

Original Research Article

Ankle brachial pressure index to assess atherosclerotic risk in hypertensive subjects

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Received: 03 January 2017

Accepted: 07 January 2017

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ABSTRACT

Background: This research was planned to study correlation of ankle brachial pressure index (ABPI) with clinical features, laboratory investigations and anthropometric measurements in patients of essential hypertension and to establish association of atherosclerosis risk in hypertensive subject.

Methods: This prospective observational year-long study was conducted after the institutional ethics committee approval in outpatient department of a tertiary care hospital. 153 adult non-pregnant patients were enrolled after written informed consent. Out of these, 51 patients each were of stage I hypertension, stage II hypertension and normal blood pressure. The ABPI were measured in the posterior tibial arteries using a Doppler ultrasound probe. The detailed demographic and anthropometric data was entered in proforma and data statistically analyzed.

Results: In our study 28 (55%) out of 51 patients in stage II Hypertension had low ABPI as compared to 23 (45%) out of 51 patients in stage I Hypertension. No patients with normal blood pressure had low ABPI. There is significant correlation of stage of hypertension and ABPI ($p < 0.001$). Mean ABPI (0.9102) in stage II hypertensive was low as compared to stage I hypertensive (0.9124) and normotensive subjects (1.0263). ABPI was inversely correlated with lipid profile. The hypertensive subjects with duration of hypertension for more than 5 years, the mean ABPI was significantly lower (0.8773) than those hypertensive subjects who had duration of hypertension less than 5 years (0.9526) ($p < 0.001$).

Conclusions: ABPI proves to be a non-invasive, bed side modality to assess the atherosclerotic risk in hypertensive patients.

Keywords: ABPI, Atherosclerosis, Hypertension

INTRODUCTION

Hypertension is an important cause of cardiovascular morbidity and mortality.¹ It can often be asymptomatic till the time of presentation. In the emergency department we find patients with hypertension presenting directly with cerebrovascular or cardiovascular complication due to advanced stages of hypertensive atherosclerotic disease.

Arteriosclerosis is generalized disease widely affecting arterial vascular system. Hypertension is a major risk factor for atherosclerosis as well as arteriosclerosis.

Symptomatic peripheral vascular disease is independently associated with up to a six-fold increase in cardiovascular mortality risk as compared to the normal population.

The aim is therefore to accurately diagnose and aggressively medically treat subjects with peripheral vascular disease, not only to improve the patients' functional ability, but also to prevent disease progression and the occurrence of other cardiovascular events such as myocardial infarction and stroke.²

Although primary determinants of cardiovascular disease have been clearly established and are used to predict

future cardiovascular risk, simple, non-invasive and inexpensive tests that help in vascular risk prediction are useful.

The Ankle Brachial Pressure Index (ABPI) is the ratio of ankle to brachial systolic blood pressure, and a value of less than <0.9 indicates the presence of flow limiting arterial disease affecting the limb. The ABPI is used in assessment of vascular risk in asymptomatic patients. ABPI is a simple, quick, non-invasive tool that can accurately identify peripheral vascular disease and atherosclerosis but is grossly underutilized. It is simple method, can be performed in office or clinic setting. The present study was planned to determine prevalence of low ABPI to predict future cardiovascular risk in hypertensive subjects. We evaluated ABPI in normotensive subjects, patients with, stage I and II hypertension and studied its correlation with diastolic blood pressure, anthropometric measurement and dyslipidaemia. Present study might help in risk assessment and prediction of cardiovascular diseases in asymptomatic hypertensive subjects with use of ABPI, a non-invasive tool.³

METHODS

This was an observational and prospective study, done after obtaining institutional ethics committee permission and after obtaining written informed consent from subjects. Stage I and II hypertensive patients were enrolled from hypertension clinic of our institution. The age and sex matched non hypertensive subjects from medical outpatient department / wards were the controls. Patients diagnosed to have peripheral vascular disease, diabetes mellitus, those with significant edema feet and females with pregnancy induced hypertension were excluded from the study.

Total 153 patients were included in the study. Out of these, 51 patients were of stage I hypertension (systolic BP 140-159 and / or diastolic BP 90-99 mm Hg), 51 patients were of stage II hypertension (systolic BP 160 and above and / or diastolic BP of 100 mm Hg and above and 51 patients were normotensive subjects (JNC VII). Individual patients were asked detailed history about hypertension, personal habits, occupation and other systemic diseases.

Detailed physical examination including relevant general and systemic examination was done. Blood pressure measurement recording of systolic and diastolic (phase V) blood pressure in right arm after 10 minute of rest, in supine position, using random zero sphygmomanometer was done. Anthropometric examination, systemic examination including cardiovascular, respiratory, and gastrointestinal and central nervous system were done. Ankle systolic pressures were measured in posterior tibial artery of both right and left leg, and brachial systolic pressures were measured in brachial artery of the right then left hand using Doppler ultrasound probe. The routine investigation mandatory for all hypertensive

patients (as per JNC – VII recommendations) were entered into the proforma.

RESULTS

We evaluated 153 participants in present study of which 76 (49.7%) were females and 77 (50.7%) were males. All the participants were evaluated as per protocol and subsequently divided into three groups as stage I hypertension, stage II hypertension and normotensive subjects. There were 51 (33.3%) patients in each of the three groups. In the group with stage I hypertension, 25 were males and 26 females with mean age of 50.55 (±7.1) years. In stage II hypertension group, 26 were males and 25 females with mean age of 50.08 (±7.2). In normotensive group out of 51, 26 were males and 25 females with mean age of 50.14 (±7.8). Each group was further divided into various age groups like 30-39, 40-49, 50-59, and 60-69 years, and the percentages of patients were 5.2%, 40.5%, 44.4%, and 9.8% respectively in our study. Of the 76 female studied, 46% were post-menopausal and 19% had history of intake of oral contraceptive pill currently or in the past.

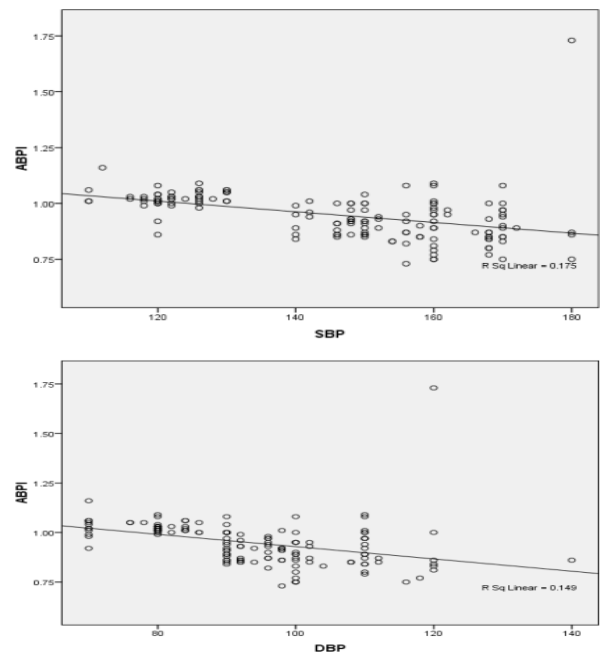


Figure 1: Correlation of systolic and diastolic blood pressure with ABPI.

Table 1: Variables of correlation.

Variables	r (Correlation coefficient)	P value	Significance
ABPI SBP	-0.419	<0.001	Significant
ABPI DBP	-0.386	<0.001	Significant

(Pearson’s Correlation coefficient); (P <0.05 – Significant)

Out of the total 153 subjects 23 (15%) had history of ischemic heart disease and 23 (15%) history of stroke.

Out of the 153 studied subjects 38 (24.8%) subjects were smoker, 52 (33%) were tobacco chewer and 29 (18%) were addicted to alcohol. The data was entered using MS-Excel-2007 and analysed using SPSS-16 software. Appropriate statistical tests like Un-paired t test, One way ANOVA test, Pearson's correlation were used as per the data. The 'p' value less than 0.05 was taken as significant. We compared all three groups with age-sex matched control population. There was highly significant correlation of systolic blood pressure and diastolic blood pressure with ABPI in hypertensive subjects as shown in Table 1 and Figure 1.

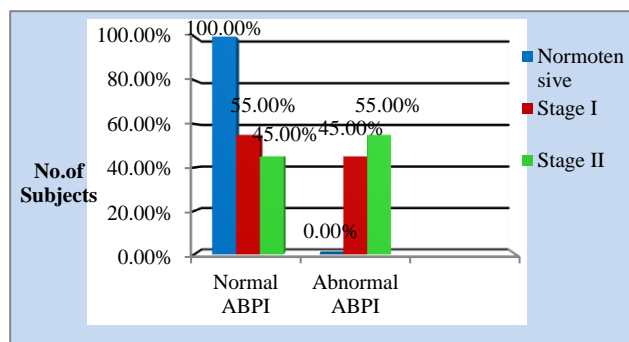


Figure 2: Percentage of patients with abnormal ABPI in three groups (p < 0.001).

In present study 28 (55%) out of 51 patients in stage II Hypertension had low ABPI as compared to 23 (45%) out of 51 patients in stage I Hypertension. No patients with normal blood pressure had low ABPI (Figure 2). There is significant correlation of stage of hypertension and ABPI (p < 0.001). Mean ABPI (0.9102) in stage II hypertensive was low as compared to stage I hypertensive (0.9124) and normotensive subjects (1.0263) (Figure 3).

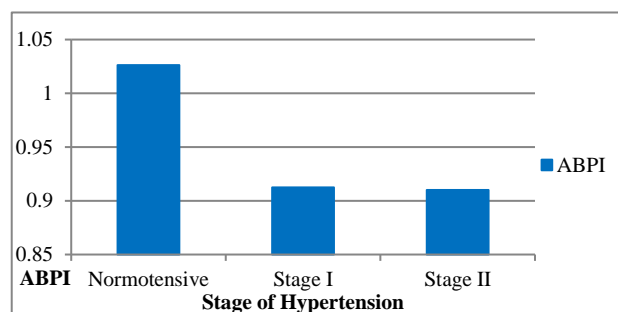


Figure 3: Mean ABPI in three groups.

Mean ABPI was less in females as compared to males, however the difference between two was not significant statistically. The mean ABPI in 35 postmenopausal women was lower 0.8991 as compared to those 41 females not reached menopause (0.9678). This difference is highly significant (p 0.001).

Table 2: Binary Logistic Regression Analysis showing factors influencing low ABPI in hypertensive patients.

	B	S.E.	Wald	df	P value	Significance
Age	0.120	0.057	4.426	1	0.035	Significant
Gender	2.945	1.353	4.736	1	0.030	Significant
Waist Hip ratio	2.979	5.811	0.263	1	0.608	Not significant
Stage of HT	-0.620	0.824	0.567	1	0.452	Not significant
BMI	-0.425	0.188	5.119	1	0.024	Significant
Cholesterol	0.011	0.010	1.213	1	0.271	Not significant
Triglyceride	-0.007	0.008	0.875	1	0.350	Not significant
Serum Creatinine	1.317	1.689	0.608	1	0.436	Not significant
Serum Uric acid	0.081	0.546	0.022	1	0.882	Not significant
CVA	-1.345	1.088	1.528	1	0.216	Not significant
IHD	-2.071	1.065	3.778	1	0.052	Not significant
Alcohol	0.250	1.139	0.048	1	0.826	Not significant
Smoking	-0.960	0.933	1.058	1	0.304	Not significant
Tobacco	-1.427	1.014	1.981	1	0.159	Not significant
Family history of HT	-0.635	0.984	0.416	1	0.519	Not significant
Duration of HT	-2.898	0.793	13.343	1	<0.001	Significant
Waist Circumference	10.011	11.311	0.783	1	0.376	Not significant
Waist to Height ratio	16.188	19.377	0.698	1	0.403	Not significant

The mean ABPI significantly decreased with advancing age (p < 0.001) Mean ABPI in smokers (0.9326) was lower than non-smokers (0.9552) (p 0.268). The mean ABPI in studied subject with IHD was lower (0.9091) as

compared to those without IHD (0.9568) (p 0.052). The mean ABPI in hypertensive patients having cerebrovascular accident in studied population was low (0.8809) as compared to those who did not have it

(0.9618). The difference between the two groups is statistically highly significant ($p=0.001$). The mean ABPI in the subjects with abnormal BMI was lower than the subjects with normal BMI. The mean ABPI in subjects with abnormal waist circumference was lower than the subjects with normal waist circumference. The mean ABPI in subjects with abnormal waist to height ratio is significantly lower (0.9403) than the subjects with normal waist to height ratio (0.9911) ($P=0.030$). The mean ABPI in subjects with hypercholesterolemia was significantly lower (0.8946) than subjects with normal cholesterol (0.9685) ($P=0.030$). The mean ABPI in subjects with hypertriglyceridemia is significantly lower (0.8826) than in subjects with normal serum triglyceride level (0.9666) ($p < 0.001$).

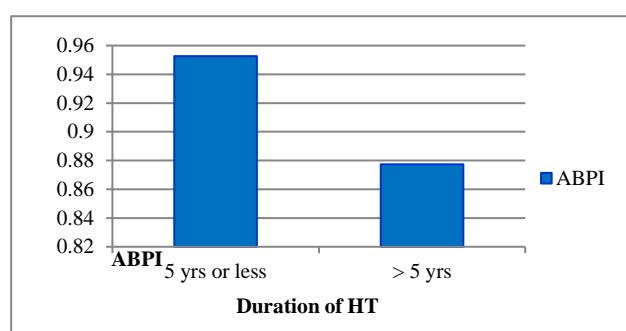


Figure 4: Mean ABPI in hypertensive patients with duration of HT.

Duration of hypertension had inverse relation to ABPI. The hypertensive subjects with duration of hypertension for more than 5 years, the mean ABPI was significantly lower (0.8773) than those hypertensive subjects who had duration of hypertension less than 5 years (0.9526) ($p < 0.001$). (Figure 4) Binary Logistic Regression Analysis (Table 2)

From Univariate analysis it appears that outcome was influenced by many factors like age, stage of hypertension, menopause, h/o CVA, Waist to height Ratio, Serum Cholesterol, Serum Triglyceride and duration of HT. To determine which are the factors influencing outcome when considered together, binary logistic regression analysis was done. Low ABPI was statistically associated with advancing age, gender, body mass index and duration of hypertension for more than 5 years.

DISCUSSION

Hypertension plays a significant role in the development of arteriosclerosis and atherosclerosis. Hypertension has been shown, in epidemiologic and experimental studies, to accelerate atherosclerotic vascular disease and increase the incidence of clinical complications. Atherosclerotic vascular disease is a process that frequently involves the entire vascular system in an individual. The presence of peripheral vascular disease signifies a high risk of

cardiovascular morbidity and mortality even in asymptomatic subjects. Symptomatic peripheral vascular disease is independently associated with up to a six-fold increase in cardiovascular mortality risk as compared to the normal population. The aim is therefore to accurately diagnose and aggressively medically treat subjects with peripheral vascular disease. The Ankle Brachial Pressure Index (ABPI) is a simple, quick, non-invasive tool that can accurately identify peripheral vascular disease but is grossly underutilized by medical practitioners outside of the vascular surgical arena.

In current study we evaluated ABPI in hypertensive and non-hypertensive patient. The stage I and II hypertensive patients were compared with age and sex matched normotensive subjects. We found significant correlation between stage I / stage II hypertensive and control group. We found significant correlation of ABPI with stage of hypertension. 28 (56%) of stage II hypertension had low ABPI as compared to 23 (44.2%) subject in stage I hypertension and nil in normotensive group. We found significant inverse correlation between ABPI and systolic and diastolic blood pressure which is accordance with all previous study.

On Univariate analysis for studying the effect of various factors on ABPI, we found that as the stage of hypertension advances the ABPI decreases significantly. With advancing age ABPI decreases and this decrease in ABPI in relation to the age in years is statistically significant. Though females had lesser mean ABPI than males, the difference was not statistically significant. The family history of hypertension, abnormal BMI, abnormal waist circumference did not show significant effect on ABPI in our study. However factors like postmenopausal status, abnormal waist to height ratio, hypercholesterolemia, hypertriglyceridemia and duration of hypertension (>5 years) had significant effect on ABPI. To determine which were the factors influencing ABPI when considered together, binary logistic regression analysis was done. It showed that ABPI was significantly related to age, gender, Body Mass Index and prolonged duration of hypertension (>5 years).

Smoking is strong independent risk factor for low ABPI. In present study we found that smokers had lower ABPI as compared to non-smokers, however the difference was not statistically significant. Smoking was a strong independent risk factor for low ABPI among the elderly women in the multicentre study for osteoporotic fracture. Newman et Al reported significant correlation of smoking and low ABPI in elderly. Kamath Ganesh et al found in their study, high degree of association between cigarette smoking (>20 cigarettes) and the development of PAD in Indian population⁴. Smoking has been strongly related to ABPI in Scottish men and women 55 to 74 years of age. In present study, there was no statistical difference in the ABPI in patients with tobacco chewing as addiction. We did not find correlation between ABPI and alcoholism. One study in Chinese

men suggestive of alcohol consumption was associated with peripheral artery disease, and consumption of less than 60 g/d had an inverse association with peripheral atherosclerosis whereas consumption of 60 g/d or more had a positive association.⁵

In present study, the mean ABPI in patients with ischemic heart disease (IHD) was lower than those who did not have IHD. However the difference was not statistically significant. Out of 23 patients with ischemic heart disease, 15 patients (65 %) had low ABPI similar to previous study. In Sweden population, Ogren M et al found that cardiac event rate was 25% (17/67) in the group with low ABPI and 10% in the other group.⁶ M. Kornitzer et al described ABPI is an independent predictor of ten year coronary heart disease mortality in asymptomatic middle aged males.⁷

In present study the mean ABPI in patients having CVA was low (0.8809), when compared to the subjects not having CVA, the difference in ABPI was highly statistically significant. Similar results have been obtained in various previous studies. In Framingham study, Murabito JM et al found, low ABI is associated with risk of stroke or transient ischemic attack in the elderly.⁸ In ARIC study, Albert W Tsai et al studied relation of ABPI and 7 year ischemic stroke incidence. They concluded that, Low ABI was strongly associated with increased incidence of ischemic stroke, but the relationship was substantially reduced after adjustment for major cardiovascular risk factors.⁹ F Purroy et al concluded from their study that, abnormal ABI was associated with classical risk factors, especially hypertension, increases risk of stroke.¹⁰ The incidence of ischemic heart disease and cerebrovascular accident increases with abnormal ABPI.

From various studies it is concluded that ABI measurement should be part of vascular risk assessment in asymptomatic patient to predict future cardiovascular risk.¹¹⁻¹⁶ In various trials, the sensitivity, specificity, reliability, validity of ABPI was studied. Caruana Mf et al studied the validity, reliability, reproducibility and extended utility of ankle to brachial pressure index. Their study has shown that, the ankle to brachial pressure index (ABPI) remains the cornerstone of non-invasive assessment of the patient with symptomatic peripheral arterial disease. Anand Doobay et al studied sensitivity and specificity of ankle brachial index to predict future cardiovascular outcomes. They did meta- analysis of 9 studies. They found sensitivity and specificity of a low ankle brachial index to predict incident coronary heart diseases were 16.5% and 92.7%, for incident stroke were 16.0% and 92.2%, and for cardiovascular mortality were 41.0% and 87.9%, respectively. The corresponding positive likelihood ratios were 2.53 (95% CI, 1.45 to 4.40) for coronary heart disease, 2.45 (95% CI, 1.76 to 3.41) for stroke, and 5.61 (95% CI, 3.45 to 9.13) for cardiovascular death. Hence from their study they concluded that ABPI is highly specific but not sensitive

for predicting cardiovascular disease.¹⁷ Guo x and Li j et al studied sensitivity and specificity of ankle-brachial index for detecting angiographic stenosis of peripheral arteries in Chinese patients. In their study they found, that the ABI value shows a decreasing tendency with increasing severity of stenosis in patients with PAD. ABI measurement is an accurate and reliable non-invasive alternative to conventional DSA in the assessment of lower extremity arteries. In Rotterdam study both Carotid Intima Media Thickness and ABPI were found equally effective in predicting future risk of myocardial infarction.¹⁸

Kornitzer M, et al described ABPI is an independent predictor of ten year coronary heart disease mortality in asymptomatic middle aged males.⁷ J lee et al studied non-invasive measures of subclinical atherosclerosis such as the ankle brachial index (ABI) could improve risk prediction and provide more focused primary prevention strategies. After the study, they recommend that the ABI be incorporated into routine cardiovascular screening and that the potential of its inclusion into cardiovascular scoring systems should be examined.¹⁵ Markus A Busch et al studied, low ABI independently predicted subsequent cardiovascular risk and mortality in patients with acute stroke or TIA.

ABI measurement may help to identify high-risk patients for targeted secondary stroke prevention.¹⁹ The ankle-brachial index (ABI) is widely accepted as a diagnostic test for evaluation of lower extremity peripheral artery disease (PAD) in patients with symptoms of intermittent claudication or rest ischemia. However, the majority of patients with PAD are asymptomatic; therefore, measurement of the ABI only when prompted by symptoms will result in most cases of PAD going unrecognized. CL Heald et al have done longitudinal study comprising 11 studies with 44,590 subjects from six different countries were included. They concluded that ABI may help to identify asymptomatic individuals in the general population who are at increased risk of subsequent cardiovascular event. They strongly recommended incorporation ABI measurement into cardiovascular prevention programmes.¹³

The American heart association (AHA) prevention conference V described the ABI as strong and independent risk factor for cardiovascular mortality and recommended it should be used to detect sub clinical disease in the prevention of cardiovascular mortality and stroke. The AHA recommended that the ABI might be a useful addition to the assessment of CHD risk in selected populations, especially in people aged 50 years and older or those who appear to be at intermediate or higher risk for CVD on the basis of traditional risk factor assessment, such as cigarette smokers or individuals with diabetes mellitus, who have a particularly high risk for PAD. If a patient is found to have an abnormal ABI, this patient can be elevated to a higher risk category. The high relative risk in patients with abnormal ABIs is similar to that of

patients who qualify for the AHA secondary-prevention regimen.^{20,21} ABPI is important tool for prediction of cardiovascular mortality even in a asymptomatic person. Practitioners should be updated with use of ABPI, its sensitivity and specificity, standardized techniques of using this non-invasive method.

An essential contribution to the current understanding of ABPI and cardiovascular risk prediction would be large scale study adequately powered to assess the predictability of ABPI after adjusting for all conventional risk factors such as diabetes, hypertension, smoking and hyperlipidaemia. Conducting such study is the only reliable way to show conclusively that low ABPI has an incremental predictive over traditional methods of risk assessment.

CONCLUSION

Patients with stage I and stage II hypertension have highly significantly low ABPI than age-sex matched controls. Fall in ABPI was directly related to severity of hypertension. There is highly significant inverse correlation between ABPI and systolic / diastolic blood pressure. ABPI was found to be significantly low with advanced age, patients with CVA, postmenopausal status, abnormal waist to height ratio, hypercholesterolemia, hypertriglyceridemia and duration of hypertension for more than 5 years. On logistic regression analysis, low ABPI was statistically associated with advancing age, gender, body mass index and duration of hypertension for more than 5 years. Our study has signified the importance of ABPI, a non-invasive bedside technique in the atherosclerotic risk assessment in hypertensive subjects.

ACKNOWLEDGEMENTS

Authors would like to acknowledge the guidance and support of Dr Amar R Pazare, Professor and head of department of Medicine, Seth G S Medical College and K E M Hospital, Mumbai for this project.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Salagre SB, Itolika SM, Chavan RJ. Ankle brachial pressure index to assess atherosclerotic risk in hypertensive subjects. *Int J Res Med Sci* 2017;5:403-9.