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Original Article

Surgery Section

Peripheral Arterial Diseases in Type 2 Diabetes Mellitus: A Cross-sectional Study Using Ankle-Brachial Index

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ABSTRACT

Introduction: India is fast emerging the diabetes capital of the world. Diabetic patients are at high risk for Peripheral Arterial Diseases (PAD). It is a major risk factor for lower extremity amputation and is also accompanied by high likelihood of systemic cardiovascular disease and stroke. Ankle-Brachial Index (ABI) measurement using a hand held Doppler and sphygmomanometer is a simple, non invasive, reproducible and economical tool to diagnose PAD. An ABI < 0.9 is diagnostic of PAD even in asymptomatic patients and can be used to predict morbidity and mortality from cardiovascular diseases.

Aim: To estimate Type 2 diabetic patients having asymptomatic PAD using ABI.

Materials and Methods: This hospital based cross-sectional study was conducted on all diabetic patients who were admitted to various departments of the hospital without symptoms of PAD. Total 183 patients were included in the study who underwent measurement of ABI using a hand held Doppler and sphygmomanometer, following ABI protocol and after obtaining an informed consent.

Results: Out of 82 (number of patients arrived after excluding other risk factors) patients, 58 (70.7%) patients had a normal ABI (>0.9) and 24 (29.3%) patients had a decreased ABI (<0.9). Among these 24 patients, 18 patients (22%) had mild PAD, five patients (6.1%) had moderate PAD and one patient (1.2%) had severe PAD. The prevalence of PAD was 29.3% (19.25-39.35, 95% confidence interval).

Conclusion: ABI is a good screening tool for identifying asymptomatic PAD in diabetic patients, which aids in reduction of lower extremity amputations and prevention of ischaemic cardiovascular disease associated with PAD.

Keywords: Hyperglycaemia, Macrovascular complications, Microvascular complications

INTRODUCTION

Diabetes mellitus is one of the leading non-communicable diseases of the 21st century. India with more than 62 million diagnosed diabetics is fast earning the title of 'Diabetes Capital of the World" [1]. Diabetes imposes a heavy toll on the vascular system, with both macrovascular and microvascular complications. PAD is one of the macrovascular complications of Type 2 DM [2]. Prevalence of PAD is higher among diabetics and has a predilection for lower limbs. It has been hypothesised that the metabolic abnormality in the pre-diabetic phase predisposes to a more distal and aggressive atherosclerosis. Once diabetes has developed, this process is accelerated due to chronic hyperglycaemia, endothelial damage, non-enzymatic glycosylation and poly-neuropathy which in turn could lead to impaired vascular remodelling and collateral formation [3].

PAD in extreme cases manifests as claudication or gangrene, but in most cases, goes by undetected. Up to 40% of patients with PAD are asymptomatic, while another 50% of patients describe a variety of leg symptoms different from classical intermittent claudication [4].

PAD is a major cause of morbidity and mortality among diabetic population. As PAD becomes symptomatic, there is a decrease in quality of life and is associated with functional impairment [5]. The development of intermittent claudication can significantly reduce walking speed and distance, resulting in a progressive loss of function and long term disability [6]. In more extreme cases, Critical Limb Ischaemia (CLI) may develop, leading to ulceration of the foot [7]. It is a major risk factor for lower extremity amputation and also a high likelihood of systemic cardiovascular disease and stroke [8].

The proportion of diabetics with PAD has been difficult to determine due to its asymptomatic nature and presence of neuropathy. Also, there are several methodological challenges impeding the accurate diagnosis of the condition across different levels of health care setting. Measurement of ABI

has emerged as a non-invasive and economical method of diagnosing PAD [9]. The patient is diagnosed with PAD when ABI < 0.9 [10]. An ABI <0.9 is used to diagnose PAD and is also a marker of increased morbidity and mortality from cardiovascular diseases [11]. ABI has been validated against colour duplex scan and was found to be 82.6% sensitive and 100% specific in detecting PAD [12].

Studies have been conducted both in health care centers as well as in the urban population for estimation of the prevalence of PAD among Type 2 diabetics. The studies conclude that a large proportion of diabetics have a decreased ABI below 0.9 [13,14]. However, there are no studies to establish diabetes as an independent risk factor for PAD in asymptomatic patients.

Early diagnosis of PAD can help patients to effectively manage the condition and prevents its long term sequelae. This study attempts to estimate the hidden burden of asymptomatic PAD among Type 2 diabetes mellitus patients and hence emphasize on the importance of regular checking of ABI in diabetics for early diagnosis and management.

MATERIALS AND METHODS

A cross-sectional study was conducted in the Department of General Surgery on all diabetic patients admitted to various departments of MS Ramaiah Teaching Hospital, Bengaluru, India without symptoms of PAD after obtaining ethical clearance. The study was conducted over a period of two months, July and August 2015. Informed consent was taken from the patients before including them in the study.

Patients above the age of 30, who were admitted to all wards of the Tertiary Care Center and gave history of being diagnosed with Type 2 diabetes mellitus were investigated. Fasting plasma glucose, Random Plasma Glucose (RPG) and 2 hour plasma glucose were checked. American Diabetes Association (ADA) defines diabetes mellitus as Fasting Plasma Glucose (FPG) level of 126 mg/dL (7.0 mmol/L) or higher, or a 2-hour plasma glucose level of 200 mg/dL (11.1 mmol/L) or higher during a 75 gm Oral Glucose Tolerance Test (OGTT), or a random plasma glucose of 200 mg/dL (11.1 mmol/L) or higher in a patient with classic symptoms of hyperglycaemia or hyperglycaemic crisis [15]. Patients meeting the above criteria were evaluated and demographic details were collected.

Symptomatic patients (claudication, gangrene, ulcers), patients with one or more of the other known risk factors of PAD (hypertension, hypercholesterolaemia, chronic smokers, chronic alcoholics) and patients with ABI above 1.4 were excluded. Relevant investigations for the diagnosis and to rule out risk factors were carried out.

Patients were asked to lie down for 10 minutes. The patient's ankle and brachial systolic blood pressures were measured in supine position using a hand held Doppler ultrasound and a sphygmomanometer. ABI is defined as the ratio of the systolic blood pressure at the ankle divided by systolic pressure at the arm. ABI is a quick, accurate, non-invasive, reproducible, inexpensive tool to aid in diagnosis of PAD. The normal ABI is >1 and ABI <0.9 defines PAD. PAD is classified as mild (0.9-0.7), moderate (0.4-0.69) and severe (<0.4). ABI >1.4 indicates arterial calcification [9].

STATISTICAL ANALYSIS

Descriptive statistics like mean, standard deviation, median, range, etc., was used to summarise the quantitative parameters. Prevalence of PAD was estimated with 95% confidence interval. Qualitative parameters were presented as proportion. Chi-square test was used to compare the difference in proportion between male and female. Data was entered in Microsoft excel and was analysed using SPSS version 20.0. The p-value less than 0.05 was considered as statistically significant.

RESULTS

A total of 82 patients were included in this study. Out of 82 patients, 48 (58.5%) were male and 34 (41.5%) were female. The study included patients aged between 31-80 years with a BMI ranging from 15.9-35.3 kg/m^2 [Table/Fig-1]. [Table/Fig-2] shows calculated ABI values. The prevalence of PAD was 29.3% (19.25-39.35), with a 95% confidence interval.

The ABI of males and females were compared to see if there was a significant difference. Out of all 24 (29.3%) patients with decreased ABI, 11 patients (45.8%) were male and 13 (54.2%) were female. Chi-square test was used to compare the difference between genders. The p-value was 0.133 (>0.05) and hence the difference between the genders was considered insignificant.

	Age (yrs)	Height (cm)	Weight (kg)	BMI (kg/m^2)
Mean	51.77	160.12	64.48	25.2
Median	50	160	65	25
Standard Deviation	10.768	9.47	12.02	4.5
Minimum	31	135	43	15.9
Maximum	80	178	93	35.38

[Table/Fig-1]: Demographic details of patients.

ABI Value	Frequency	Percentage (%)
Normal (>0.9)	58	70.7
Abnormal	24	29.3
Mild PAD (0.79-0.89)	18	22
Moderate PAD (0.69-0.79)	5	6.1
Severe PAD (0.59-0.69)	1	1.2
Total	82	100

[Table/Fig-2]: ABI values of the patients.

The time since the patients were diagnosed ranged from 3 days to 36 years. The data was analysed to check for a relation between duration of diabetes mellitus and decreased ABI. The median duration in patients with normal ABI was 36 months and in patients with decreased ABI was 60 months. Mann-Whitney test was performed to compare time of diagnosis in ABI and non-ABI. The p-value was 0.073 (>0.05) and hence there is no significant difference between time of diagnosis and ABI.

DISCUSSION

The study attempts to estimate the proportion of asymptomatic diabetic patients having PAD (ABI<0.9). The accurate assessment of PAD in diabetics has been confounded by several factors. Several patients remain asymptomatic for a long time with peripheral neuropathy often altering pain perception. This study aimed at tackling all these factors and estimating the proportion of Type 2 diabetics having unrecognised PAD.

In studies conducted in India using ABI, which is the preferred screening method, prevalence of PAD in a mixed population of symptomatic and asymptomatic diabetics ranges from 10-35% [13,14,16,17] [Table/Fig-3].

Study Reference	Location of Study	Number of Diabetic Subjects	Prevalence of PAD
Sahana P et al., [13]	Kolkata, India	410	141 (34.4%)
Premalatha G et al., [14]	Chennai, India	80	5 (6.3%)
Binu M et al., [16]	Kulasekharam, India	100	19 (19%)
Agarwal A et al., [17]	New Delhi, India	146	21 (14.4%)
Al-Kaabi J et al., [18]	UAE	394	33 (9%)
This study	Bengaluru, India	82	24 (29.3%)

[Table/Fig-3]: Comparison of prevalence of PAD in diabetics in various studies.

In a similar study conducted by Sahana P et al., in a Tertiary Care Center in Kolkata in 2010, 410 diabetic subjects were evaluated using ABI [13]. PAD in this cross-sectional study was found in 141 subjects (34.4%). In the present study, out of the 82 subjects studied, 24 (29.3%) had PAD. The advantage of our study is the exclusion of other risk factors of PAD and the detection of PAD in asymptomatic patients with no other comorbidities.

Premalatha G et al., conducted a study in Chennai, India in 2010 in two residential colonies [14]. The low prevalence in this study (6.3%) as compared to the present study (29.3%) may be due to the difference in study subjects.

Binu M et al., conducted a study in a Tertiary Care Center in 2011 in Kulasekharam, Tamil Nadu, India [16]. They included 100 women with one year history of detected Type 2 diabetes mellitus and symptomatic patients, patients with other risk factors of PAD such as smoking or tobacco chewing and patients with established coronary artery disease were excluded. They selected 100 non-diabetic women as a control. Prevalence of PAD in the asymptomatic diabetics was found to be 19%, which was significantly higher than the control group where prevalence was only 3%. This study established the correlation of PAD with diabetes and the need for regular ABI checking in diagnosed asymptomatic diabetic patients to prevent complications of accelerated atherosclerosis. The present study had similar inclusion and exclusion criteria and also showed high prevalence of PAD among diabetics.

Agarwal A et al., studied 146 patients in a study conducted in New Delhi in 2012 [17]. Prevalence was found to be 14.4%. They discovered that prevalence of CAD was higher in patients with PAD (52.38%) than in those without PAD (24%). This established PAD as a predictor for cardiovascular morbidity and mortality. In the study conducted by Al-Kaabi J et al., in a Diabetes Center in UAE, PAD prevalence was significantly lesser (9%) [18]. We have established that PAD can be a silent threat to the patient's health and early detection and prevention of symptoms and complications is possible.

LIMITATION

Study limitations included lack of confirmatory tests like invasive arteriography which is considered the gold standard of diagnosis. The study was based in a Tertiary Care Center and prevalence cannot be generalized for the whole of India. Multicenter study is needed. The small sample size is another limitation of the study. There is a need for further studies in the relation between diabetes and PAD, excluding all other factors as well as studies on benefits of diagnosis of PAD in the asymptomatic stage. Follow-up studies for progression of PAD is required.

CONCLUSION

Prevalence of PAD in asymptomatic diabetics without any other comorbidity is high. PAD is an increasingly important complication of Type 2 diabetic subjects which confers poorer prognosis in diabetics as compared to non diabetics. A simple ABI measurement identified a large number of patients with previously unrecognized PAD. In clinical practice, PAD is often missed or under diagnosed, especially in patients with chronic hyperglycaemia who may remain free of any symptoms till the disease reaches an advanced, irreversible stage. The problem may not come to light until it is too late due to co-existing diabetic neuropathy. Regular use of ABI may help in early detection and management of PAD and in prevention of the

high ischaemic cardiovascular risk associated with PAD.

Patients with decreased ABI (<0.9) should be monitored. Prompt risk reduction programs are necessary with diet and lifestyle modification. Strict glycaemic control is essential. Follow-up and further investigations like magnetic resonance angiography, computerised tomography or invasive arteriography may be required.

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