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Original Article

Assessment of arterial stiffness in patients with metabolic syndrome in Ecuador: A cross-sectional study

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ABSTRACT

Background: Metabolic syndrome increases cardiovascular risk, and causes damage to the vascular wall. Through this mechanism, it might increase arterial rigidity, leading to further complications and heart strain. The use of a device that measures arterial rigidity can help determine if metabolic syndrome is related to a higher vascular stiffness and changes in estimated arterial age.
Methodology: Cross-sectional study at Luis Vernaza hospital of Guayaquil, Ecuador. Inpatients and outpatients from the Department of Cardiology with a full blood panel and echocardiogram were included. We used the IDF criteria to diagnose metabolic syndrome and measured arterial rigidity parameters in all of them, including augmentation indexes, central blood pressure, pulse wave velocity and arterial age.
Results: 95 patients were included for analysis, 44.2% were females and 55.8% were males. Mean age was 61.7 years (±13.1). Metabolic syndrome was diagnosed in 49.5% of our patients and it was significantly more prevalent in women. We found significant differences in PWV, augmentation indexes, and peripheral and central blood pressure between metabolic and non-metabolic syndrome patients. There was a non-significant relationship between estimated arterial age and metabolic syndrome ($p = 0.32$).
Conclusion: Patients with metabolic syndrome have an increased arterial rigidity. This, added to the high prevalence of the disease we found in our sample, shows the high cardiovascular risk these patients are at. A multidisciplinary approach to management is needed, along with patient collaboration. The introduction of these devices to measure arterial stiffness in developing countries can improve diagnosis and therapy of patients with cardio-metabolic conditions.

1. Introduction

Metabolic syndrome has a high prevalence around the world, with recent estimates of up to 30% of the population having this disorder [1,2]. The International Diabetes Federation (IDF) defines it as abdominal obesity plus two of four additional criteria: hyperglycemia or diabetes mellitus, low HDL cholesterol (<40 mg/dl in males or <50 mg/dl in females) and high triglycerides (>150 mg/dl), and arterial hypertension [3–5]. Individuals with metabolic syndrome have a higher than normal cardiovascular risk for myocardial infarction, stroke, or peripheral vascular disease, chronically affecting blood vessels [6,7]. Most of the patients with metabolic syndrome have diabetes, many of them also have hypertension, and the condition greatly predisposes to diabetes mellitus in people who don't suffer from it already [2,8].

The use of devices that allow physicians to assess arterial rigidity and vascular age can provide insight into the function of the blood vessels in the presence of metabolic syndrome [9]. Devices such as SphygmoCor® or Arteriograph® have been validated for the noninvasive assessment of vascular rigidity in both healthy and diseased populations [10,11]. Increased arterial stiffness is recognized as a cardiovascular risk marker [11]. Pulse wave velocity (PWV) is one of the most important parameters to determine arterial stiffness, measuring the speed difference between the forward systolic impulse wave of the left ventricle and the reflex backward impulse wave from the peripheral arteries [12–14]. Such reflex wave contributes to systolic blood pressure, and by dividing this contribution by the pulse pressure, we can obtain an augmentation index, which is another important feature in the measurement of arterial stiffness [15,16]. Both parameters are said to increase progressively as the person ages [17]. These

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Table 1
Differences in the arterial stiffness variables measured in both metabolic and non-metabolic syndrome patients (n = 95).

Variable	Non-metabolic syndrome mean (DS)	Metabolic syndrome mean (DS)	t value	p value*
Pulse wave velocity (ms^{-1})	8.4 (±1.5)	9.5 (±1.7)	1.1	0.001
Brachial systolic blood pressure (mmHg)	121.8 (±14.6)	138.3 (±17.9)	16.5	<0.001
Brachial diastolic blood pressure (mmHg)	76.6 (±10.1)	86.2 (±12.6)	9.6	<0.001
Brachial augmentation index (%)	−17.9 (±20.3)	−4.7 (±20.7)	13.2	0.002
Central (aortic) augmentation index (%)	26.5 (±13)	32.1 (±11.7)	5.6	0.031
Central systolic blood pressure (mmHg)	122.8 (±15.5)	137.7 (±18.2)	14.9	<0.001
Central diastolic blood pressure (mmHg)	75.9 (±10.4)	85.6 (±12.4)	9.8	<0.001
Central pulse pressure (mmHg)	45.9 (±11.1)	51.8 (±15.8)	5.9	0.038

* A significant p value was accepted as <0.05.

devices also provide an estimate of vascular age according to the degree of rigidity and inflammation [18].

The presence of metabolic syndrome is damaging to blood vessels, and may contribute to increased vascular rigidity. A study aimed to evaluate arterial stiffness measurements in patients with metabolic syndrome will be helpful to determine whether metabolic syndrome is related to an increase in rigidity and vascular age, adding even more cardiovascular risk to this entity. This could be of special usefulness for the practice of medicine in developing countries, where this kind of technologies are just being introduced, and where local research is needed initially for the medical community to get familiarized with them.

2. Methodology

We conducted an observational, cross-sectional study at the Department of Cardiology of Luis Vernaza hospital in Guayaquil, Ecuador, between November and December 2015. We included every patient admitted to the Department of Cardiology who had a full blood panel including glucose, glycohemoglobin A1c, and lipid panel, and also had an echocardiogram made during the most recent hospitalization. We also included individuals from our outpatient Cardiology clinic with a complete laboratory screening and echocardiogram from the last 2 months. The reason for the need of an echocardiogram was to confirm a previous history of left ventricular hypertrophy. Patients with agitation, incapacitating dyspnea, BMI >50 or abdominal girth >150 cm were excluded because of technical difficulties related to the procedure of measurement with the Arteriograph® device.

This study was approved by the Ethics Committee of the Department of Research of Luis Vernaza hospital. All the patients signed an informed consent for participation, which was elaborated in line with the parameters of the Helsinki Declaration. All patients agreed to be tested and to have the results of this research published.

We obtained demographic and clinical data regarding age, gender, smoking, history of hypertension and/or diabetes, and history of left ventricular hypertrophy. Also, we measured abdominal girth, and brachial blood pressure. Using the Arteriograph® system, an oscillometric measurement device, we obtained measurements of brachial and central augmentation indexes, central systolic and diastolic blood pressure, pulse wave velocity (PWV) and arterial age [17]. We retrieved values for triglycerides, HDL cholesterol, glycaemia, and glycated hemoglobin from the laboratory data.

The IDF criteria [5] were used to diagnose metabolic syndrome, but when assessing the cutoff values for abdominal girth, we used the ALAD criteria since they describe the parameters for Latino populations [19]. Statistical analysis was conducted with SPSS Statistics® 22, using Student's *t*-test, chi-square test and Pearson's correlation to test the results, with a p value of <0.05 accepted as significant.

3. Results

A total of 100 patients were included in this study, five of whom met exclusion criteria, leaving us with 95 patients for analysis. Regarding gender, 42 (44.2%) of the included individuals were female and 53 (55.8%) were male, with a mean age of 61.7 years (±13.1). We found that 58 (61.1%) of our patients had hypertension, 29 (30.5%) had diabetes, and 33 (34.7%) had left ventricular hypertrophy according to their echocardiogram studies.

Overall, 47 (49.5%) of our patients had metabolic syndrome, but an even higher number had an increased abdominal girth, with 82 (86.3%) individuals presenting it. The non-metabolic syndrome group was thus comprised of 48 (51.5%) patients. We found a significant difference regarding the presence of metabolic syndrome between males and females ($p < 0.001$), with it being more common in women.

We conducted the measurements of arterial stiffness parameters in all the patients, and found significant differences in PWV, augmentation indexes, and peripheral and central blood pressure between metabolic and non-metabolic syndrome patients, with the latter group having lower values (Table 1). These results did not change even after adjusting for left ventricular hypertrophy or smoking history.

To assess the relationship between the arterial age measured by the device and the presence of metabolic syndrome, we divided the patients by age group, and we obtained non-significant results ($p = 0.32$), which did not change even after adjusting for smoking ($p = 0.28$) or ventricular hypertrophy ($p = 0.71$). These results are shown in Table 2. Also, a non-significant result ($p = 0.32$) was obtained when we tried to assess the correlation between chronological age and PWV.

4. Discussion

The diagnosis of metabolic syndrome was reached in almost half of our patient sample. Even though statistical reports show a worldwide prevalence around 30%, previous epidemiological studies have shown that the prevalence of metabolic syndrome is higher in Latin American populations, possibly because of dietary or cultural factors [2,19,20]. Furthermore, an overwhelming percentage of our patients had abdominal obesity, defined as an abdominal girth surpassing the normal cutoff values for gender

Table 2
Arterial age measured by the Arteriograph® device, in patients with and without metabolic syndrome (n = 95).

		Metabolic syndrome	
		No	Yes
Arterial age group (years)	<30	3	0
	30–40	2	1
	40–50	8	6
	50–60	13	11
	>60	22	29

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