# ANGIOSCAN-01 CAPABILITIES IN THE DIAGNOSIS OF EARLY VASCULAR AGING IN METABOLIC SYNDROME

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***ABSTRACT***

*This article describes the angiscon -01 capabilities in the diagnosis of early vascular aging in metabolic syndrome which is an anatomical and pathological condition involving hardening of the vascular wall of the arteries or one or more exchange of this part. The vital method of examination is finger photopletysmography which is usually the first step to detect a degenerative process, and in this article the authors try to maximize the capabilities of diagnosis of a degenerative process like arterial aging and stiffness.*

***Key words:*** *early vascular aging, arterial stiffness, metabolic syndrome, pulse wave velocity.*

## INTRODUCTION

Vascular age was defined as the predicted age in the best fitting multivariable regression model including classical risk factors and treatment and pulse wave velocity, in a subset of the referencevalues for Arterial Stiffness.

-Arterial stiffness describes the rigidity of the arterial wall and it can affect on perfusion and microcirculation of all organs and tissues. Arterial stiffness is primarily determined by structural components of the arterial wall, elastin and collagen in

particular, vascular smooth muscle tone, and transmural distending pressure. Arterial stiffness is a marker of vascular disease and a risk factor for cardiovascular morbidity and mortality in adults is gaining support, and the role of arterial stiffness in the development of cardiovascular disease is increasingly emphasised. These kind of risk factors may be increase in metabolic syndrome. Metabolic syndrome is the medical term for a combination of diabetes, high blood pressure (hypertension) and obesity. Metabolic syndrome may be diagnosed if you have 3 or more of the following:

- being very overweight or having too much fat around your waist
- high triglyceride levels (fat in the blood) and low levels of HDL (the "good" cholesterol or healthy) in your blood, which can lead to atherosclerosis (where arteries become clogged with fatty substances such as cholesterol)
- high blood pressure that's consistently 140/90mmHg or higher

an inability to control blood sugar levels (insulin resistance)

Especially hypercholesterolemia may lead to early vascular aging by infiltration on the blood vessel.

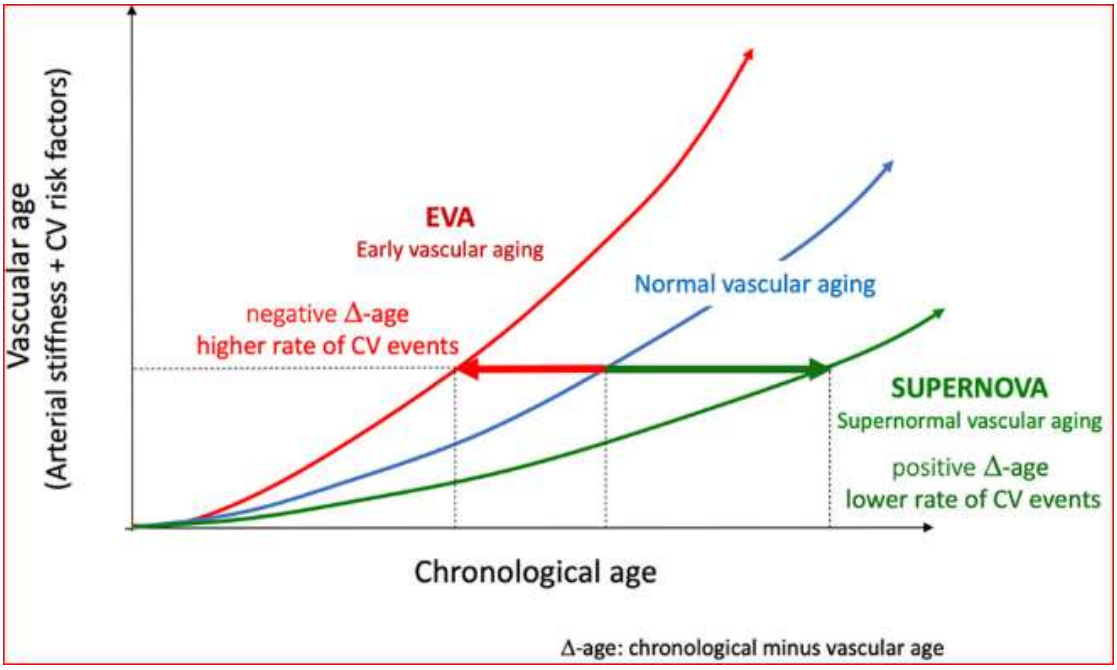
Pulse wave velocity (PWV) is defined as the velocity at which the pressure waves, generated by the systolic contraction of the heart, propagate along the arterial tree. The evaluation of PWV provides complementary information about the elastic properties of arterial system. The higher PWV corresponds to lower vessel distensibility and compliance and, therefore, to higher arterial stiffness. As the mechanical properties of the arterial walls change along the arterial system, from the large arteries to the periphery, PWV is also affected by these changes. The pulse waves travels through the arteries and its velocity depends of the vessel. PWV increases with the distance from the heart, along with the elastic condition of the arterial wall, which is affected by a variety of factors in the pathological process.

Epidemiology

Changes in arterial stiffness are evident in early childhood. In adults, arterial stiffness has been observed to progress at the average rate of 0.2 to 0.7 m/s for every 5 years of life. The state of the science is limited by the small number of studies with repeated measures of arterial stiffness and determinants of arterial stiffness

progression, as well as limited studies in children and diverse race/ethnic groups. Several extant studies suggest that beyond age, cardiometabolic risk factors and adverse lifestyle behaviors contribute to arterial stiffening. Therefore, arterial stiffness is important in the assessment of healthy vascular aging and a possible target for the prevention of subclinical and clinical disease. Evidence for increasing progression of arterial stiffness with age was reinforced by a larger study, the ASMI ( Andijan State Medical Institute, Uzbekistan) study, which measured cfPWV 4 years apart in 1300 men and 760 women with an average age of 62 years at baseline. Study investigators observed a gradient in the 5-year progression in cfPWV with age. Among study participants 55–59 years old at baseline, the 5-year change in cfPWV was 0.18 m/s, increasing to 0.36 m/s in those 60–64 years at baseline, 0.80 m/s in those 65–69 years old at baseline, and finally 0.99 m/s in those 70 years or older.

Classification of vascular aging. Vascular ageing (VA) is a process that can capture the early (generally asymptomatic) features of vascular degeneration. Given that a measure of VA encompasses the cumulative effect of all cardiovascular risk factors on the arterial wall over the life course, compared to more traditional risk factors which may fluctuate in time, a measure of VA may help identify those at elevated cardiovascular risk. The state of the blood vessels begins to lose its natural physiological properties as a person ages as below shown.




If a person does not have additional diseases, blood vessels undergo normal aging (NOVA). We can observe a supernormal vascular aging in people who have

strictly followed the rules of a healthy lifestyle throughout their lives. However, in people with metabolic syndrome, hyperlipidemia, high blood pressure, and high glucose levels cause premature changes in blood vessels and are called early vascular ageing (EVA).

## HISTORY AND SYMTOMS

Back in 2008, Nilsson proposed the concept of "early vascular ageing" (EVA) . It was proposed as a definition of changes in the vascular wall that are not characteristic of a person of a given age and sex, and is a new concept for the study of patients with high CV risk, which include patients with Metabolic Syndrome. Vascular ageis a general integral indicator of the development of many chronic diseases (such as CVD, type 2 diabetes mellitus [DM 2 type] and oncological diseases). In 2019, it was proposed to express very high and very low arterial stiffness in terms of EVA and Supernormal Vascular Aging (SUPERNOVA), respectively .

VA includes a large spectrum of alterations affecting the functional and structural components of the arterial wall irrespective of size, traditionally included in the definitions of atherosclerosis and arteriosclerosis. Arteriosclerosis involves primarily the tunica media and is associated with replacement of elastin fibres with stiffer collagen, destruction of muscle fibres, and formation of calcium deposits in the media. Vessel wall changes lead to an increase in arterial stiffness with an associated increase in premature wave reflections and a decline in the buffering capacity to pulsatile arterial blood flow, which has consequences for cardiovascular health. These include: elevated pulse pressure (PP) and development of isolated systolic hypertension, increased left ventricular afterload, leading to ventricular re-modelling and hypertrophy, diastolic dysfunction, impaired exercise capacity, and, in the long-term, the risk of new-onset heart failure and consequently decrease perfusion in micro-vasculature of target organs. This may be particularly pertinent to organs such as the brain and kidneys which have a high demand for blood flow and, therefore,

have low resistance. The clinical consequences include small artery re-modelling and damage in the brain, kidney and other organs.

## MATERIAL & METHODS

The developed method is based on monitoring the state of arterial function (arterial wall stiffness and the state of endothelial function). For this purpose, optical sensors operating in the near infrared region are used, allowing reliable registration of the pulse wave volume.

The hardware part of the device can be conventionally represented in the form of a specialized two-channel photoplethysmograph. At the same time, during the development of the Angioscan-01 device, the main attention was paid to the qualitative reception of the initial signal. Thanks to the use of optical sensors with a large dynamic range, it became possible to register both the constant component of the signal (DC) associated with the constant optical density of tissues, and the variable component of the signal (AC), mainly the activity determined by the heart (Fig.1). The bandwidth of the photoplethysmograph channel ranges from 0 to 30 Hz. The digitization frequency of the signal is 1000 Hz, this value is determined by the need to measure time intervals with an accuracy of 1 ms. This is especially important when registering the rate of delay (phase shift) of the pulse wave passage during the occlusion test.

## RESULTS

10 studies reporting on photopletysmographyc signs of VA and some systematic reviews related to the evaluation of different treatments were found. Ten different parameters were identified to quantify lumbar spinal stenosis. Most often reported measures for VA were arterial stiffness, pulse wave velocity and lipid spectr of blood. Arterial stiffness describes the rigidity of the arterial wall and its complications. For VA arterial stiffness and rigidity were typically used. Only three of 50 primary studies included in the systematic reviews reported on quantitative measures for defining inclusion criteria of patients in prognostic studies.

## CONCLUSIONS

There is a need for consensus on well-defined, unambiguous photopletysmographyc criteria to define vascular aging in order to improve diagnostic accuracy and to formulate reliable inclusion criteria for clinical studies.

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