

The impact of physical activity on subclinical atherosclerosis in patients with metabolic syndrome

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Abstract

The metabolic syndrome (MetS) is a distinctive phenotype associated with an increased risk of vascular disease. The aim of the study was to investigate the influence of physical activity at patients with SM and subclinical atherosclerosis. Subclinical atherosclerosis was assessed by flow mediated vasodilation (FMD) by brachial artery in 116 participants with MetS without clinical changes of cardiovascular disease; on B-mode ultrasound images, with the use of a 10 MHz linear-array transducer in terms of fasting for 8 hours. The MetS was defined according to the IDF criteria. Endothelial dysfunction was diagnosed if flow-mediated dilatation was less than 10%. A group of 38 from the 116 participants underwent a six months program of moderate physical activity. The mean FMD by patients with lack of activity was 3.15% and of the patients with physical activity was 6.85% ($p < 0.001$). Patients with metabolic syndrome have subclinical atherosclerosis; with increased endothelial dysfunction. Physical activity on a short term of six months decreased the endothelial dysfunction. Severe impaired endothelial function was noticed by patients without physical activity.

Keywords: *metabolic syndrome, subclinical atherosclerosis, flow mediated vasodilation, physical activity.*

Rezumat

Sindromul metabolic (SM) este definit ca o constelație de factori de risc de origine metabolică asociat cu un risc crescut de afecțiuni cardio-vasculare și diabet zaharat de tip II. Obiectivul studiului a fost de a evalua influența activității fizice moderate asupra pacienților cu SM și ateroscleroză subclinică. Ateroscleroza subclinică a fost evaluată prin vasodilatația mediată de flux (FMD) la nivelul arterei brahiale à jeun pe imagini ecografice obținute în B-mode cu utilizarea unui transducer de 10 MHz la 116 pacienți cu SM fără modificări clinice de boala coronariană. Criteriile de includere au ținut cont de definiția sindromului metabolic elaborată de IDF în 2005. Ateroscleroză subclinică a fost considerată la valori mai mici de 10% ale FMD. 38 de pacienți dintre cei 116 incluși în studiu au fost supuși unui program de activitate fizică moderată. Valoarea medie a FMD a fost de 3.15% la pacienții cu SM și comportament sedentar, iar la pacienții cu SM și activitate fizică moderată a fost de 6,85% ($p < 0,001$). S-a constatat că pacienții cu SM prezintă disfuncție endotelială accentuată. Activitatea fizică moderată poate influența favorabil disfuncția endotelială prezentă.

Cuvinte cheie: *sindrom metabolic, ateroscleroză subclinică, vasodilatația mediată de flux, activitate fizică.*

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Introduction

The MetS is a cluster of the most dangerous heart attack risk factors: diabetes and prediabetes, abdominal obesity, high cholesterol and high blood pressure. A quarter of the world's adult's have MetS. MetS causes moderate increases in all-cause and CVD mortality (1) In the general population, metabolic syndrome is associated with a marked increase in the risk not only of new onset diabetes mellitus but also of new onset office and daily-life hypertension, and left ventricular hypertrophy (2).

Although MetS is related to CHD, there is no epidemiological justification for using it, rather than other criteria, as a risk predictor for CHD (3). The underlying cause of the MetS remains controversial, but the syndrome helps identify individuals at high risk for cardiovascular disease (CVD) and type 2 diabetes. Development of atherosclerotic cardiovascular disease is a major cause of morbidity and mortality. The patterns of MetS components and the longitudinal changes that lead to the MetS are different in men and women. Interestingly, components with the highest prevalence prior to MetS development, such as elevated blood pressure, are not necessarily the stronger risk factors (4). Endothelial dysfunction is now regarded as an early pivotal event in atherogenesis and has been shown to precede the development of clinically detectable atherosclerotic plaques in the coronary arteries (5), a major key in development of cardiovascular and metabolic complications. Endothelial dysfunction of either the coronary, the peripheral, or the cerebral vasculature is a predictor of vascular events and appears to be a marker of uncontrolled atherosclerotic risk that adds to the burden of the genetic predisposition to cardiovascular disease (6). Endothelial dysfunction is characterized by a reduction of the bioavailability of vasodilators, in particular, nitric oxide (NO), whereas endothelium-

derived contracting factors are increased (7). This imbalance leads to an impairment of endothelium-dependent vasodilation, which represents the functional characteristic of endothelial dysfunction. Impaired endothelial function may be a common denominator of pathogenesis of microvascular complications and atherosclerosis in T2DM (8).

It is known that arterial stiffness is increased in patients with metabolic syndrome irrespective of the definition criteria (11). Body weight favors the clustering of coronary heart disease risk factors. overweight and obesity, however, do not independently associate with carotid atherosclerosis (12). Several analyses from the ARIC study have shown that the metabolic syndrome, as well as individual metabolic syndrome components, is predictive of the prevalence and incidence of coronary heart disease, ischemic stroke, carotid artery disease and diabetes. (13)

The aim of the study was to investigate the association of clinically defined metabolic syndrome with subclinical atherosclerosis defined by flow mediated vasodilation.

Method and material

The study enrolled 116 patients with MetS, 74 men (63.79%) and 42 women (36.20%) with a mean age of 50.70 ± 8.39 . The MetS was defined according to the IDF criteria 2005: **Central obesity** (defined as waist circumference >94 cm by male and >80 cm female) plus any two of the following four factors: **raised TG level:** > 150 mg/dL (1.7 mmol/L), or specific treatment for this lipid abnormality; **reduced HDL cholesterol:** < 40 mg/dL (1.03 mmol/L) in males and < 50 mg/dL (1.29 mmol/L) in females, or specific treatment for this lipid abnormality; **raised blood pressure:** systolic BP > 130 or diastolic BP > 85 mm Hg, or treatment of previously diagnosed hypertension; **raised fasting plasma glucose (FPG)**

> 100 mg/dL (5.6 mmol/L), or previously diagnosed type 2 diabetes (If above 5.6 mmol/L or 100 mg/dL, OGTT is strongly recommended but is not necessary to define presence of the syndrome).

Patients underwent ECG and ergonometric tests, negative for coronary disease.

The exclusion criteria's were: smokers, chronicle arteriopathy of lower limbs, cerebrovascular disease (stroke), coronary disease, diabetes treated by insulin, kidney and liver failure, psychiatric disorders, malignancies, consumption of alcohol per day over 30gr. The method of assessing the endothelial dysfunction was flow mediated vasodilation. We measured the flow-mediated dilatation (FMD) of the brachial artery (endothelium dependent vasodilatation) on B-mode ultrasound images, with the use of a 10 MHz linear-array transducer in terms of fasting for 8 hours.

The vascular diameter in systolic and diastolic longitudinal plane was measured guided by the principle of "leading-edge", followed by determination of basal medium velocity by pulse Doppler (average of at least 3 determinations). To obtain stimulated blood flow in the brachial artery is placed the sphygmomanometer antecubital at the forearm. After recording the basal velocity average, the sphygmomanometer cuff was swollen above the systolic blood pressure (usually over 50 mmHg) for 5 minutes, to achieve brachial artery ischemia. Dilation of the resistance vessels downstream through the mechanism of self sudden deflation of the cuff increased the blood flow in brachial artery (active hyperemia) and the shearing stress at this level with consecutive dilation of the brachial artery. The maximum velocity was measured by pulse Doppler in first 15 seconds of cuff deflation and maximum diameter of the brachial artery was determined at 45-60 seconds post hyperemia. The brachial artery diameter was measured in the same

cardiac cycle to avoid variations caused by arterial compliance (7,9,10). Endothelial dysfunction was diagnosed if flow-mediated dilatation was less than 10%.

A group of 38 patients from the 116 participants underwent a program of moderate physical activity over a six months period of time.

The following recommendations have been made: patients were subjected to an aerobic physical training program, at least 5 times/ week, with the intensity of training at the maximal heart rate of 135-140 b/min. The training sessions were of 30 minutes. Each training program was preceded by a period of 10 min warm-up exercises for the upper and lower limbs, at a maximal heart rate 20 beats/min higher than the heart rate at rest.

The recommended physical activities were: walking briskly or walking on the slope on treadmill, jogging, cycling, swimming, aerobic dance exercises, racket sports.

Results

The characteristics of the subjects enrolled in this study are presented in table I.

The patients who underwent the program of physical activity had lower values of glycemia (112.54 mg/dl \pm 21.36) and abdominal waist (108.45 cm \pm 9.10) than the sedentary group of participants (glycemia 117.11 mg/dl \pm 26.24 and abdominal waist 118.39 cm \pm 9.32).

After adjustment for covariates the mean FMD was 3.15% \pm 5.85 by the patients with MetS without physical activity and the mean FMD by patients with MetS who underwent moderate physical activity was 6.86% \pm 5.06 with a p ANOVA < 0.001 (Table II) (figure 1).

Table I. Characteristics of the study group

Parameters	Men (mean ± SD)	Women (mean ± SD)
Number	75	41
HDL	38.27 ± 9.64	43.39 ± 12.42
Triglycerides	204.09 ± 132.04	172.45 ± 76.79
Glycemia	128.20 ± 42.45	137.51 ± 55.55
Abdominal waist	113.10 ± 11.67	114.22 ± 14.50
BMI	31.93 ± 5.24	34.05 ± 5.89
FMD%	4.96 ± 6.55	6.61 ± 7.20

Table II. Endothelial dysfunction in patients with MetS

Parameters	Patients with moderate physical activity (n=38)	Patients without physical activity (n=78)	p
FMD%	6.86 ± 5.06	3.15 ± 5.85	<0.001

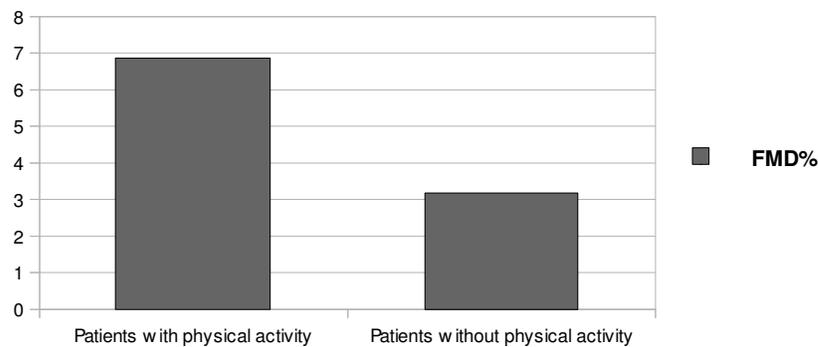


Figure 1. Endothelial dysfunction in patients with MetS

Discussions

In our study the patients subjected to a moderate physical activity program presented an improvement in endothelial dysfunction. Moreover, the subjects included in this study didn't benefit of a strict diet and of supplementary pharmacological methods. This endothelial dysfunction may be an attractive primary target in the effort to optimize individualized therapeutic strategies to reduce cardiovascular morbidity and mortality.

In literature high-intensity exercise training is more beneficial than moderate-intensity exercise training for reducing cardiovascular risk at rats with the metabolic syndrome so further studies are needed to develop a training program that slows or stops, alone or in associations with pharmacological methods, the progression from subclinical to clinical atherosclerotic disease (13).

Conclusion

Patients with MetS have subclinical atherosclerosis with increased endothelial dysfunction present.

A short term moderate physical activity improved the endothelial dysfunction in patients with MetS.

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