Ankle Brachial Pressure Index as a Measure of Peripheral Vascular Disease in Type 2 Diabetic Patients

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Abstract

Background: Diabetes mellitus is a common worldwide disease, it occurs in 10-20% of population and is a well-known cause of vascular complications which include microvascular and macrovascular. The ankle brachial pressure index (ABPI)is a measure of peripheral arterial diseases (PAD).

Aim of study: To calculate the ankle brachial pressure index as a measure for macrovascular complications in patients with type 2 DM, and correlate it with different risk factors.

Patients and methods: For fifty type 2 DM patients, ABPI was measured, and relationship between it and diabetes duration, age, gender, low density lipoprotein (LDL) and triglycerides (TG) levels, and body mass index were studied.

Results: The values of ankle brachial pressure index were found significantly low in patients with type two diabetes mellitus in relation to diabetes duration and high levels of LDL or TG, and no significant relationships were found between low ABI with age, gender, or body mass index.

Conclusion: In type two diabetic patients ankle brachial pressure index is a measure of peripheral vascular diseases, and it correlates with DM duration and high LDL or TG levels.

الخلاصة

ان مرض السكري من الامراض واسعة الانتشار ويصيب ١٠-٢٠% من سكان العالم وهو سبب معروف للعقابيل الوعائية والتي تشمل الاوعية الدموية الدقيقة والاوعية الدموية الكبيرة. ويعتبر مؤشر ضغط الكاحل-الذراع مقياس لامراض الشرايين المحيطية. في هذه الدراسة تم قياس مؤشر الكاحل-الذراع لخمسين مريض مصابين بداء السكري من النوع الثاني، ،وتمت دراسة العلاقة بين مؤشر الكاحل-الذراع مع مدة المرض،العمر،جنس المريض،تحليل الدهون قليلة الكثافة والدهون الثلاثية ،ومؤشر كتلة الجسم. وكانت قيم مؤشر الكاحل-الذراع تتناسب عكسيا مع مدة المرض وزيادة قيمة تحليل الدهون قليلة الكثافة او الدهون الثلاثية.

Introduction

Diabetes mellitus (DM) refers to a group of common metabolic disorders that share the phenotype of hyperglycemia[1].

Adults with diabetes are at a 2-4 folds increased risk of cardiovascular events relative to those without diabetes[2]. Vascular complications can be caused by micro and macroangiopathy. Macroangiopathy in diabetes consists mainly of an accelerated form of atherosclerosis and affects the medium and large size arteries like coronary, carotid and peripheral arteries, thus increasing the risk of myocardial infarction, stroke and diabetic foot disease [3-6].

Diabetes mellitus is especially considered as an important risk factor for peripheral arterial diseases (PAD)[7,8]. PAD is primarily the result of atherosclerotic changes in the vessels[9]. It is commonly manifested as intermittent claudication or critical limb ischemia[10,11]. A large majority of individuals, particularly elderly[12] are asymptomatic and there is a slow and gradual progression of disease[13].

The ankle brachial pressure index (ABPI) is the first noninvasive test for atherosclerotic accumulations[14]. It has been used for numerous years to identify individuals with a compromised blood supply to the lower extremities. The frequently asymptomatic course of peripheral vascular disease (PVD) and the inaccuracy of the physical examination necessitates the use of ABPI as a routine part of the clinical evaluation. It correlates with the measurement of the blood pressure[15, 16]. It is highly informative for stenosis of the lower extremities of > 50 %[16-19].

The reference values were presented at TransAtlantic Intersociety Consensus Working Group in 2005: normal is 0.90, mild PVD; 0.75-0.90, moderate PVD; 0.5-0.75, less than 0.5 severe PVD. Values more than 1.3 considered falsely elevated (non-compensated vessels). It has been proven that the low (<0.9) as well as the high (>1.3) ABPI are related to an increased cardiovascular risk. Identifying individuals with extreme values may be used for an evaluation of the cardiovascular risk. ABPI values less than 0.9 have a sensitivity of 95% and specificity of 99% for PVD [16-18].

Patients and Methods

Fifty patients with T2DM were enrolled in this study (25 males and 25 females), aged 40-70 years, with average duration of DM of 3-25 yr (11.42±6.6 yr), and they were treated with oral hypoglycemic agents.

The patients were selected from the registered patients of AL-Najaf Center for Diabetes and Endocrinology at Al-Sader Medical City in 2012.

Patients with history of smoking, atrial fibrillation, renal impairment, age above 70 years, uncontrolled hypertension, patients with ABPI values > 1.3, or any leg ulcer were excluded from the study.

From all patients, history was obtained and physical examination performed. Body mass index (BMI) was calculated,12 hours fasting lipid profile and serum creatinine level were measured using standard laboratory methods.

Renal impairment excluded by creatinine clearance (CrCl) value using the Cockcroft-Gault equation [20]:

$$\text{Creatinine clearance} = \frac{(140\text{-age}) \times \text{body wt}}{72 \times \text{serum creatinine(mg/dl)}} \times 0.85\text{(in female)}$$

Patients with CrCl values less than 90 in male (80 in female) were excluded from the study.

Lipid levels were regarded elevated if low density lipoprotein (LDL) level is above 130 mg/dl or the triglycerides level is above 250 mg/dl in a 12 hours fasting lipid tests[21].

Calculation of ABPI

The ABPI was calculated to all patients, by measuring the systolic pressure of both upper limbs (brachial artery) and of both lower limbs (posterior tibial and dorsalis pedis arteries) by using a sphygmomanometer (WelchyAllyn) and a douplex system (a high resolution ultrasound instrument Siemens, Acuson X500, 5-10 MHz linear array transducer probe) done by sonographer.

The examination was done in supine position and the highest values of upper limbs regarded as brachial systolic pressure and ankle systolic pressure was calculated to each lower limb separately as the upper value of either posterior tibial or dorsalis pedis arteries. Then ABPI calculated to each side by dividing the ankle systolic pressure over the brachial systolic pressure.

Normal range of ABPI is 0.9-1.3 values below 0.9 considered as peripheral vascular insufficiency, while those above 1.3 were discarded from the study[16].

Statistical analysis

For statistical study SPSS system (T-test and Anova test) was used and P-values less than 0.05 were considered as significant. Microsoft Excel 2003 was used for statistical analysis of this study.

Results

Out of the 50 patients, 20 patients had abnormally low ABPI (<0.9). Patients were divided into 4 groups according to diabetes duration, as in tables (1) and (2). Group one, 14 patients had duration ≤ 5 years non of them had low abnormal ABPI, with P-value of (0.780, 0.823) to the Lt. ABPI and Rt. ABPI respectively. Group two, 13 patients had duration 6-10 years, 2 of them had abnormally low ABPI, with P-value of (0.780, 0.823) to the Lt. ABPI and Rt. ABPI respectively.

Group three, 12 patients had duration11-15 years,7 of them had abnormally low ABPI, with P-value of (0.001, 0.002) to the Lt. ABPI and Rt. ABPI respectively. Group four, 11 patients had duration of > 15 years, all of them had abnormally low ABPI with P-value of (<0.001) to both Lt. ABPI and Rt. ABPI. So significant association between ABPI and DM duration is present.

Out of 23 patients with high lipid levels, 13 of them had low ABPI, with a P-value of 0.031 in Lt. ABPI , and 0.017 in Rt. ABPI. This means that significant association between ABPI and hyperlipidemia is present. Tables (3) and (4).

There was no significant relation between gender, age, and BMI and ABPI. Tables (5, 6, 7, 8, 9, 10)

Table 1 Patients groups according to duration of DM.

Duration of DM	No.of patients	Patients with low ABPI
≤ 5yr.	14	0 (0%)
6-10 yr.	13	2 (15%)
11yr.-15	12	7 (58%)
> 15yr.	11	11 (100%)

Table 2 The relation between ABPI and duration of diabetes in type 2 diabetic patients.

	Duration of D.M.	No	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		p-value
						Lower Bound	Upper Bound	
Lt. ABPI	≤ 5yr	14	0.9793	0.04632	0.01238	0.9525	1.0060	0.780
	6-10yr	13	0.9708	0.07005	0.01943	0.9284	1.0131	0.780
	11-15yr	12	0.8467	0.10612	0.03063	0.7792	0.9141	0.001
	> 15yr	11	0.7282	0.08693	0.02621	0.6698	0.7866	0.001
	Total	50	0.8900	0.12723	0.01799	0.8538	0.9262	
Rt. ABPI	≤ 5yr	14	0.9771	0.03292	0.00880	0.9581	0.9961	0.823
	6-10yr	13	0.9685	0.07081	0.01964	0.9257	1.0113	0.823
	11-15yr	12	0.8450	0.15969	0.04610	0.7435	0.9465	0.002
	> 15yr	11	0.7618	0.10323	0.03112	0.6925	0.8312	0.001
	Total	50	0.8958	0.13179	0.01864	0.8583	0.9333	

Table 3 Patients groups according to fasting lipid levels

Lipid levels	No. of patients	Patients with low ABPI
High	23	13 (56%)
normal	27	7 (26%)

Table 4 The relation between ABI and fasting lipid levels in type 2 diabetic patients

	Lipid levels	No.	Mean	Std. Deviation	Std. Error	p-value
Lt.ABPI	high	23	0.8483	0.13381	0.02790	0.031
	normal	27	0.9256	0.11181	0.02152	
Rt.ABPI	high	23	0.8483	0.15649	0.03263	0.017
	normal	27	0.9363	0.09115	0.01754	

Table 5 Patients groups according to gender

Gender	No.of patients	Patients with low ABPI
Male	25	8 (36%)
Female	25	12 (48%)

Table 6 The relation between ABPI and gender in type 2 diabetic patients.

	Gender	No.	Mean	Std. Deviation	Std. Error	p-value
Lt.ABPI	male	25	0.8884	0.12684	0.02537	0.930
	female	25	0.8916	0.13021	0.02604	
Rt.ABPI	male	25	0.9092	0.12079	0.02416	0.478
	female	25	0.8824	0.14316	0.02863	

Table 7 Patients groups according to age

Age (yr)	No. of patients	Patients with low ABPI
< 50	6	1 (16%)
50-59	18	7 (38%)
≥ 60	26	12 (46%)

Table 8 The relation between ABPI and age in type 2 diabetic patients

BMI (kg/m^2)	No.	Patients with low ABPI
19.5-24.5	16	8 (50%
25-29.5	15	5 (33%)
≥ 30	19	7 (37%)

Table 9 Patients groups according to BMI

	Age (yr)	No.	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		p-value
						Lower Bound	Upper Bound	
Lt. ABPI	40-49	6	0.9600	0.08462	0.03454	0.8712	1.0488	0.314
	50-59	18	0.8994	0.13104	0.03089	0.8343	0.9646	0.314
	60-69	26	0.8673	0.12979	0.02545	0.8149	0.9197	0.112
	Total	50	0.8900	0.12723	0.01799	0.8538	0.9262	
Rt. ABPI	40-49	6	0.9750	0.06124	0.02500	0.9107	1.0393	0.160
	50-59	18	0.8867	0.15793	0.03722	0.8081	0.9652	0.160
	60-69	26	0.8838	0.12090	0.02371	0.8350	0.9327	0.132
	Total	50	0.8958	0.13179	0.01864	0.8583	0.9333	

Table 10 The relation of ABPI and BMI in type 2 diabetic patients

	BMI	No.	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		p-value
						Lower Bound	Upper Bound	
Lt. ABPI	≤ 24.5	12	0.8642	0.17640	0.05092	0.7521	0.9762	0.545
	25-29.5	19	0.8932	0.11748	0.02695	0.8365	0.9498	0545
	≥ 30	19	0.9032	0.10301	0.02363	0.8535	0.9528	0.416
	Total	50	0.8900	0.12723	0.01799	0.8538	0.9262	
Rt. ABPI	≤ 24.5	12	0.8592	0.14362	0.04146	0.7679	0.9504	0.276
	25-29.5	19	0.9132	0.11480	0.02634	0.8578	0.9685	0.276
	≥ 30	19	0.9016	0.14229	0.03264	0.8330	0.9702	0.391
	Total	50	0.8958	0.13179	0.01864	0.8583	0.9333	

Discussion

ABPI was used in many studies to judge the presence of PAD and it can be used as a screening test for persons susceptible to have PAD such as patients with type 2 diabetes. In the clinical setting the ABPI is often used before more invasive testing such as angiography[22].

The relationship between ABPI and different risk factors was studied.
The results revealed significant correlation with duration of diabetes, as Donnelly R et al. found that PAD progresses more rapidly in diabetic patients and its prevalence also increases significantly with the duration of diabetes[23].

Vicente I, Lahoz C et al., and Beach W et al. found that diabetes duration, and dyslipidaemia have been recognized as risk factors for the occurrence of PAD in the diabetic population[24,25].

Veves et al at their study stated that most diabetic patients including vascular regulation abnormalities and all of these increased significantly with DM duration[26]. Jue Li et al found in their study that DM duration and hypertension duration are the two important risk factors for low ABPI in diabetic patients[27].

However studies by Tseng H et al, Janka U. et al, and Katsilambros L et al found the relation of duration of diabetes and development of macroangiopathy is controversial[28-30]. However Rabia et al did not find any significant association between the duration of DM and PAD in their diabetic population[31].

Regarding hyperlipidemia, Jensen et al. found a strong correlation between ABPI and abnormalities in LDL and TG[32]. Other study by Lyudmila G et al. concluded that Apolipoprotein B appears most statistical significant factor of ABPI according to the reference range values of ABPI and the routine lipid profile with the atherogenic indices give an idea about the number of the LDL particles, while the Apolipoproteins express their number per density, in other words it is an indirect measurement of the quantity of the oxygenated LDL[33,34].

Svein A et al. found in two studies that there is no significant difference in PAD in relation to gender which corresponds to the results of this study[35,36].

Many studies like that of Planas A et al. have found no association between the BMI and low levels of ABPI, and in this study there was no statistically significant difference in different BMI groups[37].

In this study no significant statistical association was found between increasing age of the patients with type 2 DM and abnormally low ABPI that may be due to unequal numbers of patients in each age group however most of studies regarded age as an important factor for the development of PAD and hence abnormally low ABI like the study of Jue Li et al. who found that increasing age is significantly associated with PAD in patients with type 2 DM[27].

Conclusions

1. In type 2 diabetic patients, there was significant relation between low ABPI and duration of DM and hyperlipidemia.
2. No significant correlations between low ABPI and age, gender, or BMI were found.

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