Editorial

Is it time to look at the arterial wall for prevention? Anatomy and function by ultrasound beyond flow mediated dilatation

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Unhealthy eating, lack of physical activity, stress and smoke pollution, among other agents, interact on our metabolism and genes, producing molecular changes that determine cellular, tissue and organic alterations, which are at the base of the risk factors for the development of diabetes,[1] cancer[1,2] cognitive impairment and dementia[3] cardiovascular diseases and their complication.[1,4] The possibility of correcting these threats to health opens the hope of comprehensive prevention.

Also in some countries outside the first world, it has been proven that nearly half of the studied adult population has metabolic syndrome of insulin resistance and hypertension, two thirds are overweight or obese and one in eight have diabetes,[5] which are the main risk factors of cardiovascular diseases, cognitive impairment and dementia.[3]

Cardiovascular diseases can have unforeseen complications, which are sometimes their first and serious manifestation: myocardial or cerebral infarction or even sudden death.Population-based cardiovascular risk tables provide guidance in determining risk,[6] but do not determine whether it will occur in a given individual. In less educated and socio economically deprivated populations, the risk could be underestimated in half of the persons.[7]

Atherosclerosis, the most frequent cause of premature and avoidable death, passes for years asymptomatically, with anatomical and functional damage to the arterial walls. The unrepaired damage to our body at the molecular, cellular, tissue and organic levels, which develops throughout life and accelerates towards the fourth decade, determines the rate of aging and predisposes to diseases and their complications.[4] Conventional cardiovascular studies, which are done on a daily basis, such as physical or pharmacological stress studies to detect myocardial ischemia, are of great value in the diagnosis and management of symptomatic diseases, but they do not usually detect atherosclerosis when it is asymptomatic, which it could be the optimal time for prevention.

Ultrasound sonography is safe, non-invasive and can be accessible for prevention studies. In recent decades, non-invasive ultrasound studies of the anatomy and function of the arterial walls have been developed. Its great contribution to risk prediction has been confirmed .[8–17] These studies detect alterations even before the clinical manifestations of the disease.

Endothelial function and arterial stiffness are the main manifestations of arterial function and can be studied non-invasively using ultrasound.

The endothelium is the main stage of the agents that produce oxidative stress and inflammation. Oxidative stress and chronic inflammation, which are present in most chronic diseases, are early associated with endothelial dysfunction (ED). Insulin resistance, the main factor in metabolic syndrome, is considered the metabolic state of inflammation.[18] Endothelial dysfunction is strongly associated with the metabolic syndrome of insulin resistance and also with arterial hypertension.[19]

Flow-mediated vasodilation (FMD) of the brachial artery is an ultrasound technique and the most studied method to determine endothelial function, since it is non-invasive, reproducible, and has a good correlation with prognosis.[8] Endothelial dysfunction can be present very early in a person's life. Endothelial dysfunction is at the base of the development of atherosclerosis[17] and of the main causes of morbidity and mortality from chronic diseases worldwide: diabetes, cardiovascular diseases and cancer. The presence of ED was associated with a higher incidence of diabetes[9] malignant solid tumors[11] cardiovascular disease and total mortality.[10] In cognitively normal older adults, endothelial function determined by FMD was correlated with beta-amyloid peptide, a marker of cognitive impairment.[20] In another study, FMD was worse in people with mild cognitive impairment, vascular dementia or Alzheimer's disease than in controls. A multivariate analysis showed a high predictive value of FMD in the mini-mental state examination score.[21]

The most widely used and studied method to determine arterial stiffness is the pulse wave velocity (PWV) by tonometry, due to its reproducibility and its correlation with cardiovascular prognosis. Pulse wave velocity was worse in people with mild cognitive impairment, vascular dementia or Alzheimer's disease.[22] Two ultrasound methods also allow estimating arterial stiffness, are associated with cardiovascular prognosis, and have a high correlation with PWV by tonometry. One of these ultrasound methods is the determination of PWV by vascular Doppler ultrasound, measuring the transit time of the aortic flow from the origin of the carotid artery to the femoral artery.[23] The other method is cardiac ultrasound and it estimates arterial stiffness by determining the ratio between pulse pressure and stroke volume index.[24,25] Both methods are reproducible, well correlated with PWV by tonometry and with prognosis.[23–25] Cardiac ultrasound bring us the opportunity to search for other factors

that make cardiovascular risk higher: left ventricular hypertrophy[26] and dysfunction[27] wall motion abnormalities[28] atheroma plaques or dilatation of the thoracic or abdominal aorta,[29,30] fat around de heart[31,32] and hepatic steatosis,[33] among others.

The susceptibility to the development of atherosclerosis and its severity can be studied, in its anatomical aspect, within the framework of prevention, by means of carotid ultrasound. The carotid ultrasound of high-resolution with automatic edge detection, determines intima media thickness, carotid diameter, the presence of atheroma plaques, their extension and degree of stenosis. We can thus detect the presence of atherosclerosis, even before it manifests itself as a disease. Subclinical carotid atherosclerosis and its severity are associated with the development of coronary and cerebral cardiovascular disease,[16] the progression of cognitive deficit[14] and mortality.[34,35] It allows estimating the "arterial age"[36,37,38] and monitoring its evolution.[16] The visualization by patients of their subclinical carotid atherosclerosis, detected by carotid ultrasound, can improve adherence to lifestyle modifications and medication.[39] With intensive and personalized treatments, repair can be achieved, with at least partial regression[16] of damage and thus improve "arterial age". The prognostic value of carotid ultrasound for cardiovascular complications was similar to that of the coronary calcium score,[40] which is a method that involves irradiation and may be more expensive.

The previously described ultrasound studies, which noninvasively determine the structure of the arterial wall and its function with a single device, add prognostic value independent of cardiovascular risk factors and classical studies[8-17,25,29,30,34–36,40–42]

It may be useful to deepen the evaluation of cardiovascular risk, in people with intermediate cardiovascular risk, overweight or obesity, metabolic syndrome of insulin resistance or diabetes, obstructive sleep apnea, kidney insufficiency, personal or family history of premature vascular disease or recurrence of cardiovascular events.

Non-invasive ultrasound studies of the arterial wall and its function can determine prognosis, the residual risk despite treatment and thus guide towards the need to increase its intensity or modify it.[41,42] The time has come to look at the arteries by ultrasound for prevention.

Through comprehensive and intensive treatment, the correction of the metabolic profile, endothelial dysfunction, increased arterial stiffness and carotid intima-media thickness, and the regression, albeit partial, of the atheroma plaques can be achieved and thus avoid complications, with improvement in quality and prolongation of life.

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Conflicts of interest

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