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Peripheral arterial disease in diabetes mellitus at Banpong Hospital

Kajohnsak Jintanon*

Bunyuen Dethdit**

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Background : *There have been many studies and international presentations about detection of peripheral arterial disease (PAD) in diabetic patients. The importance of PAD is its relationship with other atherosclerotic diseases, and in severe PAD the patient suffers from poor circulation of the lower extremities. There are few centers in Thailand examined PAD in diabetic patients. The ankle – brachial index is a simple method to detect the presence of PAD related 95 % significantly using doppler scanning methods.*

Objective : *We intended to measure the presence of, and assess, PAD in diabetic patients attending the diabetic clinic in Banpong Hospital. This was done by ankle-brachial index (ABI) measurements, and analysis of the relation of ABI with uncontrollable and controllable diabetic care factors.*

Method : *494 diabetic patients attending the diabetic clinic were asked to volunteer for measurements of ABI which were performed by measuring the systolic blood pressure of both ankles and both arms and conducting calculations. Analysis of data was done by use of SPSS software version 9.0 for descriptive analysis and relation of ABI with general and diabetic care factors.*

Results : *We found PAD (ABI < 0.9) in 4.9% of the diabetic patients attending the diabetic clinic in Banpong Hospital. In multiple stepwise regression analysis with ABI as a dependent variable, period of DM developed ($p < 0.05$), length of smoking ($p < 0.05$), history of hypertension ($p < 0.05$), aging ($p < 0.05$), and fasting plasma glucose ($p < 0.05$) were included in explanation of PAD.*

* Department of Medicine, Banpong Hospital, Ratchaburi Province

**Outpatient Department, Banpong Hospital, Ratchaburi Province

Conclusions : *ABI measurement is a simple method that can be used to check diabetic patients for the presence and severity of PAD where attention must be on old age, period of DM developed, length of smoking, history of hypertension and control of blood glucose.*

Key words : *Peripheral arterial disease, Diabetes mellitus.*

Reprint request : Jintanon K, Department of Medicine, Banpong Hospital, Ratchaburi Province 70110, Thailand.

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ภูมิหลัง : *มีการศึกษา และการแสดงผลการศึกษาหลายครั้งในการค้นหาโรคหลอดเลือดแดงส่วนปลายอุดตันในผู้ป่วยเบาหวาน ความสำคัญของโรคหลอดเลือดแดงส่วนปลายอุดตัน เนื่องจากมีความสัมพันธ์กับโรคหลอดเลือดแดงเสื่อมอื่น ๆ อีกทั้งผู้ป่วยที่มีโรคหลอดเลือดแดงอุดตันอย่างรุนแรงจะมีอาการเจ็บป่วยจากการที่มีการไหลเวียนโลหิตไม่เพียงพอต่อการไปหล่อเลี้ยงขา มีการศึกษาโรคหลอดเลือดแดงส่วนปลายอุดตันในผู้ป่วยเบาหวานในศูนย์การแพทย์ของเมืองไทยน้อยมาก การวัดค่าดัชนีความดันโลหิตที่ข้อเท้าต่อข้อศอกเป็นวิธีง่าย ๆ ที่เราใช้ในการตรวจสอบว่ามีโรคหลอดเลือดแดงส่วนปลายอุดตัน ซึ่งพบแล้วว่ามีความสัมพันธ์อย่างมีนัยสำคัญทางสถิติ 95 % กับการตรวจด้วยวิธีใช้ doppler scanning*

วัตถุประสงค์ : *เพื่อค้นหาว่ามีผู้ป่วยเบาหวานที่รักษาในคลินิกเบาหวานของโรงพยาบาลบ้านโป่งมีผู้ที่ป่วยด้วยโรคหลอดเลือดแดงอุดตันโดยวิธีการวัดค่าดัชนีความดันโลหิตที่ข้อเท้าต่อข้อศอกหรือไม่เป็นจำนวนเท่าไร และวิเคราะห์หาความสัมพันธ์ระหว่างค่าดัชนีความดันโลหิตที่ข้อศอกต่อข้อเท้ากับปัจจัยที่เกี่ยวข้องในการดูแลผู้ป่วยเบาหวาน ทั้งที่เราสามารถควบคุมได้และไม่สามารถควบคุมได้*

วิธีการ : *ผู้ป่วยเบาหวานที่มาตรวจรักษาที่คลินิกเบาหวานของโรงพยาบาลบ้านโป่งจำนวน 494 คน สมัครใจตรวจวัดค่าดัชนีฯโดยได้รับการวัดความดันโลหิตซีสโตลิคของข้อเท้าและข้อศอกทั้งสองข้างแล้วคำนวณค่าดัชนี ฯ การวิเคราะห์ข้อมูลทำโดยใช้โปรแกรมสำเร็จรูป SPSS9.0 เพื่อศึกษาข้อมูลทั่วไป และวิเคราะห์ความสัมพันธ์ระหว่างค่าดัชนีฯกับปัจจัยที่เกี่ยวข้องในการดูแลผู้ป่วยเบาหวาน*

ผลการศึกษา : *มีผู้ป่วยเบาหวานที่มีโรคหลอดเลือดแดงส่วนปลายอุดตันที่แสดงโดยค่าดัชนี ฯ < 0.9 เท่ากับ 4.9 % ของผู้ป่วยเบาหวานที่มาคลินิกโรคเบาหวานในโรงพยาบาลบ้านโป่งในการวิเคราะห์ด้วยการวิเคราะห์ถดถอยพหุคูณโดย ABI เป็นตัวแปลตาม จำนวนปีที่เป็นเบาหวาน, ระยะเวลาที่สูบบุหรี่, ประวัติการความดันโลหิตสูง, อายุและค่าน้ำตาลในเลือดเป็นปัจจัยที่มีผลกระทบในทิศทางตรงกันข้ามกับค่าดัชนี ฯ อย่างมีนัยสำคัญทางสถิติที่ใช้ในการอธิบายการเกิดมีโรคหลอดเลือดแดงส่วนปลายอุดตัน*

สรุป : *การวัดค่าดัชนีความดันโลหิตที่ข้อเท้าต่อข้อศอกเป็นวิธีการง่าย ๆ ที่เราสามารถใช้ตรวจหาการเกิดโรคหลอดเลือดแดงอุดตันในผู้ป่วยเบาหวาน ซึ่งควรให้ความสนใจในผู้ป่วยที่มีอายุมาก เป็นเบาหวานมานานแล้ว ผู้ที่สูบบุหรี่มานาน,ผู้ที่มีประวัติความดันโลหิตสูงและผู้ที่ไม่สามารถควบคุมค่าน้ำตาลได้ดี*

It has long been known that diabetes mellitus (DM) is a risk factor of peripheral arterial disease (PAD).[1] PAD develops more frequently, rapidly, and extensively in diabetes case than in non-diabetic individuals.[2] PAD in diabetes has a particular predilection for the tibial and peroneal arteries between the knees and ankles.[1] Assessment of PAD should be done as part of annual review by history taking and clinical examination. [1]

Nowadays there are only a few centers in Thailand examining PAD in diabetic clinics because of limitations in experience and interest by vascular internists.

In the European Diabetes Symposium 1996 it was stated in the epidemiology discussion that glucose levels determined peripheral vascular and other atherosclerotic events, and PAD developing rates rise with poorer glucose control. Diabetes with known PAD have increased 15 fold in mortality rates due to cardiovascular disease and coronary heart disease.[3,4]

The clinical symptoms of PAD result from progressive narrowing of lower limb arteries.[3-5] PAD may develop in the beginning when diabetes is first detected but it may also gradually develop later over a long period without any clinical symptoms.[5]

An ankle-brachial systolic pressure index (ABI) of < 0.9 correlates with disease on duplex scanning and is > 95 % specific in detecting angiogram-positive PAD, with progressively lower ABI indicative of more severe disease. [5] When PAD is presented, more details should be obtained by using a simple doppler scanning apparatus to examine posterior tibial and dorsalis pedis systolic blood pressure and arterial narrowing. [1,3,5]

Objectives

Our objectives in this study were :

1. ABI measurements of diabetic patients at the diabetic clinic in Banpong Hospital

2. The occurrence of PAD in the diabetic patients at diabetic clinic in Banpong Hospital

3. The relation of PAD with controllable and uncontrollable factors in diabetic care.

Materials and Method

Patients

1. We asked for volunteers to determine ABI in the diabetic clinic.

2. Medical history, type of diabetes, treatments, records of FPG in 1 year, HbA1c in 1 year, blood pressure, symptoms of PAD and other associated diseases were recorded.

Instrument

We used the type 78352 C automatic sphygmomanometer built for bedside monitors by Hewlett-Packard

Measurement and determination of ABI :

Diabetic patients attending the diabetic clinic in the OPD department at Banpong Hospital were examined for their ankle-brachial indexes by first laying down for at least 5 minutes.

Their systolic blood pressures at both dorsalis pedis arteries of lower extremities and both brachial arteries of upper extremities were examined.

The ABI was determined by calculation from the equation of :

ABI = systolic blood pressure (ankle) / systolic blood pressure (arm) [5]

We modified the ABI determination by using the lowest

systolic blood pressure between the two ankles and the average of both brachial systolic blood pressures to calculate a minimum ABI as an indicator of unilateral disease.

Statistical methods :

We used the SPSS for Windows version 9.0 software program to analyze the data. In descriptive analysis, we studied for means, standard deviations, and percentages of age, sex, period of DM developed, types of DM, treatments of DM, FPG, HbA1c, systolic blood pressure, diastolic blood pressure, history of hypertension, smoking and duration of smoking, symptoms of PAD, and ABI.

After the ABI values of the patients had been determined, the patients were seperafed into three groups using ABI < 0.9, 0.9- -0.99 and > 1.0. ABI < 0.9 assumed the presence of PAD, ABI = 0.9 - 0.99, was the intermediate group and ABI = > 1.0 was normal. The characteristics of the three groups were then analyzed and compared by the Pearson Chi- Square tests model.

The relation of ABI and patient factors were analyzed, including general and diabetic care factors. A multiple stepwise regression method was used with the equation;

$$Y = K + b1x1 + b2x2 + b3x3 + \ldots\ldots\ldots bnxn.$$

Results

The general characteristics of diabetic patients in which the ABI was studied are demonstrated in table 1. In this study, there were more women (331) than men (164). The percentage and length of smoking in men were greater than in the women. Means of ABI were 1.09, 1.1 in men and 1.09 in women. HbA1c were performed in 189 patients and were analyzed separately from other factors. The ABI was seperated into 3 groups: ABI < 0.9 represent of PAD [group 1], ABI = 0.9 – 0.99 represent the intermediate group [group 2], ABI = > 1.0 represent normal ABI [group 3]. We found that PAD [ABI < 0.9] in DM was 4.9 %, in the intermediate group [ABI 0.9 – 0.99] was 12.1 % and in the normal group [ABI = > 1.0] was 83.0 % as shown in graph 1

We compared the two groups of diabetic patients with PAD [ABI < 0.9, group 1] and the diabetic patients with normal ABI [ABI = > 1.0, group 3] as the control group and results are in table 2. The means, standard deviations, and percentages of the variables are presented in table 2. Age, period of DM developed, FPG, HbA1c, history of hypertension, and length of smoking were different in both groups with a 95 % confidence interval. The Pearson Chi- Square values of all variables are also shown in table 2. The descriptive data of ABI = 0.9 - 0.99 are shown in the last column of table 2. HbA1c were analyzed with original data in the correlation test with the Pearson Chi-Square test.

The relations between ABI and age, period of DM developed, length of smoking, history of hypertension, FPG values were demonstrated in graph 2-6. We used multiple stepwise regression analysis, and found that there were 5 risk factors affected to ABI significantly in the best model. These risk factors were :

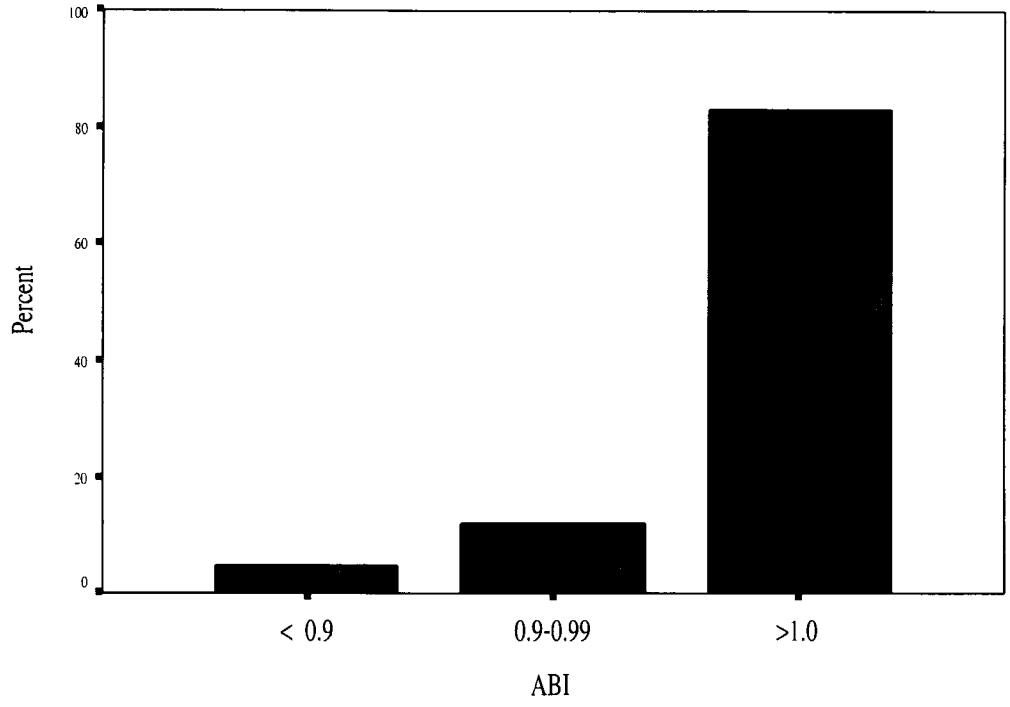
1. Period of DM development (affected in negative direction) [T= - 5.332]

2. Length of smoking (affected in negative direction) [T = - 3.882]

3. History of hypertension (affected in negative direction) [T = - 3.308]

Table 1. General characteristic of 494 diabetic patients in whom ABI were assessed.

Characteristic	Men (164)	Women (330)	Total (494)
Age, year, mean (SD)	63.50 (10.23)	60.33 (9.37)	61.38 (9.77)
Years developed DM ,mean(SD)	8.82 (7.25)	7.36 (5.95)	7.85 (6.44)
Types of DM			
1. Type 1, N (%)	3 (1.8)	6 (1.8)	9 (1.8)
2. Type 2, N (%)	161 (98.2)	324 (98.2)	485 (98.2)
Treatments of DM			
1. Diet, N(%)	3 (1.8)	5 (1.5)	8 (1.6)
2. Oral drug, N(%)	135 (82.3)	274 (83.1)	409 (82.8)
3. Oral drug + insulin, N(%)	21 (12.8)	39 (11.8)	60 (12.1)
4. Insulin, N(%)	5 (3)	12 (3.6)	17 (3.4)
Fasting plasma glucose ,mean (SD)	144.66 (41.42)	149.41 (40.63)	147.83 (40.92)
HbA1c, mean (SD)	8.95 (1.81)	7.95 (1.60)	8.29 (1.74)
Systolic BP, mmHg, mean (SD)	138.76 (17.38)	138.59 (18.86)	138.65 (18.36)
Diastolic BP, mmHg, mean (SD)	78.24 (8.43)	78.06 (8.38)	78.12 (8.39)
Hypertension, N(%)	46 (28)	99 (30.0)	145 (29.4)
Smoking, N(%)	104 (63.4)	28 (8.5)	132 (26.7)
Time of Smoking, years ,mean (SD)	19.21 (20.57)	1.68 (6.97)	7.50 (15.51)
Symptoms of PAD,			
1. No symptom, N(%)	60 (36.6)	103 (31.2)	163 (33.0)
2. Grade 1, N(%)	95 (57.9)	197 (59.7)	292 (59.1)
3. Grade 2, N(%)	6 (3.7)	20 (6.1)	26 (5.3)
4. Grade 3, N(%)	1 (0.6)	10 (3.0)	11 (2.2)
5. Grade 4, N (%)	2 (1.2)	0	2 (0.4)
ABI, mean (SD)	1.10 (0.13)	1.09 (0.13)	1.09 (0.13)
ABI			
1. < 0.9, N (%)			24 (4.9)
2. 0.9 – 0.99, N(%)			60 (12.1)
3. =, > 1.0, N (%)			410 (83.0)



Graph 1. Percent of volunteers in each groups.

Table 2. Characteristic of diabetic patients with ABI < 0.9 [PAD], ABI = > 1.0 [normal] and ABI = 0.9-0.99 (intermediate group) Pearson Chi Square values and p values between PAD and normal.

Characteristics	ABI < 0.9 (24) [PAD]	ABI = > 1.0 (410) [normal]	$\chi 2$	p	ABI 0.9-0.99 (60) [intermediate]
Age, years, mean (SD)	69.54 (8.23)	60.32 (9.39)	75.777	0.005*	65.37 (10.45)
Sex			0.381	0.537	
Men N (%)	9 (37.5)	129 (31.5)			26 (43.3)
Women N (%)	15 (62.5)	281 (68.5)			34 (56.7)
Years of diabetes, years (SD)	16.29 (9.63)	7.09(5.55)	93.861	0.000*	9.67 (7.78)
Types of DM			0.548	0.459	
Type 1 N (%)	1 (4.2)	8 (2.0)			0
Type 2 N (%)	23 (95.8)	402 (98.0)			51 (100)
FPG, mg% (SD)	136.21 (33.94)	146.06 (39.16)	167.822	0.038*	164.62 (50.45)
HbA1c,% (SD) [not adjusted]	7.77 (2.20)	8.26 (1.75)	104.237	0.001*	8.67 (1.39)
Treatment of DM			3.713	0.294	
Diet, N (%)	1 (4.2)	7 (1.7)			0
Oral drug, N(%)	17 (70.8)	346 (84.4)			46 (76.7)
Oral drug + Insulin, N (%)	4 (16.7)	44 (10.7)			12 (20.0)
Insulin, N (%)	2 (8.3)	13 (3.2)			2 (3.3)

Table 2. Continuous.

Characteristics	ABI < 0.9 (24) [PAD]	ABI = > 1.0 (410) [normal]	$\chi 2$	p	ABI 0.9-0.99 (60) [intermediate]
Systolic blood pressure, mmHg (SD)	145.33 (18.77)	137.71 (17.83)	96.424	0.102	142.35 (20.97)
Diastolic blood pressure, mmHg (SD)	77.54 (8.86)	78.08 (8.28)	55.602	0.113	78.63 (9.05)
History of hypertension,			4.328	0.037*	
No, N (%)	13 (54.2)	302 (73.7)			34 (56.7)
Yes, N (%)	11 (45.8)	108 (26.3)			26 (43.3)
Smoking			1.157	0.282	
1. No, N (%)	16 (66.7)	313 (76.3)			33 (55.0)
2. Yes, N (%)	8 (33.3)	97 (23.7)			27 (45.0)
Time of smoking, years (SD)	14.63 (24.17)	5.88 (12.89)	70.515	0.000*	15.72 (22.88)
Symptoms of PAD,			4.373	0.358	
No symptom, N (%)	5 (20.8)	143 (34.9)			15 (25.0)
Numbness, N (%)	18 (75.0)	236 (57.6)			38 (63.3)
Intermittent cluadication, N (%)	0	21 (5.1)			5 (8.3)
Rest pain, N (%)	1 (4.2)	8 (2.0)			2 (3.3)
Gangrene or ischemic ulcer, N (%)	0	2 (0.5)			0

* demonstrate the significant of difference between both groups.

4. Age (affected in negative direction) [T = - 2.627]

5. Smoking (affected in negative direction) [T = -2.033]

The five risk factors together help explain ABI in 16.4% of the diabetic patients where the factor that influenced the most was period of DM developed, and under this was length of smoking, history of hypertension, age and FPG, as shown in table 3.

From table 3, an equation that predicts ABI in diabetic patients can be made as;

$Y = 3.58 - 0.239D - 0.167T - 0.140H - 0.122A - 0.086S$

where D = Period of DM developed

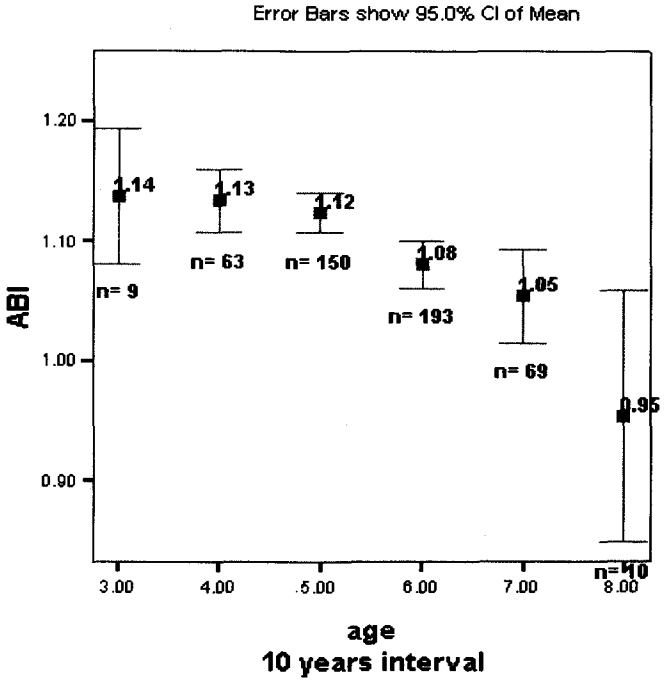
T = Length of smoking

H = History of hypertension

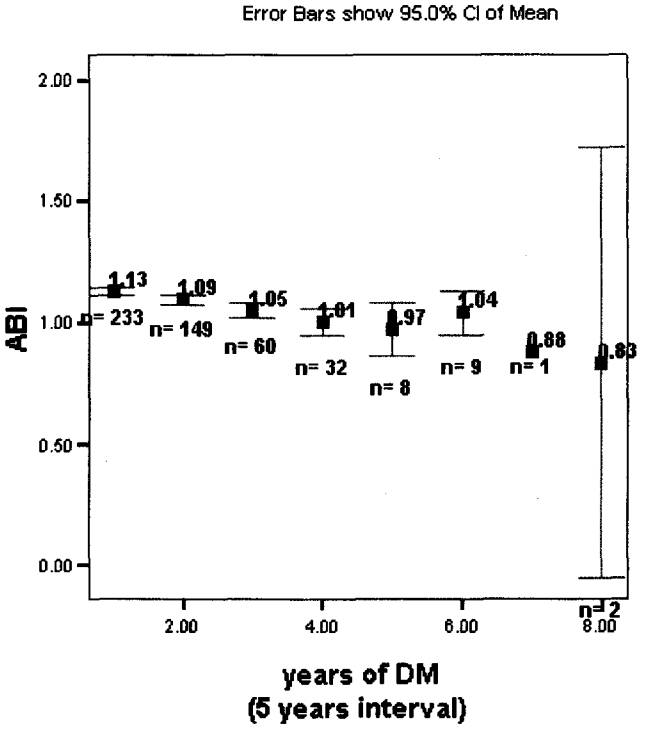
A = Age

S = Fasting plasma glucose

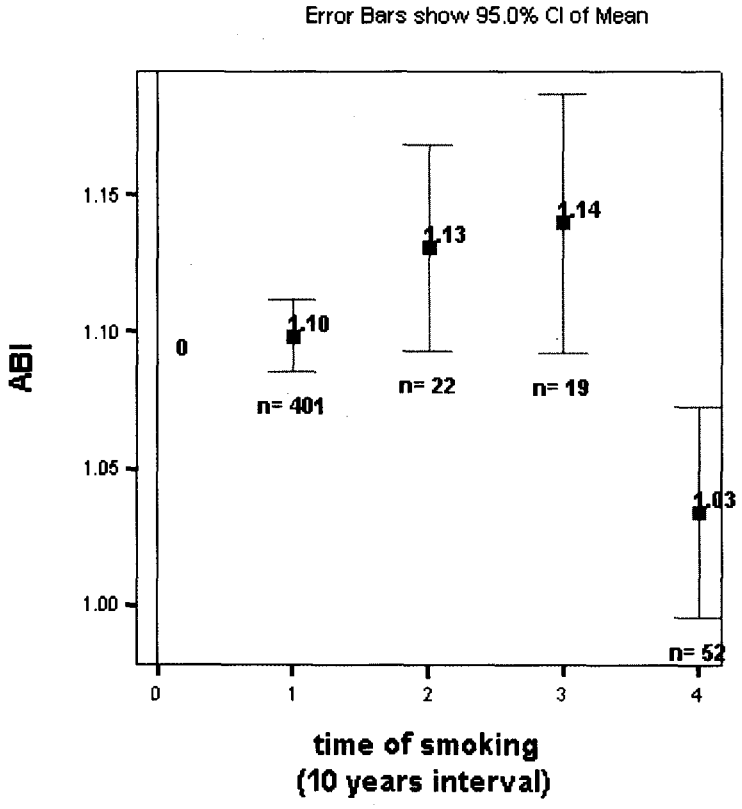
Graph 2-6. Demonstrate relation between ABI and age interval, years DM developed, time of smoking, history of hypertension and blood glucose.



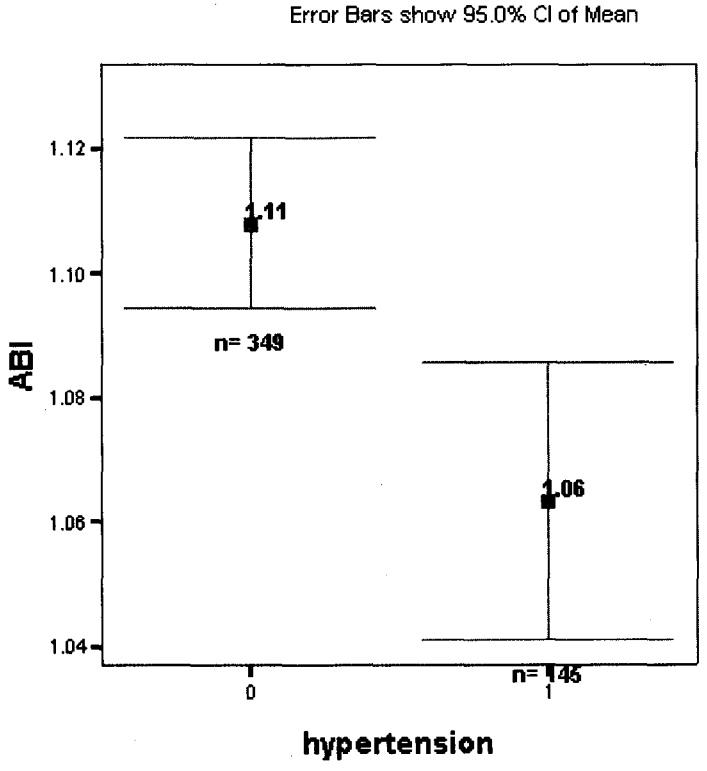
Graph 2. ABI with 6 age intervals in DM.



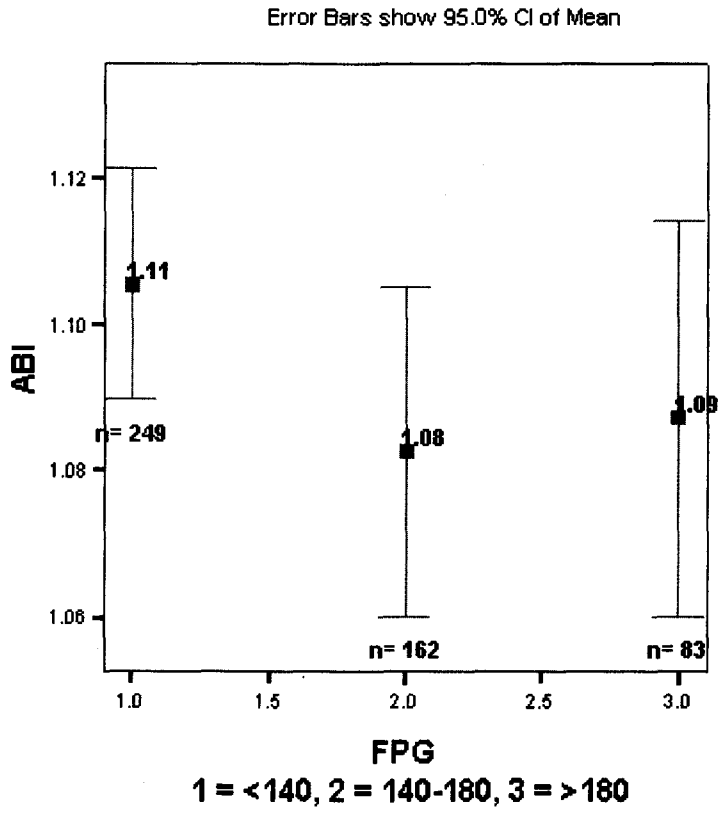
Graph 3. ABI with 8 five years intervals in DM.



Graph 4. ABI with time of smoking in DM.



Graph 5. ABI with history of hypertension in DM.



Graph 6. ABI with FPG values in DM.

Table 3. Result of multiple stepwise regression analysis of factors that affect to ABI.

Risk factors	R2	R2 plus	Regression coefficients		T	Power
			B	Beta		
Years of DM	0.098	0.098	- 1.924E-02	- 0.239	- 5.332*	1
Time of smoking	0.130	0.032	- 5.569E-03	- 0.167	- 3.882*	2
History of hypertension	0.147	0.017	- 0.159	- 0.140	- 3.308*	3
Age	0.157	0.010	- 6.476E-03	- 0.122	- 2.627*	4
FPG	0.164	0.007	- 1.093E-03	- 0.086	- 2.033*	5
Constant			3.580		20.656*	

Discussion

After analysis of the result of ABI measurements in diabetic patients, we found that means of ABI values were 1.09 in total, 1.10 in men and 1.09 in women. In addition we found that PAD in diabetic patients [ABI < 0.9] in our diabetic clinic was 4.9 % of patients and is demonstrated by graph illustration.

In our study, the percentage of PAD in DM patients may be underestimated because of the measurement method.

The correlation of the diabetic patient factors with ABI < 0.9 and = > 1.0 was analyzed and it was found that there were significant correlations with age, period of DM developed, FPG, HbA1c, history of hypertension, and length of smoking with a 95 % confidence interval. We demonstrated the relationship of affecting factors and ABI by graphic illustrations.

The factors related in both groups but not significantly different were types of DM, types of treatments in DM, systolic blood pressure, diastolic blood pressure and symptoms of PAD.

By using multiple stepwise regression, we made the best equation explaining affecting factors and ABI in the 16.4 % of patients.

We concluded that ABI in diabetic patients [in our study = 1.09] is near normal [> 1.0 or 1.1 in some series]. The percentage of PAD in DM is about 5%. The affecting factors that we should observe in diabetic patients whom are suspected of PAD are period of DM development, aging, length of smoking, history of hypertension, and fasting plasma glucose.

Some affecting factors must be studied with more data are HbA1c, types of treatments and hemostatic factors. In the case of controlling plasma glucose (FPG), the affecting factor may be due to the natural history of diabetes.

We suggest that ABI measurements be should done in older diabetic patients, those who developed DM for a long period, those with a history of hypertension, those smoking for a long period and those with poor controlling of plasma glucose.

Lastly, we suggest that ABI measurements in DM patients should be done in a larger population with a longitudinal study.

Summary

We measured ABI in diabetic patients attending the diabetic clinic in Banpong Hospital and found that mean of ABI was 1.09 which are in normal range. The percentage of PAD [ABI < 0.9] was 4.9%. We found that in diabetic patients, ABI is correlated with period of DM development, length of smoking, history of hypertension, age, and fasting plasma glucose.

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