Predictive value of ankle-brachial index, toe-brachial index and toe blood pressure in patients with diabetes

Valor pronóstico del índice tobillo-brazo, el índice dedo-brazo y la presión arterial del dedo en el paciente con diabetes

M. Martín Fuentes, V. Martín Borge, L. Herranz de la Morena, L. Sáez de Ibarra, M.A. Puma Duque, L.F. Pallardo Sánchez

Diabetes Unit. Endocrinology and Nutrition Service. University Hospital La Paz. Madrid

Abstract

Introduction: Patients with diabetes have a higher frequency of vascular peripheral disease. Objective: To evaluate, in the diabetic patients, the usefulness of the ankle-brachial index, the toe-brachial index and the toe blood pressure to predict the risk of later appearance of a vascular event in lower extremities. Material and methods: We measured the ankle-brachial index (ABI), the toe-brachial index (TBI) and the toe blood pressure in 123 patients with diabetes. We compared the mean value of these parameters between patients with and without vascular event. We analyzed the predictive value of this parameters and the independent contribution of each one of them. Results: The mean value of TBI, ABI and toe blood pressure were significantly lower in patients who had a vascular event. The patients with ischemia by ABI, ischemia by TBI and with lower value of toe blood pressure have an increased risk of presenting a vascular event. Only ischemia by ankle-brachial index, toe brachial index and toe blood pressure were independent predictors of later appearance of a vascular event. Conclusions: The usefulness of ankle-brachial index, toe brachial index and toe blood pressure to predict a vascular event in patients with diabetes has been demonstrated. In addition, ankle-brachial index and toe blood pressure have an independent predictive value.

Keywords: peripheral arterial disease, ankle-brachial index, toe-brachial index.

Introduction

Cardiovascular disease, including coronary disease, cerebrovascular disease and peripheral vascular disease, is the main cause of morbimortality in patients with diabetes, and constitutes also the main factor that contributes to the direct and indirect health costs of the disease. The peripheral vascular disease has been demonstrated as a predictor of cardiovascular mortality and coronary heart disease, and also as a marker of systemic atherosclerotic disease. Using the ankle-brachial index as a diagnosis method, the prevalence of peripheral vascular disease in patients with diabetes over 40 years of age ranges between 20 and 29%, according to authors.

In people with diabetes, the risk of having peripheral arterial disease has some special characteristics, increasing its presence with age, the duration of the diabetes and the presence of peripheral neuropathy. In these patients, the disease is limited especially to the region between the knee and the ankle, affecting mainly the tibial and peroneal arteries. The complications, especially in lower limbs are much more frequent and more serious in patients with diabetes than in those who do not suffer it, and represent the main risk factor for amputations of lower extremities.

Resumen

Introducción: La enfermedad vascular periférica es muy frecuente en pacientes con diabetes. Objetivos: Evaluar, en el paciente diabético, la utilidad del índice tobillo-brazo, el índice dedo-brazo y la presión arterial del dedo para predecir el riesgo de aparición de un evento vascular en las extremidades inferiores. Material y métodos: Se evaluaron 123 pacientes diabéticos. Se midieron el índice tobillo-brazo (ITB), el índice dedo-brazo (IDB) y la presión arterial (PA) del primer dedo del pie. Se compararon los valores medios de los parámetros en los pacientes con y sin evento. Se analizó su valor predictivo y la contribución independiente de cada uno. Resultados: Los valores medios de ITB, IDB y PA en el primer dedo fueron menores en los pacientes con evento vascular. La isquemia por ITB, la isquemia por IDB y el menor valor de PA en el primer dedo aumentaron el riesgo de presentar un evento vascular. Se demostraron, como predictores independientes, la isquemia por ITB y la PA del dedo. Conclusions: Se demuestra la utilidad del IDB, el ITB y la PA del dedo a la hora de predecir el mayor riesgo de aparición de un evento vascular en las extremidades inferiores en el paciente con diabetes, presentando un valor predictivo independiente el ITB y la PA del dedo.

Palabras clave: enfermedad vascular periférica, índice tobillo-brazo, índice dedo-brazo.
limbs; the frequency of the last ones is 20 times higher than in the general population.

The early detection of peripheral vascular disease in these patients is essential to prevent complications. The use of non-invasive and reproducible methods, as the measurement of ankle-brachial index and toe-brachial index can help to achieve this.

The aim of this study is to assess, in the diabetic patient, the usefulness of ankle-brachial index, the toe-brachial index finger and the toe blood pressure to predict the risk of subsequent development of a vascular event in the lower limbs.

Materials and methods
We conducted a retrospective longitudinal study in which we evaluated 123 patients with diabetes followed-up in the consultations of the Diabetes Unit of the Hospital La Paz, in Madrid since 2000 until 2008. The 78.9% had T2D and 65% were men.

We measured the ankle-brachial index (ABI), the toe-brachial index (TBI) and the blood pressure (BP) of the first toe in all the patients. For this, we used a Doppler with a frequency of 8 MHz emission, a cuff for the manual taking of the blood pressure and a reduced size cuff for the first toe. The patients were placed in supine position, with the arms outstretched. The determinations were made at the level of the brachial artery, posterior tibial, dorsalis pedis and foot toe.

In order to calculate the value of the ankle-brachial index, we measured blood pressure of patients in the arm and maleolar level, and we divided the highest value obtained in the measurement of the posterior tibial arteries and dorsalis pedis between the values of the systolic blood pressure of the arm. The calculation of the toe-brachial was made dividing the blood pressure in the arteries of the toes between the values of the brachial artery.

We defined the ischemia as an ankle-brachial index <0.9 and a toe-brachial index <0.6. A systolic blood pressure in the toe <30 mmHg was considered critical ischemia.

Moreover, we consider vascular events, the onset of ulcers in the lower limbs, the need of undergoing arterial invasive procedures and the amputation surgery.

| Table 1. Characteristics of the patients
| Type of diabetes (%) | T1D: 21.1 / T2D: 78.9 |
| Mean of age (years) | 60.8 ± 11.5 |
| Mean duration of the diabetes (years) | 15.1 ± 13.4 |
| Mean HbA1c (%) | 7.8 ± 1.5 |
| Presence of blood hypertension (%) | 64.2 |
| Presence of dyslipemia (%) | 69.1 |
| Tobacco habit (%) | 42 |
| Diabetic nephropathy (%) | 37.5 |
| Diabetic retinopathy (%) | 48.8 |
| Diabetic neuropathy (%) | 42.1 |
| Coronary disease history (%) | 48.8 |
| Cerebrovascular disease history (%) | 7.3 |

| Table 2. Comparison of the mean values of different parameters
| With event | Without event | p |
| ABI (mean ± SD) | 0.6 ± 0.2 | 0.9 ± 0.3 | 0.000 |
| TBI (mean ± SD) | 0.3 ± 0.2 | 0.6 ± 0.2 | 0.000 |
| BP of first toe (mean ± SD) | 46.2 ± 22.7 | 75.3 ± 32.4 | 0.001 |

The median follow-up of patients was 3 ± 1.7 years and the median follow-up of 2 years. Statistical analysis was performed using SPSS version 11.0. We compared the average ankle-brachial index, toe-brachial index and toe blood pressure in patients with and without event by means of Mann-Whitney non-parametric test.

In addition, we analyzed the predictive value of different parameters using logistic regression, and a multiple logistic regression model was applied in order to analyze the independent contribution of each parameter. A p <0.05 was considered relevant with a 95% CI.

Results
Table 1 depicts the clinical characteristics of the patients. During the follow-up, 9.8% (12 patients) showed at least one vascular event in the lower limbs. From these, 2 patients had two events and another 2 suffered three events. The vascular events that we found were as follows: 7 patients had uninfected ulcers, 2 patients had infected ulcers, 2 patients underwent amputation of a toe and 1 patient required a supracondylar amputation and 3 patients required invasive arterial procedures.

We compared the average values of different parameters among patients who showed an event and those who did not, and we found the ankle-brachial index, the toe-brachial index and the blood pressure of the first toe significantly lower in patients who suffered a vascular event compared to those who had not (table 2).

It could be observed an increased risk of a vascular event in patients with ischemia diagnosis through the measurement of the ankle-brachial index and toe-brachial index, and also in those with a lower blood pressure in the first toe. In the case of the first toe blood pressure, by each mmHg it increased, the event risk decreased 0.96 times. (ABI ischemia: OR= 8.29; CI, 1.73-39.72; p= 0.001. TBI ischemia: OR= 4.91; CI, 1.03-23.44; p= 0.017. BP first toe: OR= 0.96; CI, 0.93-0.99; p= 0.000.)

We conducted a multiple regression model in which we introduced all the parameters: ankle-brachial index, toe-brachial index and first toe blood pressure. Together, the ischemia by ankle-brachial index turned out to be independent predictors (OR= 5.45; CI, 1.09-27.33; p= 0.015) and toe blood pressure (OR= 0.97; CI, 0.94-0.99; p= 0.009).

Discussion
The patient with diabetes shows a peripheral arterial disease frequently causing a relevant morbimortality. The American Diabe-
tes Association (ADA) recommends the annual exploration of the diabetic foot and an initial assessment of peripheral arterial disease, including clinical claudication history and the determination of foot pulse. Peripheral vascular disease might not show symptoms, especially in the early stages, in addition, the coexistence of neuropathy in many patients difficult the recognition of the symptoms. For this reason, the ADA also recommends the performance of the ankle-brachial index in patients over 50 years, with or without symptoms, and considering it in those under 50 years with other risk factors.1,7,8

The usefulness of this technique is limited because, in diabetics, the presence of arterial calcifications is quite frequent, therefore there is a resistance to the compressibility of the arteries that distorts the results; in this case it has been demonstrated as an alternative only for diagnosis, the use of the toe-brachial index.9,10 However, as demonstrated in this study, measurement of the blood pressure in the toe might be a parameter to provide additional risk information with an independent predictive value.

Besides its diagnostic role in peripheral vascular disease, the ankle-brachial index was presented as an independent risk marker of cardiovascular morbimortality in studies conducted on diabetic and non diabetic patients.11

Most studies evaluate the predictive value of ankle-brachial index as a risk marker or coronary disease in patients with and without diabetes, showing the presence of diabetes mellitus as a risk factor.12-14

In our study, diabetic patients who during the follow-up showed a vascular event in the lower limbs had lower values of toe-brachial index, ankle-brachial index and toe blood pressure compared to those who had not shown any events. Moreover, it could be stated that both the existence of ischemia by the ankle-brachial index and the value of the toe blood pressure increased independently the risk of suffering a vascular event in the lower limbs.

As regards to the limitations of the study, it should be convenient to perform it with a longer follow-up and extending the number of patients, to perform a more exhaustive statistical analysis that will eliminate confusion factors that might have conditioned the results.

In summary, the diagnosis of ischemia in diabetic patients using the ankle-brachial index and toe-brachial index indicates an increased risk of vascular events in the future. And the value of the arterial pressure of the toe is demonstrated as predictor of independent risk. The demonstration of these parameters as predictors of complication risks in the peripheral vascular disease in diabetic patients should help us in the early diagnosis of this disease in order to avoid such complications, carrying out a closer follow-up of these patients, acting on the factors that might aggravate the vascular pathology and undertaking an adequate education about the possible outbreaks.

Declaration of potential conflict of interests
M. Martín Fuentes, V. Martín Borge, I. Herranz de la Morena, I. Sáez de Ibarra, M.A. Puma Duque and L.F. Pallardo Sánchez state that there are no conflicts of interest as regards to the content of this article.

References