%)	6 (20.68%)
Total Cholesterol ≥ 200 mg/dl	22 (70.96%)	8 (27.58%)
Triglyceride ≥ 200 mg/dl	21 67.74%)	4 (13.79%)

Table-7: Stratification of severity of PAD according to value of ABPI

ABPI Value	Subjects (n=60)	Interpretation
above 1.3	0	Abnormal Vessel hardening from PVD
1.0 - 1.3	5	Normal range
0.9 - 1.0	28	Acceptable
0.8 - 0.9	12	Some arterial disease
0.5 - 0.8	15	Moderate arterial disease
under 0.5	0	Severe arterial disease

Discussion

The World Health Organisation describes Peripheral Vascular Disease as a cluster of conditions in which atherosclerosis, or narrowing of blood vessels, occurs in the peripheral circulation, particularly in the legs. It can cause severe disability as the affected limbs are at risk of amputation and infection. Peripheral arterial disease (PAD) is a significant complication of diabetes mellitus and accounts for the majority of amputations among these patients with diabetes.[1,2] Despite its associations with increased morbidity and mortality, PAD is significantly under-diagnosed and under-treated in the general population. The ankle-brachial pressure index (ABPI) is a, simple, accurate, rapid, inexpensive, non-invasive measurement & the initial test for screening and diagnosing peripheral arterial disease.

Aim of our study was to determine the association of PAD in diabetic and non-diabetic subjects. Our study consist total 60 subjects. Out of which 30 patients were having type 2 diabetes mellitus at least for 5 years or more. Out of 30 diabetic subjects 22 (73.33%) were having PAD and out of 30 non-diabetic 9 (30%) were having PAD with p value < 0.001 which indicates significant association between diabetes mellitus and PAD. Similar finding were observed in other studies.[6] In diabetic and non-diabetic group age and sex were matched. Anthropometric measurements like height, weight, BMI, body surface area, waist circumference, hip circumference and waist hip ration were noted and compared in subjects with PAD and subjects without PAD. Our results show that abnormal BMI, abnormal body surface area and abnormal waist hip ratio are positively associated with the PAD. Our study also shows that abnormally increased blood sugar levels and increase in HBA1c are also positively associated

with development of PAD. Our study data also shows that dyslipidaemia is highly associated with development of PAD.

Different studies show that prevalence of PAD is more in older age. The Rotterdam study done by Meijer, W. T et al. (2000) suggested that age older than 75 years was an important risk factor for PAD.[7] Comparing sex in study conducted by Raj Mohan et al (2010), shows that in PAD subject 48.1% were male while in non-PAD subjects 48.9% were male with P- value of 0.054 which suggests that there was no significant gender difference between two groups. In our study out of 14 female subjects 6 (42.85%) were suffering from PAD while out of 46 male subjects 25 (54.34%) were suffering from PAD with p value of >0.05 which shows that there is no significant association between PAD and sex.[8]

In our study we carried out anthropometric measurements such as height, weight, BMI, body surface area and waist hip ratio. We found the significant correlation between abnormal BMI (>25 kg/sq.m.) and development of PAD with p value of < 0.01. On the contrary the study conducted by Raj Mohan et al (2010), showed no significant correlation between these parameters.[8]

Few studies have compared the severity and prevalence of PAD among diabetics versus non diabetic subjects. In the Framingham study 20% of the men and women with intermittent claudication had diabetes compared with 6 persons of those without intermittent claudication. In Raj Mohan et al (2010), the mean HBA1c in PAD subjects was 8.19% and in non-PAD persons it was 7.89% and p value was not significant.[8] In Elizabeth Selvin et al. (2006), it was shown that individuals with poor glucose control (HBA1c >7.5%) were more than 5 times as likely to develop intermittent claudication and also 5 times as likely to have hospitalization for PAD compared with comparable individuals with good glycaemic control(HBA1C <6%).[9] In our study the mean FBS in PAD subjects was 172.87 while in non-PAD subjects was 119.55 with p value < 0.01 which shows positive association between abnormal FBS and PAD. While measuring PP2BS, the mean was 235.35 in PAD subjects and

155.34 in non-PAD subjects with p value of <0.001 which shows highly positive co-relation between abnormal PP2BS and PAD. The mean HBA1c in PAD subjects was 9.23 and in non-PAD subjects the mean was 6.43 with p value <0.001 which shows highly significant co-relation between Abnormal HBA1c and PAD.

A cross-sectional study was conducted among 4,526 National Health and Nutrition Examination Survey (1999–2002). Among non-diabetic subjects, the age-standardized prevalence of peripheral arterial disease was 3.1, 4.8, 4.7, and 6.4% for participants with an A1C <5.3, 5.3–5.4, 5.5–5.6, and 5.7–6.0%, respectively. The prevalence of peripheral arterial disease was 7.5 and 8.8% for diabetic participants with A1C <7 and ≥7%, respectively. The p value for this data was <0.001 which was highly significant. Thus an association exists between higher levels of A1C and peripheral arterial disease, even among patients without diabetes. Individuals with A1C levels ≥5.3% should be targeted for aggressive risk factor reduction, which may reduce the burden of subclinical cardiovascular disease even among those without diabetes.[10]

Hypercholesterolemia is a major risk factor for atherosclerotic disease. It has been suggested that hypercholesterolemia has a greater impact on the risk of coronary artery disease and less on PAD. In the Framingham Heart Study, an elevated total cholesterol level was associated with a twofold increased risk for intermittent claudication. In study conducted by Raj Mohan et al (2010), the mean total cholesterol in PAD and non-PAD group were 5.04 mmol/liter and 5.34 mmol/liter respectively with p value of 0.049. The HDL cholesterol was 1.24 mmol/liter and 1.38 mmol/liter for both the group respectively with p value of 0.011. The relation between LDL cholesterol and PAD was not significant with mean value being 3.04 mmol/liter and 3.14 mmol/liter respectively. Similarly triglyceride level was also not significantly correlated with PAD.[9]

In Rotterdam study conducted by Meijer, W. T et al. (2000) also inferred that there was a clear inverse relation with HDL cholesterol level and PAD and direct relation between serum cholesterol level and PAD.[8]

In our study the mean HDL in PAD subjects was 37.45 and in non-PAD subjects was 45.57 with p value of <0.001 which shows that PAD is highly associated with abnormal HDL level. The mean LDL in PAD subjects was 134.48 and in non-PAD subjects 102.83 and has p value <0.001 which shows highly significance between abnormal LDL and PAD. The mean total cholesterol in PAD subject was 219.64 and in non-PAD subjects 175.41 with p value of <0.001 which shows positive relation between abnormal total cholesterol and PAD. The mean triglyceride in PAD subjects was 233.22 and in non-PAD subjects 141.65 having p value of <0.001 which shows positive association between abnormal triglyceride level and PAD.

The study conducted by Stanek, E. J et al showed that out of 2568 patients with peripheral arterial disease 37% had isolated high LDL and 42% had high triglyceride. 45% of men had low HDL (<40 mg/dl) and 41% of women had low HDL (< 50 mg/dl). There is a significant, under-treated burden of dyslipidaemia in patients with PAD, particularly elevated LDL-C concomitant with low HDL-C and/or high TG. Targeted prevention strategies should include lifestyle and pharmacologic interventions directed at modifying the entire lipid panel.

Conclusion

The results obtained by our study seem to be encouraging and justify the necessity of this kind of study on larger scale. The prevalence of PAD seems to be significantly high in diabetic subjects as compared to non-diabetic subjects. Older age seems to be an important, non-modifiable risk factor for development of PAD. Assessment of anthropometric measurements suggests that overweight and obesity might have significant impact on development of PAD. Measurement of ABPI appears to be important in diagnosing PAD in symptomatic as well as asymptomatic subjects.

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