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Association of Anthropometric index and Cardiovascular Risk Factors with Ankle Brachial Pressure Index in Newly Detected Type 2 Diabetes Mellitus

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Abstract

Background: Peripheral arterial disease (PAD) is a progressive condition that leads to stenosis and occlusion of the arterial bed and is a marker of systemic atherosclerosis. Smoking; type 2 diabetes mellitus (T2DM) is the most important risk factors of PAD. Overweight and obesity increase the risk of T2DM.This study was conducted to evaluate an association between anthropometric indices and cardiovascular risk factors with ankle-brachial pressure indices (ABPI) in newly detected T2DM.

Aims: To observe the association between the anthropometric index and cardiovascular risk factors with ABPI in newly detected T2DM patients evaluated by duplex color Doppler study of lower limb arteries.

Methods: This cross-sectional study was carried out in the Department of Radiology and Imaging BIRDEM Academy, Dhaka, from January 2017 to July 2018. A total of 65 samples from the adult population referred to the above-mentioned hospital for duplex color Doppler study of lower limb arteries were included in this study. Statistical analyses of the result were obtained by using window-based computer software devised with statistical packages for social sciences (SPSS-22).

Results: The mean age was 63.06 ± 9.69 years with ranged from 48 to 83 years and the male to female ratio was almost 2:1. More than half (50.7%) patient's BMI had 23-26.9 kg/m^2 (Overweight) and 25 (38.5%) obese. More than three fourth (79.7%) patients had hypertensive blood pressure, 56 (86.2%) patients had dyslipidemia, and 30 (46.2%) patients were ex-smoker and 10 (15.4%), current smoker. There were significant negative correlation (r=-0.603; p=0.001) found between BMI with ABPI right, (r=-0.436; p=0.001) between blood pressure with ABPI right, (r=-0.390; p=0.001) between lipid profile with ABPI right, (r=-0.542; p=0.001) between smoking with ABPI right, Similarly, there were also significant negative (r=-0.627; p=0.001) between BMI with ABPI left, (r=-0.305; p=0.014) between blood pressure in ABPI left, (r=-0.533; p=0.001) between blood lipid profile with ABPI left and (r=-0.533; p=0.001) between smoking with ABPI left.

Conclusion: From this finding of the study it can be concluded that there were significant inverse relation between ABPI and BMI, blood pressure, lipid profile, smoking.

Keywords: Anthropometric index; Cardiovascular risk factors; Ankle brachial pressure index; Type 2 diabetes mellitus

Introduction

Peripheral arterial disease (PAD) in terms of atherosclerosis of lower extremity vessels below aortic bifurcation is considered to be an important marker of cardiovascular disease. Increasing prevalence, concomitant morbidity/ mortality and misleading symptoms of PAD have urged the physician to increase their awareness about diagnosis and also the treatment of PAD [1]. Peripheral arterial disease (PAD) predominantly affects the elderly and prevalence increases with age in both genders [2]. Its prevalence in the general population varies from 4 to 10% and can exceed 20% in patients over the age of 70 years [3]. Despite this, there is a low prevalence of symptomatic patients with intermittent claudication [2]. One multicenter study [4] described a PAD prevalence of 10.5% in the general population and found that only 9% of patients reported claudicating.

Many of the traditional risk factors of cardiovascular disease play an important role here, such as Hypertension (HTN), Dyslipidemia (DLP) and Smoking [5]. Inflammation/coagulation biomarkers like high sensitivity C-reactive protein (hs-CRP), fibrinogen and D-dimer may also be associated with PAD and/or may worsen the outcome of the disease [6]. Another important issue is the asymptomatic PAD which includes 20 to 50.0% of the patients [7]. Hyperlipidemia is another risk factor that favors the development of PAD, but in the study, it was not significantly different in cases and controls. It may result from the strong association between T2DM and dyslipidemia in both groups which concealed its pure effect on PAD. Patients with type 2 diabetes mellitus may suffer from foot ulcers, with the lifetime prevalence as high as 25% [8]. In these patients, neuropathy and PAD are two of the major risk factors of foot ulcers. In the previous study in adult Nigerian patients with diabetes, none of the anthropometric indices (BMI, WHR, and WC) were found significant [8]. The positive correlation between short stature and PAD was reported in Chinese type 2 diabetes patients21 but was not significant in the study [1], due to their cases were taller than controls. Ankle-brachial pressure index (ABPI) is a simple, reliable and non-invasive test to detect PAD in at-risk populations. The cut-off value of 0.9 is an acceptable threshold for PAD diagnosis. Sensitivity and specificity of 95% and 100% in the general population, [9] and also 70.6% and 88.5% in type 2 diabetes mellitus (T2DM) patients with T2DM foot [10] are reported for PAD detection by this method. This study will try to evaluate the association between anthropometric body mass index and cardiovascular risk factors

(HTN, hypercholesterolemia, smoking) with symptomatic peripheral arterial disease in type 2 DM patients evaluated by duplex color Doppler study in our center.

Methods

This cross-sectional study was attempted on 65 subjects aged 45 to 85 years in the Department of Radiology and Imaging, BIRDEM from January 2017 to June 2018. The equipment used for this study: Hitachi Aloka F-37 machine with 7.5 MHz linear transducer and ankle-brachial pressure indices were calculated from the measured systolic blood pressure. A sample from the adult population of T2DM with symptoms of referred to the Department of Radiology and Imaging, BIRDEM, Dhaka for duplex color Doppler study of lower limb arteries. Inclusion Criteria includes newly detected (first diagnosed) adult type 2 diabetic patients of both sexes having symptoms like intermittent claudication, leg numbness, coldness, etc of peripheral vascular disease. Proper counseling and reassurance to the patient regarding the examination procedure were done before the color Doppler USG examination to reduce their apprehension and to get full co-operation.no other specific preparation was needed. Ethical clearance was taken from the institutional review committee of BIRDEM. A firm bed was used. lower limb arterial blood flow velocity was assessed using color Doppler imaging, an ultrasound technique that combines B scan grayscale imaging of tissue structure colored representation of blood flow on Doppler-shifted frequencies and pulsed Doppler measurement of blood flow velocities. A Hitachi Aloka F-37 with a 7.5 MHz linear phase transducer was used. Each subject was placed supine. Grayscale imaging was performed first to obtain overview anatomy of the limb. Then color flow imaging was performed for localization and assessment of brachial and anterior tibial arteries. The data was analyzed using SPSS version 20.

Result

Table 1 shows the age distribution of the study patients, it was observed that almost half (44.5%) patients belonged to age 52-60 years. The mean age was 63.06±9.69 years with ranged from 48 to 83 years. It was observed that more than two-thirds (67.7%) patients were male and 21(32.3%) were female. More than three fourth (79.7%) patients had hypertensive blood pressure and 14(21.5%) normotensive. the majority (86.2%) patients had dyslipidemia. Almost half 46.2% of patients were ex-smoker, followed by 25(38.4%) nonsmokers and 10(15.4%) current smokers.

Basic information	Number of patients	Percentage
Age		
48-50	5	7.7
52-60	29	44.5
63-70	21	32.3
78-80	4	6.2
81-83	6	9.3
Sex		
Female	21	32.3
Male	44	67.7
Blood pressure of the study patients		
Normotensive	14	21.5
Hypertensive	51	78.5
lipid profile		
Normal	9	13.8
Dyslipidemia	56	86.2
Smoking status of patients		
Ex-smoker	29	42.2
Non smoker	26	38.4
Current smoker	10	15.4

Table 1: Distribution of the study patients by Basic information (n=65).

Table 2 shows BMI of the study patients, it was observed that more than half (50.7%) patients BMI had 23-26.9kg/m^2 (Over weight).

It was observed that more than half (52.3%) patients had <0.9. The mean ABPI (right) was 0.86 ± 0.13 with ranged from 0.7 to 1.2. Almost

two third (61.6%) patients had <0.9. The mean ABPI (left) was 0.87 ± 0.18 with ranged from 0.6 to 1.3. (Table 3).

BMI (kg/m^2)	Number of patients	Percentage
18.5-22.9 (Normal)	7	10.8
23-26.9 (Over weight)	33	50.7
≥ 27 (Obese)	25	38.5

Table 2: Distribution of the study patients by BMI (n=65).

Discussion

Peripheral arterial disease (PAD) predominantly affects the elderly and prevalence increases with age in both genders. Its prevalence in the general population varies from 4 to 10% and can exceed 20% in patients over the age of 70 years [3]. The mechanism whereby height exerts negative effects on PAD in diabetic patients is not clear. While undoubtedly under a large degree of genetic control, height is influenced by early-life environmental factors, which include nutrition, psychosocial stress, chronic illness, and living circumstances. Height and atherosclerosis risk factors such as obesity are determined by genetic and early environmental influences. Malnutrition in childhood could be associated with short stature and poor health outcome [11].

ABPI(right)	Ankle brachial pressure index in right		Ankle brachial pressure index in left side	
	Frequency	Percentage	Frequency	Percentage
<0.9	34	52.3	40	61.6
≥ 0.9	31	47.7	25	38.4
Mean ± SD	0.86 ± 0.13		0.87 ± 0.18	
Range (min-max)	0.7-1.2		0.6-1.3	

Table 3: Distribution of the study patients by Ankle brachial pressure index (ABPI) right (n=65).

Previous studies reported inverse associations between total protein intake and diastolic blood pressure and between animal protein intake and systolic blood pressure. Many of the traditional risk factors of cardiovascular disease play an important role here, such as Hypertension (HTN), Dyslipidemia (DLP) and Smoking [5]. Hyperlipidemia is another risk factor that favors the development of PAD [12]. Ankle-brachial pressure index (ABPI) is a simple, reliable and non-invasive test to detect PAD in the at-risk population. The cut-off value of 0.9 is an acceptable threshold for PAD diagnosis. Sensitivity and specificity of 95% and 100% in the general population and also 70.6% and 88.5% in type 2 diabetes mellitus (T2DM) patients with T2DM foot are reported for PAD detection by this method [9,10].

In this present study, it was observed that 44.5% of patients belonged to age 52-60 years. The mean age was 63.06 ± 9.69 years with ranged from 48 to 83 years. Dahl et al. patients with a median age of 61 years. In another study Fitzmaurice et al. reported that women with median ages of 66 and 76 years, the prevalence of PAD was 5.5% and 15.8%, respectively. Hiremath et al. showed the mean age of the subjects included in their study was 55.6 ± 11.8 years [13], Oyelade et al. observed the ages of the subjects ranged from 50 to 89 with a mean age of 63 ± 8.72 [8], which are comparable with the current study. On the other hand, Koksoy et al. observed the mean age was 37.0 ± 10.6 years which is lesser with the current study [14]. In this current study, it was observed that 67.7% patients were male and 32.3% were female and male to female ratio was 2:1, which is closely resembled with Oyelade et al [8], Hiremath et al. and Dahl et al. where they found male subjects was predominated in their respective studies [13,15].

In this present study, it was observed that 50.7% of patients had overweight, 38.5% obese and 10.8% normal. Hiremath et al. observed the average BMI was highest for smokers with diabetes (26.6 ± 2.1 kg/m^2, followed by patients with diabetes who had no history of smoking (26.0 ± 2.0 kg/m^2 [13]. The group of smokers without diabetes had the lowest BMI of 25.4 ± 2.0 kg/m^2. The effects of insulin resistance and advanced age likely explain this distribution. Since we observed that patients with diabetes who smoked had more severe disease, high BMI may be considered as an independent risk factor for LEAD [13]. Kitamura et al. study has reported that carotid intima-media thickness (CIMT), measured non-invasively with high-resolution ultrasound scanning, is a well-known indicator of generalized atherosclerosis and strongly associated with risk of cardiovascular disease [16]. The finding of Leite et al. study that CIMT was positively associated with an increase in body mass index (BMI), even for the moderately overweight, suggests that the associations between height and atherosclerosis assessed in terms of CIMT may be strongly affected by BMI status [17]. In another study, Guh et al. noted that the strongest association between overweight defined by body mass index (BMI) and the incidence of type II diabetes in females (RR=3.92 (95% CI: 3.10–4.97)) [6].

In this current study, it was observed that 79.7% of patients had hypertensive blood pressure and 21.5% normotensive. Shimizu et al. short stature are associated with faster heart rates and shortened return times for reflected waves and augmentation of the primary systolic pulses [18], thus leading to increased central aortic pressure [19], while other studies have reported a positive relationship between systolic blood pressure and CIMT [20].

In this present study, it was observed that 86.2% of the patients were dyslipidemia. It was also observed that 46.2% of patients were ex-smoker, followed by 38.4% none smoker and 15.4% current smokers. Many of the traditional risk factors of cardiovascular disease play an important role here, such as Hypertension (HTN), Dyslipidemia (DLP)

and Smoking [5]. In another study, Fu et al. found 38.4 % of patients had dyslipidemia, which is lesser with the present study [21]. In this present study, it was observed that 40.0% of patients belonged to the duration of diabetes 6-10. The mean duration of diabetes was 9.03 ± 4.51 with ranged from 1-20 years.

In this current study, it was observed that 83.1% of patients were Antihypertensive users. Guh et al. study, the risk for type II diabetes, female hypertension, coronary artery disease, and male gallbladder disease were estimated based on WC measurements [6]. In this present study, it was observed that 50.8% of patients had oral drug users, followed by 41.5% insulin oral and 7.7% diet control. Ankle-brachial pressure index (ABPI) is a simple, reliable and non-invasive test to detect PAD in at-risk populations. The cut-off value of 0.9 is an acceptable threshold for PAD diagnosis. Sensitivity and specificity of 95% and 100% in the general population [9] and also 70.6% and 88.5% in type 2 diabetes mellitus (T2DM) patients with T2DM foot [10] are reported for PAD detection by this method. In this current study, it was observed that 52.3% of patients had ABPI right <0.9 and the mean ABPI right was 0.86 ± 0.13 with ranged from 0.7 to 1.2. It was also found that 61.6% of patients had <0.9 ABPI left and the mean ABPI left was 0.87 ± 0.18 with ranged from 0.6 to 1.3. Althouse et al study found PAD outcomes included new ABI ≤0.9 with a decrease of at least 0.1 from baseline, lower extremity revascularization, or lower extremity amputation [5]. Izquierdo-Porrera et al. observed moderate-to-severe PAD by measures of ABI (0.65 ± 0.19) [22]. In this current study, it was observed that more than two-thirds (67.7%) patients used stain.

In Fu et al. study taller persons have more favorable central hemodynamics which may contribute to the inverse association between height and cardiovascular mortality [21]. Independent of classical cardiovascular risk factors, height was found to be inversely associated with carotid atherosclerosis for overweight men [18].

In another study Hiremath et al [13] reported that Duplex Doppler imaging is an effective screening investigation for lower extremity arterial disease, staging and grading of the disease, providing information that can be utilized for future management and treatment planning.

In this current study it was observed that there were significant negative correlation (r=-0.603; p=0.001) between BMI with ABPI right, (r=-0.436; p=0.001) between blood pressure with ABPI right, (r=-0.390; p=0.001) between lipid profile with ABPI right, (r=-0.542; p=0.001) between smoking with ABPI right, Similarly, there were also significant negative (r=-0.627; p=0.001) between BMI with ABPI left, (r=-0.305; p=0.014) between blood pressure in ABPI left, (r=-0.533; p=0.001) between blood lipid profile with ABPI left and (r=-0.533; p=0.001) between smoking with ABPI left. Vasheghani-Farahani et al. study showed BMI had a borderline significant correlation with premature CAD as well (OR=1.05, 95% CI=1.00-1.10; p=0.066) [1]. A significant negative correlation was also observed between TSF and premature CAD (OR=0.92, 95% CI=0.89<0.96; p<0.0001). ADI did not show a significant correlation with the presence of premature CAD (p=0.10). Fu et al. investigated whether height is associated with peripheral arterial disease (PAD) in Chinese patients with type 2 diabetes and showed a short stature seems to be associated with a higher risk of PAD in Chinese diabetic patients [21]. The ABI and frequency of PAD were higher with decreasing height quartiles. An inverse association was observed between height and gender-adjusted risk of PAD. This relationship remained unchanged following further adjustment for potential confounders. Subjects in the shortest stature group had of 1.174 time's higher risk of PAD for men and 1.143 times for women, compared with those in the tallest statue group. Althouse et al. study was done to define risk factors for the incidence of peripheral arterial disease (PAD) and found age, sex, race, and baseline smoking status were all significantly associated with incident PAD [5]. In stratified analyses of time-varying covariates, changes in BMI, LDL, HDL, systolic blood pressure, and pulse pressure were most predictive among IS patients, while the change in HbA1c was most predictive among IP patients. Among patients with T2DM, traditional cardiovascular risk factors were the main predictors of incident PAD cases. Independent from classical cardiovascular risk factors, height was found to be inversely associated with carotid atherosclerosis for overweight but not for non-overweight men [18]. The above-mentioned study findings are comparable with the current study. On the other hand, Oyelade et al reported that BMI did not correlate with PAD. None of the parameters (i.e. BMI, WHR, and WC) used to assess the relationship between obesity and PAD was found to correlate with PAD [8]. PAD is a progressive occlusive vascular disease characterized by atherosclerotic changes in the intima of the artery. PAD of the lower limbs is a significant cause of morbidity affecting approximately 10 million people [23,24].

Conclusion

From the findings of this study, it can be concluded that the ankle-brachial pressure index (ABPI) is decreased with increasing body mass index (BMI), raised blood pressure, dyslipidemia & smoking which predict early development of peripheral arterial disease (PAD).

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