Original Research Article

Ankle Brachial Index as a Predictor of Coronary Artery Disease in Diabetic Patients

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Abstract

Background: Coronary artery disease (CAD) due to atherosclerosis is an epidemic in India. The incidence of coronary artery disease has doubled during past three to four decades. The role of diabetes mellitus (DM) in relation to CAD was believed to be as important as CAD itself. Owing to the similar vasculopathy characteristics, patients with DM were frequently combined with Peripheral Artery Disease (PAD). However of outpatients, clinically suspected of having CAD, the relationship and interaction between DM and PAD remains unknown. Previous investigations have shown that ankle brachial index (ABI) is a quick and useful tool for assessing and evaluating the presence of peripheral arterial disease of the lower extremities. The aim of current study was to determine the relation between ABI with angiographic stenosis and major cardiovascular risk factors in type 2 DM patients with suspected CAD.

Materials and methods: A cross sectional study was conducted at a tertiary care centre including 100 consecutive diagnosed cases of diabetes. CAD was diagnosed by a history of angina/ any past history or treatment for CAD/ ECG changes and 2 D echo findings and CAG. Ankle Brachial Index (ABI) was calculated for all patients by using Duplex Colour Doppler and ABI <0.9 was diagnosed as PVD. Statistical Analysis of data was done by using SPSS software ver. 21.

Results: About 68.9% of the cases with established CAD proven by angiography had abnormal ABI while 64.1% of the cases with normal coronary angiography had an abnormal ABI thus predicting a future risk of CAD. Mean HbA1c and uric acid levels and number of cases with microalbuminuria

was significantly higher among cases with CAD. About 92.9% of the cases with Triple vessel CAG had Positive ABI which was significantly more as compared to 68.0%, 66.7% and 47.8% of the cases who had Single, Normal and Double vessel CAG respectively.

Conclusion: Ankle brachial index is a sensitive, non-invasive predictor of coronary artery disease in diabetic patients. It however needs other markers in association for better specificity for predicting CAD.

Key words

Ankle Brachial Index, Coronary Artery Disease, Diabetes, Peripheral Vascular Disease.

Introduction

Atherosclerotic disease is a major health problem and is a leading cause of morbidity and mortality in developed countries. Coronary artery disease due to atherosclerosis is an epidemic in India. The incidence of coronary artery disease has doubled during past three to four decades [1]. It will soon emerge as the single largest disease accounting for nearly one-third of all deaths in India. Previous investigations have shown that ankle brachial index (ABI) is a quick and useful tool for assessing and evaluating the presence of peripheral arterial disease of the lower extremities, the most powerful predictor of mortality [2, 3].

Many population studies have shown that subclinical cardiovascular disease in a single vascular bed is associated with clinical disease in another bed and with subsequent cardiovascular and total mortality [4]. Several studies have demonstrated that patients with PAD are at increased risk of adverse cardiovascular events compared to those individuals without PAD [2, 3]. Consequently, there is increasing interest in ABI as a non-invasive tool capable of identifying subclinical atherosclerosis, including coronary artery disease (CAD).

The role of diabetes mellitus in relation to CAD was believed to be as important as CAD itself. Owing to the similar vasculopathy characteristics, patients with DM were frequently combined with PAD [5]. However of outpatients, clinically suspected of having CAD, the relationship and interaction between DM and PAD remains unknown. Although there are some observations indicating a relationship between ABI and CAD severity, the influence of ABI on CAD severity, lesion morphology and the risk classification for coronary angioplasty for DM patients is still unclear [5, 6].

Considering the increasing burden of atherosclerotic disease and its mortality, and also the usefulness of non-invasive, easy and practical methods for identifying atherosclerotic risk factors for prevention or early treatment of atherosclerotic diseases, the aim of current study was to determine the relation between ABI with angiographic stenosis and major cardiovascular risk factors in type 2 DM patients with suspected CAD.

Material and methods

A cross sectional study was conducted at a tertiary care centre including 100 consecutive diagnosed cases of diabetes.

Inclusion criteria

All diagnosed patients of diabetes mellitus type 2 as per WHO criteria.

Exclusion criteria

- Lower limb trauma
- Deep vein thrombosis
- Amputation/ surgery
- Leg ulcers
- Filariasis or lower limb swelling due to other causes
- Type I diabetes mellitus

CAD was diagnosed by a history of angina/ any past history or treatment for CAD/ ECG changes and 2 D echo findings and CAG. Ankle Brachial

Index was calculated for all patients by using Duplex Colour Doppler and blood pressure was measured in all four limbs at brachial and posterior tibial artery. ABI is calculated as ankle pressure/ brachial pressure and the lower ratio amongst the two is chosen.

ABI <0.9 was diagnosed as PVD. According to the ABI value, PVD was classified as: severe (<0.5), moderate (0.51–0.7), mild (0.71–0.9), and without PVD (greater than or equal to 0.9) [7]. Statistical analysis of data was done by using SPSS software ver. 21.

Results

Mean age of the study subjects was 55.52 years with 83.0% of the cases were males. About 40.0% of the cases were tobacco addicted while 27.0% and 24.0% were smoker and alcoholics respectively (**Table - 1**).

Table – 1: Distribution of patients according to Demographic parameters and risk factors (n-100).

Age (years)	
Mean	55.52
SD	1.3
Range	24.0 – 79.0
Sex (%)	
Male	83 (83.0%)
Female	17 (17.0%)
Addiction (%)	
Smoker	27 (27.0%)
Alcoholic	24 (24.0%)
Tobacco	40 (40.0%)
No	27 (27.0%)

About 68.9% of the cases with established CAD proven by angiography had abnormal ABI while 64.1% of the cases with normal coronary angiography had an abnormal ABI thus predicting a future risk of CAD (**Table - 2**).

Mean HbA1c and uric acid levels and number of cases with microalbuminuria was significantly higher among cases with CAD as compared to cases that did not have CAD. While no difference was observed with respect to triglycerides, total cholesterol and mean duration of HT and DM (**Table - 3**).

Table – 2: Association between CAD and ABI.

CAD	**N**	**ABI**		
		Normal	**Mild/ Moderate**	**Severe**
Yes	61	19 (31.1%)	42 (68.9%)	0 (0%)
No	39	14 (35.9%)	25 (64.1%)	0 (0%)

***p-value – 0.62**

About 92.9% of the cases with Triple vessel CAG had Positive ABI which was significantly more as compared to 68.0%, 66.7% and 47.8% of the cases who had Single, Normal and Double vessel CAG respectively (**Table - 4**).

Discussion

In this study, the relation between angiographic findings and ABI in patients suspected to CAD was evaluated. The results of the study indicated that prevalence of atherosclerotic risk factors was significantly higher in patients with abnormal ABI than in ones with normal ABI.

Regarding coronary artery involvement, patients with severe ABI had higher incidence of multiple vessel disease while those with mild to moderate ABI had higher incidence of single or dual vessel disease. In the present study, 67% of the subjects had ABI $\leq$ 0.9. Several studies reported that patients with PAD are at a higher risk of adverse cardiovascular events and other atherosclerotic diseases [2-5]. ABI $\leq$ 0.9 has widely been used as an indicator of PAD and adjunct to the office-based assessment of cardiovascular risk in high-risk population and is also associated with increased risk of cardiovascular mortality [8, 9].

In a systematic review, Doobay, et al. [10] determined the sensitivity and specificity of ABI in predicting future cardiovascular events. They concluded that though ABI $\leq$ 0.9 is highly specific but not sensitive in this regard, it is considered a useful cardiovascular events risk

prediction tool, especially in selected populations due to its simple assessment. In a study in Taiwan, Chang, et al. [11] studied the usefulness of ABI to predict the complex and diffuse coronary lesions in patients undergoing coronary angiography. They indicated that from atherosclerotic risk factors, diabetes, hypertension and smoking were significantly higher in ABI (+) patients. Furthermore, compared to the control group, the ABI (+) patients had more critical and stenotic lesions which were difficult to manipulate. Accordingly, they recommended using this simple, inexpensive and well-established index not only for diagnosing PAD, but also for predicting diffuse and complex lesion subtypes which would be useful in treatment procedures during hospitalization and the follow-up period after subsequent interventions. Papamicha, et al. reported similar findings regarding the use of ABI as the main variables for predicting the extent and severity of coronary disease with diabetes and high levels of HDL cholesterol [12].

Table – 3: Association between CAD and with risk factors.

Risk Factors	CAD		p- value
	Yes (n-61)	No (n-39)	
HbA1c (%)	9.63 ± 1.47	8.28 ± 0.95	< **0.01**
Uric Acid	6.05 ± 1.86	5.76 ± 1.59	< **0.01**
Triglycerides	153.82 ± 47.83	158.13 ± 44.44	**0.647**
Total Cholesterol	222.93 ± 53.89	223.92 ± 43.53	**0.919**
Microalbuminuria	32 (52.5%)	10 (25.6%)	< **0.01**
Duration of DM	4.58 ± 4.28	4.55 ± 3.86	**0.971**
Duration of HT	2.61 ± 2.18	3.80 ± 2.68	**0.057**

Table – 4: Association between CAG and severity of ABI.

CAG	N	ABI	
		Normal	Mild/Moderate
Single	25	8 (32%)	17 (68%)
Double	23	12 (52.2%)	11 (47.8%)
Triple	14	1 (7.1%)	13 (92.9%)
Normal	36	12 (33.3%)	24 (66.7%)

p- value - 0.046

In the current study, the prevalence of risk factors like uric acid levels, HbA1c levels and microalbuminuria was significantly higher in ABI (+) patients. However we did not find significant difference in traditional risk factors like duration of diabetes and hypertension, triglyceride and cholesterol levels amongst ABI (+) and ABI (-) patients.

We studied the prevalence of single, dual and triple vessel disease in ABI (+) and ABI (-) patients and found that PAD patients had a higher prevalence of TVD (92 vs 7.1%) and single vessel disease (68 vs 32%). However, we could not establish higher prevalence of PAD with dual vessel disease and we may attribute it to small sample size and selectivity of patients. Sukhija, et al. [13] studied the prevalence of left main coronary artery disease, of three- or four-vessel coronary artery disease, and of obstructive coronary artery disease in patients with and without peripheral arterial disease undergoing coronary angiography for suspected coronary artery disease. They indicated that PAD patients

had a higher prevalence of left main CAD (18% vs. < 1%), 3- or 4- vessel CAD (63% vs. 11%) and obstructive CAD (98% vs. 81%) comparing with those without PAD. Moreover, in agreement with our study, they reported a higher prevalence of smoking, hypertension and diabetes mellitus in patients with PAD than those without PAD.

In this study, compared with ABI (-) patients, the degree of occlusion in different involved vessels was more significant in ABI (+) patients. In contrast to our results, Lohare H, et al. have reported that from 41 patients only 3 had ABI ≤ 0.9 and all 3 had triple vessel disease. They concluded that there was not a direct association between ABI and significant CAD because only 3 patients out of 22 with triple vessel disease had an ABI ≤ 0.9. However, they indicated an approximately log linear relationship between ABI and CAD risk which means that the average CAD risk increased significantly at ABI values ≤ 1.0 and declined at values > 1.0 [14].

In conclusion, the findings of this research have indicated that ABI could be a useful method in assessing both the atherosclerotic risk factors and the degree of coronary involvement in suspected patients. However, making more accurate decisions for using this method in diagnosing and preventing CAD needs further studies with large sample sizes of general population. It is recommended to evaluate the relation between different levels of ABI, especially ABI > 1.4, which was not investigated properly.

Conclusion

The Ankle brachial index, a simple, inexpensive and well-established method for diagnosing patients with PAD, can be used to predict potential hazards in patients suspected of having CAD in a clinical setting. Abnormal ABI values indicated higher uric acid levels, uncontrolled diabetes and microalbuminuria, which are potential risk factors for atherosclerosis and atherosclerosis-related complications. These conclusions can be extended to patients with DM. Thus Ankle brachial index is a sensitive, non-invasive predictor of coronary artery disease in diabetic patients. It however needs other markers in association for better specificity for predicting CAD.

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