Original Article

A study on association of ankle brachial index in patients with ischemic stroke in a tertiary care hospital in eastern India

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Peripheral arterial disease (PAD) is common in elderly population especially those with underlying atherosclerotic risk factors. The objective of our study was to know the percentage of underlying PAD among ischemic stroke patients and to determine the association between abnormal ankle brachial index (ABI) and different risk factors of stroke. We conducted a cross sectional observational study over 18 months in 144 ischemic stroke patients. ABI was measured using USG Doppler device. Among the 144 patients with ischemic stroke 38.89% had ABI <0.9, suggestive of PAD. ABI also showed significant correlation with difference of SBP in upper & lower limb at each side. Low ABI was found to be associated with recurrence of vascular events. Patients with comorbidities such as hypertension, diabetes, ischemic heartdisease, previous stroke, altered lipid profile were more in low ABI group.

We conclude that screening for PAD by measurement of ABI should be done in acute stroke patients because it has important implication not only for evaluation but also for prognosis of such patients.

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Key words **: Peripheral Arterial Disease, Ankle Brachial Index, Ischemic Stroke.**

Stroke or cerebro-vascular accident (CVA) is defined as a neurologic deficit, which is sudden onset and ascribable to focal vascular cause[1]. Ischemic stroke contributes roughly 85% of total stroke incidence[2]. One of the important factor in pathophysiology of ischemic stroke is atherosclerosis[3]. These patients often have intrinsic peripheral arterial disease (PAD). As PAD is mostly asymptomatic, hence it remains undiagnosed in majority of patients[4]. Ankle Brachial Index (ABI) is a measurement that can be utilised not only for diagnosis but also for quantification of PAD[5]. In this study we wanted to get an idea regarding the prevalence of PAD in our study population and whether any association is present between the different risk factors of ischemic stroke and abnormal ABI.

Editor's Comment :

- **Considerable number of patients with ischemic stroke present with low ABI indicating peripheral artery disease, which is significantly associated with recurrence of vascular events. Hence evaluation of ABI for PAD can help us detect patients with increased risk of recurrent stroke so that they can be addressed for different treatment modalities or lifestyle changes.**
- **USG Doppler is an easy, cost effective equipment available in various health setup hence USG Doppler can be incorporated as routine investigations for patients presenting with ischemic stroke to cut the social burden of recurrent stroke & subsequent health consequences.**

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Materials and Methods

This cross sectional observational study was conducted in R G Kar Medical College, Kolkata. New onset ischemic stroke patients aged more than 45 years of either sex admitted in Medicine indoor ward was included in our study.

Patients less than 45 years, those with haemorrhagic stroke, patients with deep vein thrombosis or limb ischemia, those with lymphedema of lower limbs were excluded from our study. After scrutinising total 161 patients, 144 patients met inclusion criteria and were considered for evaluation Our study was conducted for 18 months (March 2017-

August 2018). ABI was measured with the help of USG Doppler soon after admission in the ward. The patient used to lie down for 5 to 10 minutes in supine position and the temperature of the room adjusted at comfortable level. An appropriately sized blood pressure cuff was used. The cuff used to be wrapped encircling the elbow and ankle joint. At ankle, the lower margin of the cuff was placed 2 cm superior to the medial malleolus. At elbow, BP cuff used to be wrapped parallel 2 cm above joint line.Measurement was done using 6-12 MHz Doppler ultrasound probe with gel applied over the sensor. The ultrasound probe was angled at 45° to 60° onto patient's skin over relevant artery (Brachial artery, Arteria dorsalis pedis, Posterior tibial artery). To detect the pressure, the cuff is inflated gradually to 20 mmHg above the level of disappearance of flow signal in USG machine monitor. Then cuff was slowly deflated until flow signal reappear. The sequence of limb pressure measurement (right arm brachial artery followed by right leg followed by left leg followed by left arm) was same for all patients in our study. Each value was checked twice before final consideration.ABI then calculated using the following formula

$$\text{ABI} = \frac{\text{Highest systolic BP in ankle}}{\text{Highest systolic BP of both arms}}$$

ABI normal range is 1.0-1.4. Although value between 0.91-0.99 is known as borderline, still for practical purpose we consider 0.9 as cut off. ABI more than 0.9 is normal and less than 0.9 suggests PAD. PAD can be further classified according to ABI, as mild (0.7-0.9), moderate (0.4-0.69), severe (<0.4).

We performed both general and systemic examination in all recruited patients. Severity of acute stroke in those cases was assessed using National Institutes of Health Stroke Scale (NIHSS). Initially routine blood investigations were sent for all patients. Later they undergone lipid profile, electrocardiography, trans-thoracic echocardiography.

Statistical analysis was done using Microsoft Excel spread sheet, Version 2010 and the Statistical Package for the Social Sciences (SPSS), Version 20.0. For continuous variables we calculated means, medians, standard deviations and ranges. Categorical variables were represented as frequencies and percentages. Continuous variables were compared using a Student's t-test, while categorical variables were compared using Fisher's exact test. Binary logistic regression analysis was performed to determine the likelihood of having PAD using the significant variables on chi square testing as predictor variables. P value of <0.05 was taken as level of significance.

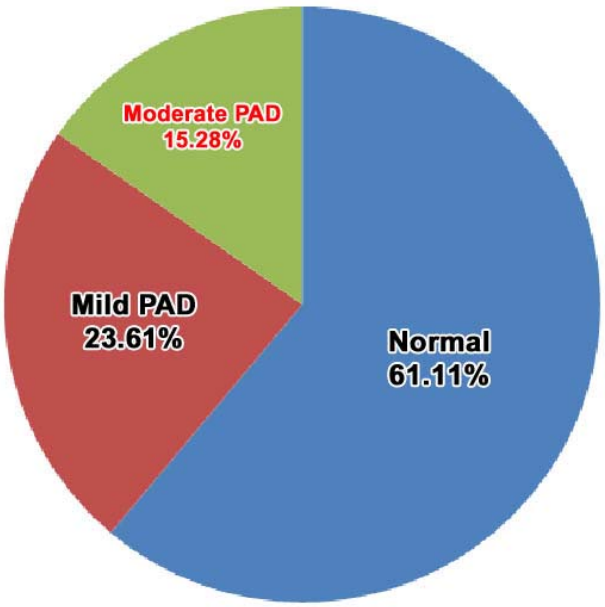

Fig 1 — Distribution of different grades of PAD

Results

Out of 144 cases studied, 82 cases (56.94%) were females while 62 cases (43.06%) were males.

Mean ABI was 0.968±0.151 and we found low ABI (<0.9) suggestive of PAD in 38.89% of patients. Mild PAD constituted 23.61% and moderate PAD 15.28% (Fig 1). In remaining 61.11% cases ABI was more than 0.9.

Maximum cases ie, 41.67% cases were in the age group of 65 to 74 years of age. The mean age was 63.51 ±8.096 years. Table 1 depicts correlation of ABI with age. It was observed that the group of patients aged ≥75 years shows significant association with ABI as the difference has P value <0.05.

Among various risk factors for ischemic stroke, hypertension was present in 50% cases and diabetes mellitus in 33.33% cases. Other risk factors were history of previous stroke in 34.72% cases, history of ischemic heart disease (IHD) in 65.3% cases. Also 27.8% were smoker and 16.67% were alcoholic. Significant association was noted between low ABI and some of these risk factors in our present study. (Table 2).

Patients with higher NIHSS score on admission

Table 1 — *Distribution of ABI in different age groups*

Age group	No of patients	ABI <0.9 (PAD)	ABI >0.9 (Normal)	P value
45-54	24	6	18	0.742
55-64	50	18	32	0.773
65-74	60	26	34	0.731
≥75	10	6	4	0.046

Table 2 — *Different risk factors and clinical and laboratory parameters in PAD and normal patients*

Risk factors	ABI <0.9 (PAD)	ABI >0.9 (Normal)	P-value
Hypertension	38	34	0.005
Diabetes Mellitus	28	20	0.898
h/o IHD	42	52	0.037
Past CVA	30	20	0.0002
smoker	10	30	0.355
alcoholic	8	16	0.649
NIHSS score	7.89±2.69	6.25±1.89	0.033
Waist Circumference	80.75±5.83	78.7±5.42	0.962
LDL	158.79±33.69	137.06±26.76	0.0033
HDL	43.75±9.12	50.98±8.64	0.316
Triglyceride	167.29±26.66	136.82±16.47	<0.0001

were more in ABI<0.9 group and mean NIHSS significantly correlated with ABI. Waist circumference was higher in patients with PAD, compared to normal. Patients with dyslipidaemia were more common in low ABI group and a significant association was found between mean values of LDL, Triglyceride and ABI. (Table 2).

A logistic regression analysis was performed to study the effects of significant variables. Having hypertension [Odds ratio (OR) 2.6, 95% confidence interval(CI) 1.30-5.19], previous history of CVA (OR 3.92, 95% CI 1.9-8.09), history of IHD (OR 2.08, 95% CI 0.99-4.35)were more likely to have PAD. Also patients having higher NIHSS score (OR 2.05, 95% CI 1.09-3.01), higher LDL (OR 1.04, 95% CI 1.01-1.07), higher Triglyceride (OR 1.09, 95% CI 1.06-1.14)has higher propensity to PAD (Table 3).

Difference between mean SBP of upper and lower limb of both sides were higher in low ABI group and they showed significant correlation with ABI (P value <0.0001) (Table 4)(Fig 2).

Discussion

Since PAD remains asymptomatic in most individuals, it often remains a neglected part in the evaluation. Presence of PAD can be detected early by measurement of ABI.

We studied 144 ischemic stroke patients. We found low ABI (<0.9) suggestive of PAD in 38.89% of patients, which includes mild PAD (23.61%) and moderate PAD (15.28%). However severe PAD (ABI <0.4) was absent in our study. Also we did not find patients having ABI >1.4. This may be because of the fact that our patient pooll contained less number of elderly people as severe PAD is more common with increasing age. Patients having low ABI was 52.8% in a study by Weimer *et al*[6]. Alvarez Sabin *et al* showed low ABI in 40.5% patients in their study, where mean value of ABI was 0.92±0.21[7]. Another study result revealed PAD in 26% of ischemic stroke patients conducted by Mohammad Selim Shahi *et al*.[8]

In our study greater number of patients ie, 41.67% were between 65 to 74 years of age. The mean age was 63.51 ± 8.096 years. Study done by Ratanakorn D showed the mean age of stroke patients was 63.5±14 years[9]. Another study showed the mean age as 64.04 ± 12.24 years in patients with normal ABI and 70.48 ± 11.78 years in patients with abnormal ABI[5].

As far as gender is concerned amongst 144 cases studied, 82 cases (56.94%) were females while 62 cases (43.06%) were males. Prevalence of PAD was

Table 3 — *Logistic regression of significant risk factors and parameters*

Risk factors and other parameters	Odds Ratio 95% CI	P value
Hypertension	2.6(1.3-5.19)	0.0041
h/o IHD	2.08(0.99-4.35)	0.0478
Past CVA	3.92(1.9-8.09)	0.0005
NIHSS	2.05(1.39-3.01)	0.0003
LDL	1.04(1.02-1.07)	0.0009
Triglyceride	1.09(1.06-1.14)	<0.0001

Table 4 — *Mean Systolic BP in PAD and normal patients*

SBP	ABI <0.9 (PAD)	ABI >0.9 (Normal)	P value
Right arm	154.07±13.85	145.23±13.81	0.0003
Right ankle	124.79±16.76	155.27±14.47	<0.0001
Difference between Right arm and ankle	28.21±11.34	14.68±3.61	<0.0001
Left arm	158.29±13.74	148.32±13.97	<0.0001
Left ankle	127.5±16.06	159±15.1	<0.0001
Difference between Left arm and ankle	30.57±9.81	14.41±4.64	<0.0001

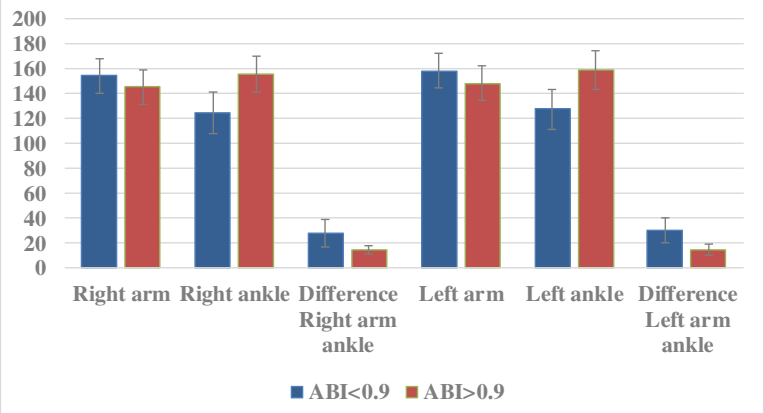

Fig 2 — Mean systolic BP in PAD and normal patients

higher among females in our study which could be attributable to age associated atherosclerosis. Tziomalos K *et al* and Gronewold J et al in their study also found higher percentage of PAD among females as 62.6% and 52.7% respectively[10,11]. However study conducted by Mohammad Selim Shahi *et al* shows different result as it shows male preponderence[8].

Various risk factors (h/o DM, HTN, IHD, past CVA) and other clinical parameters (NIHSS score, waist circumference, Systolic BP) were evaluated in our study. Hypertension was found in 50% cases and diabetes mellitus was seen in 33.33% cases. Other risk factors were history of previous stroke in 34.72% cases, history of cardiac disease in 65.3% cases. Studies carried out by various previous workers show similar observations. Low ABI has shown significant association with recurrence of vascular events (IHD, recurrent CVA)[12].

Result of different studies regarding association of PAD and stroke are controversial. Study by Weimer et al showed that patients with PAD had a significantly higher recurrent stroke risk compared to patients having ABI >0.9[6].

Patients with higher NIHSS score were more in ABI<0.9 group and mean NIHSS significantly correlated (p value 0.033)with ABI. Lee et al in their study also found that mean NIHSS was higher among PAD patients compared to normal (p value 0.003)[13].

One previous study analysed different risk factors using logistic regression and showed that older age, hypertension, history of ischemic heart disease, raised systolic blood pressure, were all significantly associated with stroke[14].

Mean systolic BP of both side upper and lower limbs were different in PAD & normal patients and this difference is statistically significant.

Difference between mean SBP of upper and lower limb of both sides were higher in low ABI group and they showed significant correlation with ABI (P value<0.0001). Sharma *et al* noted similar result in their study[15]. Patients with dyslipidaemia were more in low ABI group and ABI showed significant correlation with mean values of different components of lipid profile (LDL, HDL, Triglyceride).

Hence beyond its accuracy in diagnosis of PAD, ABI can be regarded a predictor for the development of atherosclerotic events in future. Different risk factors like HTN, DM, dyslipidaemia were associated with both PAD and CVA. Though our inferences are based on a smaller subset of patients, but it suggests that PAD is not very uncommon in CVA patients in our country. We recommend further studies, so that their correlation can be explored to a great extent.

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