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Ankle-brachial index by automated method and renal function

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RESEARCH

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ABSTRACT

Background

The Ankle-brachial index (ABI) is a non-invasive method used for the diagnosis of peripheral arterial occlusive disease (PAOD).

Aims

To determine the clinical features of patients submitted to ABI measurement by automatic method. To investigate association between ABI and renal function.

Methods

The present is a cross-sectional study. The study was performed in a private clinic in the city of Fortaleza (Ce)-Brazil. For ABI analysis, we utilized automatic methodology using a Microlife device. Data collection took place from March 2012 to January 2016. During this period, ABI was measured in 375 patients aged >50 years, who had a diagnosis of hypertension, diabetes or vascular disease.

Results

Of the 375 patients, 18 were categorized as having abnormal ABI (4.8 per cent) and 357 were normal ABI (95.2 per cent). Patients with abnormal ABI showed older mean age when compared to patients with normal ABI. Among patients with normal renal function, only 0.95 per cent showed abnormal ABI; among patients with abnormal renal function, 6 per cent showed abnormal ABI.

Conclusion

1) No differences were observed when comparing the groups regarding gender or the prevalence of hypertension, diabetes, dyslipidaemia or CAD.
2) Group with abnormal ABI had renal function greater impairment.

Key Words

Ankle-brachial, index measurement, hypertension

What this study adds:

1. What is known about this subject?

ABI is significantly associated with future cardiovascular events in high risk patients with cardiovascular diseases.

2. What new information is offered in this study?

Persons with abnormal ABI have renal function greater impairment.

3. What are the implications for research, policy, or practice?

There is a need to stimulate doing ABI in a disseminated manner in patients with many cardiovascular risk factors.

Background

The ankle-brachial index (ABI) is a non-invasive method used for the diagnosis of peripheral arterial occlusive disease (PAOD).[1] Systolic blood pressure (SBP) levels measured in the lower limbs are usually equal to or slightly higher than levels measured in the upper limbs. As a result, in case of existing arterial lesions in the lower limbs capable of causing reduction in pressure in the arterial beds distal to the lesion, there is an evident decrease in the ABI values.[2-3]

The examination consists in measuring SBP twice in the brachial artery of each arm, twice the systolic pressure in the posterior tibial artery and dorsalis pedis artery of each leg. Once the measurements are performed, the ABI is calculated for the right side by dividing the highest of the four measurements in the right ankle by the highest mean systolic BP between the two arms. The ABI measurement on the left side is analogous to that on the right side. The final ABI value is considered as the lowest value found between the two sides. The measurement of SBP can be performed manually or with an electronic device.

Manual measurement, in turn, can be performed using a stethoscope or using a Doppler device. As 12 SBP measurements are required, the test takes some time (approximately 20 minutes with well-trained examiners). It is a non-invasive and inexpensive test. The normal ABI value is ≥0.9 and it is known that values <0.9 or >1.3 are strongly related to high cardiovascular risk.

According to the VI Brazilian Guidelines of Systemic Arterial Hypertension, ABI should be measured in all patients older than 70 years; in diabetics or smokers over 50 years and in patients with complaints suggestive of intermittent claudication and in patients with alterations at the clinical assessment of the lower limbs suggestive of PAOD: (decreased pulse, cold extremities, trophic skin changes), in patients with coronary, carotid, or renal artery disease and in patients with intermediate cardiovascular risk according to the Framingham score.

In the latter condition, the ABI may reclassify the individual's cardiovascular risk. Patients with cardiovascular risk previously classified as moderate, will be considered high-risk if there is a change in ABI or other tests, such as increased carotid intima-media thickness at ultrasonography of the carotid and vertebral arteries; presence of microalbuminuria; presence of left ventricular hypertrophy on echocardiography; high C-reactive protein (CRP) or family history of premature atherosclerotic disease.[4]

An ABI value below normal (<0.9) has a sensitivity of 90 per cent to 97 per cent and specificity of 98 per cent to 100 per cent for the detection of arterial stenosis that affects 50 per cent or more of the lumen of one or more large-calibre vessels of the lower limbs, when compared to results obtained from angiographic studies.[5-7] The reported incidence of lower extremity peripheral arterial disease in western countries ranges between 530 and 2380/100.000 persons-years.[8] Supine position is more used than orthostatic one to determine ABI. When compared the two positions, orthostatic ABI value is higher than supine one.[9] As advocated by AHA, ABI teaching is part of medical curriculum in several countries. However, a nine day training program on ABI measurement is not sufficient for inexperience medical students to achieve an acceptable diagnostic accuracy in detecting PAD at risk populations.[10] Pedal pulse palpation was shown to be a reliable initial screening tool for PAD in population-based programs but only when four pedal pulses were present. In patients with fewer than four palpable pulses, ABI measurement should routinely be measured.[11] ABI is significantly associated with future cardiovascular events in high risk patients with cardiovascular diseases.[12] The objective of this paper is: determine the clinical features of patients submitted to ABI measurement by automatic method and investigate association between ABI and renal function.

Method

The present is a cross-sectional study that was approved by the Research Ethics Committee of Federal University of Ceará, approval number 145.12.09 and that complied with the ethical standards determined by Resolution N. 196 of October 10, 1996, revoked in December/2012, being replaced by resolution 466/12, which regulates research.

The patients were from a private clinic in the city of Fortaleza (state of Ceará-Brazil), called Unicordis. For ABI analysis, we utilized automatic methodology using a Microlife device. Data collection took place from March 2012 to January 2016. During this period, ABI was measured in 375 patients aged > 50 years, who had a diagnosis of hypertension, diabetes or vascular disease. As we didn't have glomerular filtration rate of 46 patients, we investigated the association between renal function and ABI only in 329 patients (Figure 1). Diagnosis of diabetes was done in four circumstances: Fasting plasmatic glycaemia ≥126mg/dL (7.0mmol/L) or 2-h PG ≥200mg/dL (11.1mmol/L) during an oral glucose tolerance test (OGTT) or A1C ≥6.5 per cent (48mmol/mol) or in a patient with classic symptoms of hyperglycaemia or hyperglycaemic crisis, a random plasma glucose ≥200mg/dL (11.1mmol/L).[13] We considered as hypertensive patients if he (she) presented a systolic blood pressure (SBP) >140mm Hg or diastolic blood pressure (DBP) >90mm Hg or both if he (she) was taking anti-hypertensive drugs.[14] Levels for diagnosis of dyslipidaemia changed according presence of vascular disease of presence for risk factors for cardiovascular diseases. We considered as dyslipidemic also the patients that were using drugs for dyslipidemia.[15]

Statistical Analysis

The t test for equality of means was performed to compare the mean age between the two groups. To ensure the prerequisites required for the test, normality and homogeneity of variance among age groups were analysed using the Shapiro-Wilk's and Levene tests, respectively. The Shapiro-Wilk's test assumes as null hypothesis that the data can be described through a normal distribution. Levene test assumes as null hypothesis the homogeneity of variances of the study group variables. Thus, the analysis that does not reject the null hypothesis is of interest. Fisher's exact test was used for the variables gender, diabetes, hypertension and CAD, regarding the association of these variables with the reported ABI. The test of equal proportions was also used as a complementary test, with the same objective. The program used for most analyses was the R, version 3.1.0. We also reported GFR accordingly interquartile ranges and we used Kolmogorov-Smirnov test with correction of Lilliefors to compare ABI across this distribution.

Results

The mean age of patients was 69.3 years (SD=11.6 years). Patients with abnormal ABI showed older mean age (80 years) with a lower standard deviation (8.9 years) when compared to patients with normal ABI, with a mean age of 68.3 years and standard deviation of 11.3 years. The mean age of the patients with abnormal ABI was significantly older than in patients with normal ABI (Table 2).

Using a five per cent significance level, there is insufficient evidence to indicate the existence of a significant association between ABI normality and gender or the presence of diabetes mellitus (DM), dyslipidaemia (DLP), systemic arterial hypertension (SAH) or coronary artery disease (CAD) (Table 3).

To investigate the association between renal function and ABI, patients grade I (normal renal function) were compared to patients grade II, III, IV and V (abnormal renal function). Among patients with normal renal function, only 0.95 per cent showed abnormal ABI; among patients with abnormal renal function, 6 per cent showed abnormal ABI (Table 4).

Reporting GRF accordingly interquartile ranges and comparing ABI across this distribution, we concluded that there was also relation between GFR and ABI (Table 5).

Discussion

The use of the oscillometric method to determine ABI is well standardized and shows good correlation with the standard methodology, using Doppler. This method, due to being easy to perform, may facilitate the initial investigation of PAOD in routine medical practice. There are some authors who consider that using the oscillometric device to determine the ABI can provide a more precise estimation of PAOD in elderly individuals than the method using Doppler. When considering the ABI measurement by Doppler as the gold standard, other authors determined a sensitivity of 71 per cent, specificity of 92 per cent and accuracy of 82 per cent for the determination of ABI <0.9 by the oscillometric method. The ankle pressures measured by this method were consistently higher in reduced ABIs.[13-15]

Diabetes, together with smoking, constitutes the main risk factor for PAOD development.[5] PAOD prevalence ranges from 9.5 per cent to 13.6 per cent in diabetic patients,[16] compared with only 4 per cent in the general population in the USA.[17] In patients from this paper, the prevalence of diabetes was 28 per cent, also showing no difference when comparing patients with normal ABI with those with abnormal ABI.

PAOD in diabetic patients has some particularities. Unlike PAOD caused by smoking, diabetes-related PAOD affects mainly the distal lower limb arteries. The main affected vessels are the popliteal artery, the anterior tibioperoneal trunk, the posterior tibial artery and the dorsal pedis artery. Additionally, there is a strong correlation between diabetes and diffuse calcification of the medial layer of the lower-limb arteries, which leads to increased arterial stiffness and its consequent false increase in blood pressure measured at the ankle, resulting in an inopportune increase in ABI values.

Medial layer calcification is frequently associated with chronic renal failure and the occurrence of peripheral neuropathy. In fact, for a reason still not well understood, surgical sympathectomy of the lower extremities causes greater calcification of these vessels in subsequent years and that helps us understand the association between the development of medial layer calcification and the presence of peripheral neuropathy.[18]

In our paper, no differences were observed when comparing the groups regarding gender or the prevalence of hypertension, diabetes, dyslipidaemia or CAD. However, we observed that the group with abnormal ABI showed higher mean age and had renal function greater impairment. This fact may be a confounder. The age may be the cause for renal function greater impairment and not abnormal ABI itself. Our findings confirm Laghari's experience that shows that the prevalence of POAD was significantly high in patients with advanced stage of chronic kidney disease (CKD).[19] This also occurs in patients with atrial fibrillation, where and ABI <0.9 is independently associated with a rapid decline in renal function.[20] Wang et al showed that in a CKD cohort, women, compared with men were at a markedly increased risk for PAD in younger age but at ages >70 years, the risk was similar across both the sexes.[21] Our data show that persons with abnormal ABI are older than persons with normal ABI. In conclusion, no differences were observed when comparing the groups regarding gender or the prevalence of hypertension, diabetes, dyslipidaemia or CAD but the group with abnormal ABI had renal function greater impairment. The limitation of this study is the fact that we have investigated the association between renal function and ABI in only 329 patients from the total of 375.

Conclusion

In conclusion, no differences were observed when comparing the groups regarding gender or the prevalence of hypertension, diabetes, dyslipidaemia or CAD but the group with abnormal ABI had renal function greater impairment.

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PEER REVIEW

Not commissioned. Externally peer reviewed.

CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

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None

ETHICS COMMITTEE APPROVAL

Comitê de Ética em Pesquisa do Hospital Universitário Walter Cantídio, aproval reference number 145.12.09

Figure 1: Design of the study

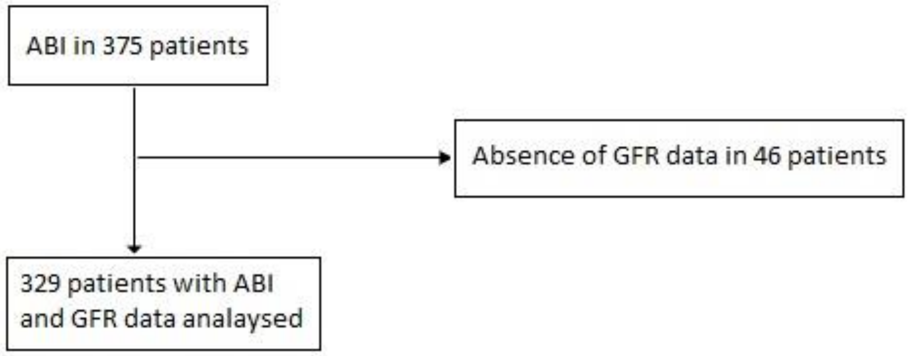

Table 1: Frequencies of patients from the clinic by gender, diabetes, dislipidemy, systemic arterial hypertension, CAD, and renal function status

Variable	**Category**	**ABI**		Total
		Abnormal	**Normal**	
Gender	Female	12 (5.85%)	193 (94.14%)	205
	Male	6 (3.52%)	164 (96.47%)	170
Diabetes	No	11 (3.97%)	266 (96.02%)	277
	Yes	7 (7.14%)	91 (92.85%)	98
DLP	No	7 (3.57%)	189 (96.42%)	196
	Yes	10 (5.64%)	167 (94.35%)	177
Hypertension	No	2 (2.53%)	77 (97.46%)	79
	Yes	16 (5.44%)	278 (94.55%)	294
Renal Function	I	1 (0.95%)	104 (99.04%)	105
	II	0 (0%)	130 (100%)	130
	III	11 (12.94%)	74 (87.05%)	85
	IV	2 (25%)	6 (75%)	8
	V	0 (0%)	1 (100%)	1
	unknown	4 (8.69%)	42 (91.3%)	46
CAD	Não	10 (3.55%)	271 (96.44%)	281
	Sim	8 (8.51%)	86 (91.48%)	94

Table 2: Mean age and standard deviation of patients by ABI classification

ABI	**Freq.**	**Mean**	**SD**
Abnormal	18	83.67*	8.17
Normal	357	67.56*	11.46
Total	375	68.34	11.9

p=0.009

Table 3: Fisher's exact test for categorical variables

Variable	Category	ABI		P value
		Abnormal	Normal	
Gender	Female	12	193	0.34
	Male	6	164	
Diabetes	No	11	266	0.26
	Yes	7	91	
DLP	No	7	189	0.45
	Yes	10	167	
Hypertension	No	2	77	0.38
	Yes	16	278	
CAD	No	10	271	0.08
	yes	8	86	

Table 4: Renal function x ABI

Variable	Category	ABI	
		Abnormal	Normal
Função Renal	I	1 (0.95%)	104(99.05%)
	II,III, IV ou V	13(6%)	211(94%)

p=0.043

Table 5: Kolmogorov-Smirnov test with correction of Lilliefors significance

		ABI
N		290
Normal data	Mean	10.74
	Error	0.11
Extremest differences	Absolut	0.22
	Positive	0.15
	Negative	-0.22
Test statistics		0.22
Significance.		0.00