

Hemodynamic particularities of the acute coronary syndromes in young patients

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Abstract

Cardiovascular diseases represent the main cause of mortality in the world. The most significant regarding the mortality are the acute coronary syndromes. A matter of current interest is represented by the affection of a great number of young patients, under 45 years, a group of age who should not normally be affected by this disease. The question arises, whether these patients are affected by the process of early vascular aging. Along with it comes the need to understand the mechanisms that lead to these cardiovascular events. The aim of this study was to evaluate the presence of early vascular aging in young patients, the correlation between the arterial stiffness and the presence of coronary atherosclerosis and the correlation between the modification of the hemodynamic parameters in young patients with acute coronary syndromes and the arterial stiffness. For the purpose of this study, we have analyzed two study groups: the SCA group, which comprised 60 patients with ages under 45 years admitted to the Clinical Emergency Hospital Bucharest, Cardiology Department, between 2016 and 2018 with a diagnosis of ACS and the MARTOR group - 60 subjects, similar regarding age and sex categories to the patients in the SCA group, who have been randomly selected from the SEPHAR III study data base. The young patients with SCA, compared to the patients from the MARTOR group, are characterized by hypervolemia, vasoconstriction, high arterial stiffness and significantly higher vascular age compared to their biological age, which can explain the early onset of the coronary atherosclerosis.

Keywords: hemodynamic parameters, acute coronary syndromes, young patients, early vascular aging, arterial stiffness

Introduction

Cardiovascular disease (CVD) is the leading cause of mortality worldwide and in Europe, responsible for

more than 62% of all deaths in Romania. [1] The studies show that more than 1,4 million of death rates are estimated every year in population with age under 75 years [2]. The ischemic heart disease (IHD) is the most significant of the CVD, responsible of more than 20% of total deaths per year [3].

The aim of this study was to evaluate the presence of early vascular aging in young patients, the correlation between the arterial stiffness and the presence of coronary atherosclerosis and the correlation between

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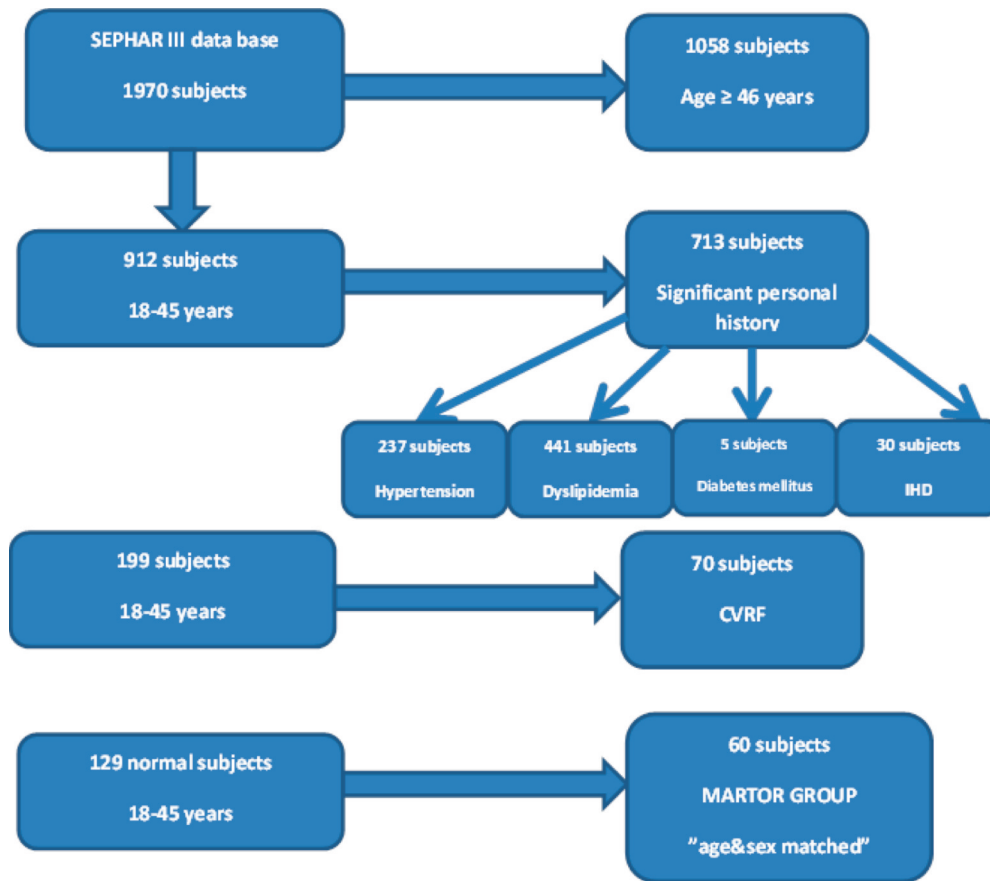


Figure 1. The control group from the SEPHAR III trial database.

the modification of the hemodynamic parameters in young patients with acute coronary syndromes and the arterial stiffness.

Material and Methods

For the purpose of analysing the hemodynamic aspects of the acute coronary syndromes in the young patients, two study groups have been created: the SCA group and the MARTOR group. The SCA group comprised 60 patients with ages under 45 years admitted to the Clinical Emergency Hospital Bucharest, Cardiology Department, between 2016 and 2018 with a diagnosis of ACS. All the patients have been treated with coronary catheterization and they all agreed to take part in this study. Controls were 60 subjects, similar regarding age (under 45 years) and sex categories to the patients in the SCA group, who have been randomly selected from the SEPHAR III study data base, after excluding

the subjects with CV risk factors, current treatment and clinical manifestations of CVD, as seen in the algorithm detailed in Figure 1.

The noninvasive hemodynamic monitorisation was made using the HOTMAN system of hemodynamic monitoring using thoracic electrical bioimpedance to gather hemodynamic data on cardiac index (CI), systolic index (SI), left ventricular stroke work index (LSWI), systemic vascular resistance index (SSVRI), volemia, vasoactivity, inotropy, chronotropy and the hemodynamic status. Arterial stiffness, measured as aortic pulse wave velocity (PWV), and wave reflection, measured as augmentation index (AIx) were measured based on oscillometric pressure curves using the Arteriograph (TensioMed, Hungary).

Statistical analysis

A descriptive analysis (means, medians, standard deviations, and range for continuous data and frequency analysis for categorical data) was performed for

Table 1. General characteristics of the two groups.

Parameter	SCA group Nr. = 60	MARTOR group Nr. = 60	P
Age, mean \pm SD (years)	41.25 \pm 3.99	39.63 \pm 5.85	p = 0.193
Sex, N (%)			
Feminine	18.3	26.7	p = 0.274
Masculine	81.7	73.3	p = 0.274
BMI, mean \pm SD (kg/m ²)	30.02 \pm 5.69	21.23 \pm 2.81	p < 0.001
Personal history	74.2 %	25.8 %	p = 0.002
Glucose levels (ml/dl)	108.87 \pm 34.32	88.33 \pm 6.73	p < 0.001
Dislipidemia			
Cholesterolemia	220.15 \pm 69.64	158.58 \pm 20.68	p < 0.001
Trygliceridemia	176.55 \pm 95.32	62.12 \pm 23.32	p < 0.001
SBP, mean \pm SD (mmHg)	124.90 \pm 18.82	124.60 \pm 12.79	p = 0.919
DBP, mean \pm SD (mmHg)	76.02 \pm 13.40	68.77 \pm 10.38	p = 0.001
MBP, mean \pm SD (mmHg)	92.25 \pm 14.76	87.33 \pm 10.13	p = 0.035

all the target variables. Kolmogorov-Smirnov test was used to analyze continuous data distribution, according to which independent samples t test or Mann-Whitney U test were further used in analysis for differences between means of 2 independent study subgroups and ANOVA or Kruskal-Wallis test were further used in analysis for differences between means of ≥ 3 independent study subgroups. Chi-square test was used to analyze differences between categorical data. Statistical analysis was performed with IBM SPSS Statistics 20.0 software at a significance level of $p < 0.05$.

Results

General characteristics of the two study groups

Based on the two study lots, who have been similar regarding the repartition on sex and age groups, patients from the SCA group were preponderant smokers (56 of the 60 patients were active smokers), dyslipidemic, with personal history of early CVD and with

glycemic values significantly higher than the subjects in the control group, as seen in Table 1.

Etiopathogenic characteristics of the patients with ACS

The main etiopathogenic mechanism of ACS was represented by the coronarian atherosclerotic lesions (46 cases, representing 76.7%, $p < 0.001$) and the most frequent clinical form was the ST-segment elevation myocardial infarction (53 cases, representing 88.3%, $p < 0.001$). This is without discussion the result of the bias of selection of the study group in a tertiary hospital, integrated in the STEMI national program (Figure 2).

Arterial stiffness evaluation

Regarding the evaluation of the arterial stiffness, we can observe clearly that the patients from the SCA study group have significant higher values of the pulse wave velocity (PWV_{ao}) than the control group, with a mean of 9.49 ± 1.92 m/s and a difference from the MARTOR group of 2.87 m/s, $p < 0.001$. Arterial age in

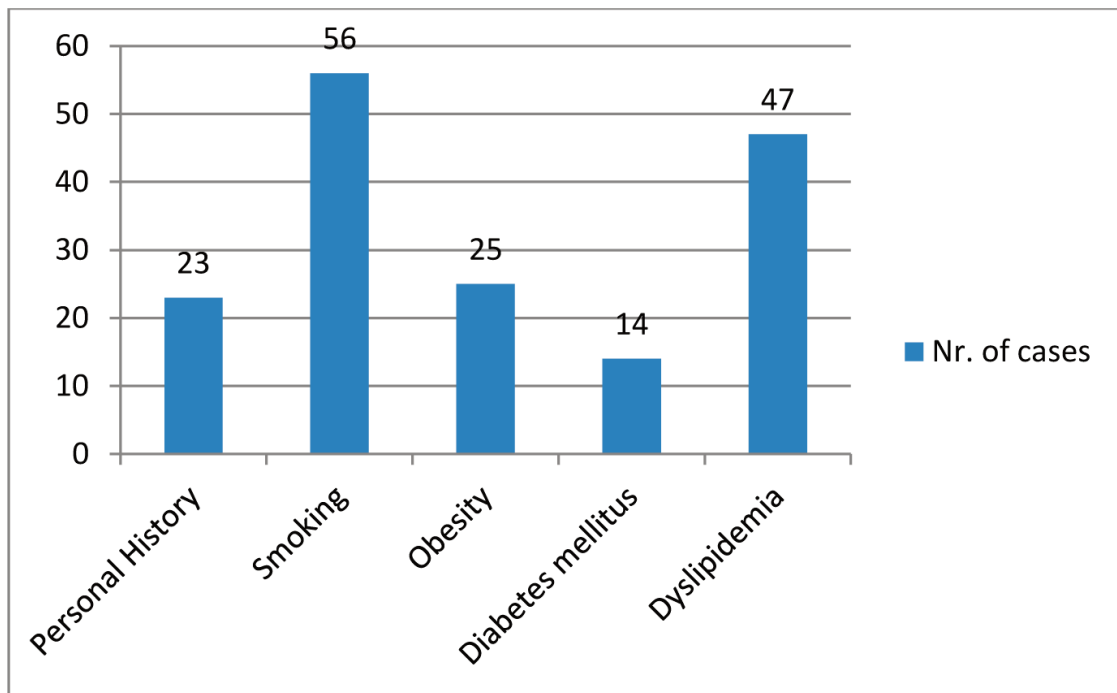


Figure 2. Etiopathogeny of acute coronary syndromes in SCA group.

the SCA group was significantly higher compared to the MARTOR group (6.5 years) and the arterial age was significantly higher than the biological age in pa-

tients from the SCA group, with a mean difference of 5.78 years, compared to the MARTOR group where the two mean ages were approximately equal (mean ar-

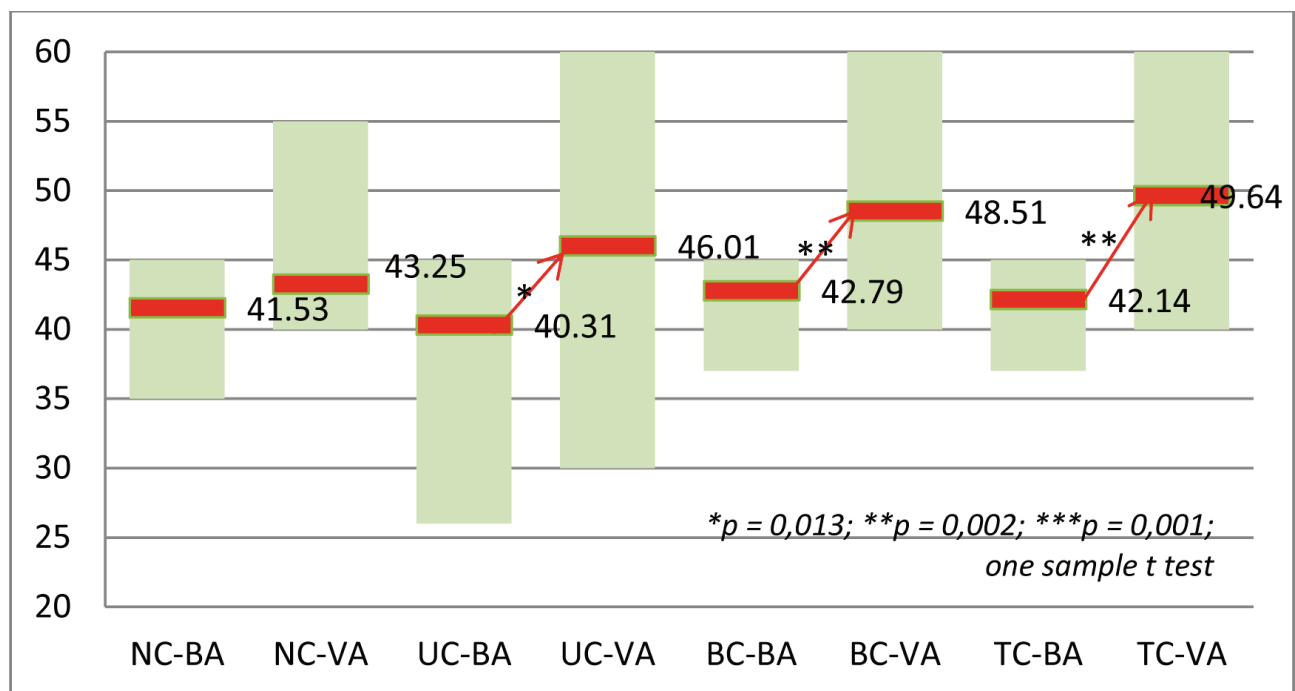


Figure 3. Comparison of vascular and biological age in patients in the SCA group grouped by coronary atherosclerotic damage categories. NC: normal coronaries; UC: uniconary; BC: bicorony; TC: tricorony; VA: vascular age; BA: biological age

Table 2. Noninvasive hemodynamic parameters evaluation.

Parameter	SCA group Nr. = 60	MARTOR group Nr. = 60	P
CI. mean ± SD (l/min/m ²)	3.34 ± 1.31	5.94 ± 1.51	p < 0.001
IS. medie ± DS (ml/beat/m ²)	44.56 ± 15.30	84.64 ± 23.09	p < 0.001
LSWI. mean ± SD (g x m/m ²)	57.31 ± 17.77	93.88 ± 26.67	p < 0.001
SSVRI. mean ± SD (dynxsecxcm-5x m ²)	190.90 ± 65.50	83.81 ± 32.56	p < 0.001

terial age – 40.53 ± 7.79 years, biological age 39.63 ± 5.85 years, p=0.207). Analysing the correlations between the arterial age and the severity of the coronary atherosclerotic lesions, we can observe a strong association, the higher mean values of the arterial age being frequently reported in patients with bi- or trivascular coronary lesions, as the lower mean values of the arterial age being reported in patients with normal coronary arteries ($r_s = 0.512$, $r_s^2 = 0.262$, $p = 0.035$) (figure 3).

Noninvasive hemodynamic evaluation

Comparing the two study groups, we can observe that the mean values of the CI, the SI and the LSWI are statistically significantly lower in the SCA group than the MARTOR group and the mean SSVRI values are statistically significantly higher in the SCA group than the MAROT group, as seen in table 2 below.

The hemodynamic state of the patients in the SCA group shows that they are predominantly normodynamics, most likely the result of the beta-blocking treatment that all patients with ACS receive, while the patients in the MARTOR group are predominantly hiperdynamics, a well-known feature of young age (figure 4).

The hemodynamic modulators evaluated allows us to outline the profile of the young patient with ACS: hypervolemic, with the predominance of vasoconstriction, hypoinotropy and hypochronotropy.

Analysing the relationship between the hemodynamic parameters, arterial stiffness and the severity of the atherosclerotic coronary lesions, it was pointed out that the severity of the coronary lesions was directly correlated to the presence of hypervolemia, vasoconstriction, high arterial stiffness and the vascular age. There is a directly proportional correlation: the atheroscle-

rotic multivascular coronary lesions is frequently associated with the hypervolemic and vasoconstrictive patients, whereas the univascular lesions and the normal coronaries were frequently associated to the patients without these hemodynamic parameters being affected [$r_s = 0.373$, $r_s^2 = 0.139$; $p = 0.042$ in the hypervolemic correlation and $r_s = 0.456$, $r_s^2 = 0.207$; $p = 0.002$ in the vasoconstriction correlation].

The higher mean values of the PWVao are frequently associated to the presence of the vasoconstriction, whereas the lower mean values of the PWVao are frequently associated to the patients without this hemodynamic parameter affected [$r_s = 0.478$, $r_s^2 = 0.228$; $p = 0.003$].

The higher mean values of the PWVao are frequently associated to the presence of the hypervolemia, whereas the lower mean values of the PWVao are frequently associated to the patients without this hemodynamic parameter affected [$r_s = 0.421$, $r_s^2 = 0.169$; $p = 0.035$].

Discussion

The results of this study show that in the young patients presenting with ACS, all the indices of arterial stiffness have been significantly higher compared to the MARTOR group, considered "healthy", proving that the patients in the SCA group are affected by the early vascular aging process.

Of all the indices that quantify the arterial stiffness, the pulse wave velocity (PWV) has been proved to be the best correlated index with the severity of atherosclerotic coronary lesions. Thus, from this point of view, between the patients from the two study groups there

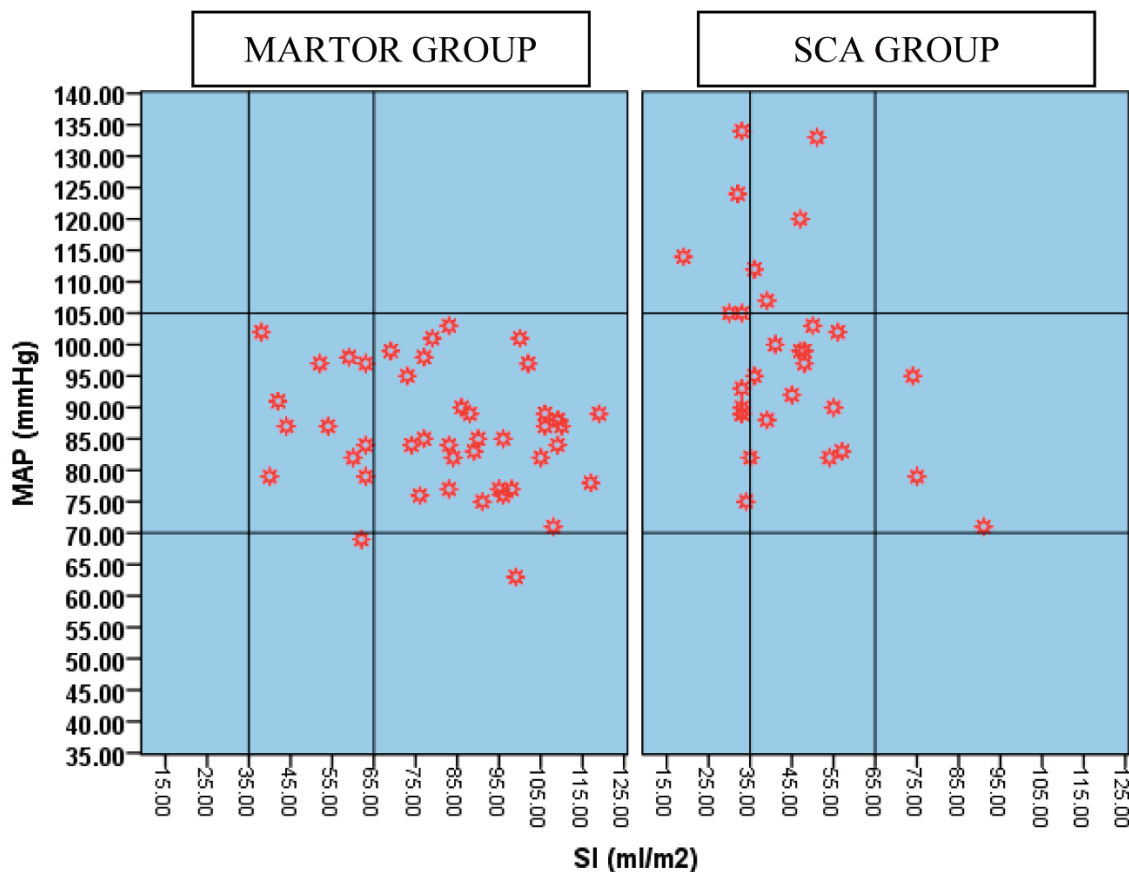


Figure 4. Scattergram showing the distribution of patients in the study group, depending on the hemodynamic status.

is a mean age difference of 5 years in the vascular ages. These high values have been anticipated, being similar to the results of another previous studies [4, 5].

The results of this study affirm the link between the high values of the PWV and active smoking, PWV values being significantly higher in the SCA group, in which all the patients were smokers. This direct association has been proved by Jatoi NA and collabs., who have analyzed the values of PWV in active smokers and non-smokers, the smokers having always higher values. [6]

93.3% of the patients from the study group were active smokers and the other 6.7% were past smokers. The high proportion of the smokers suggests that this risk factor is additionally accelerating the early vascular aging process and the onset of the CVD.

The majority of the patients from the SCA group have personal history of cardiovascular disease, documenting the genetic inheritance of predisposition to an early cardiovascular disease and even early vascular aging.

Compared to the patients from the MARTOR group, the patients from the SCA group are hemodynamically characterized by the hypervolemie, vasoconstriction, high arterial rigidity and a vascular age significantly higher compared to the biological age. A possible pathophysiological connection could be the increased sodium intake – who contributes both to the occurrence of hypervolemia and increased arterial stiffness. The direct connection between the sodium intake and early arterial stiffness is currently studied in our country by professor A. Covic.

The limitations in the statistical analysis of the data should also be taken into account. The small number of patients who were included in the SCA group (60 patients) can represent the cause of the lack of evidence on some differences or statistically significant correlations and it limits the extrapolation of the results to the entire population. Also, in this study there is no analysis on the influence of post STEMI medication on the hemodynamic and arterial rigidity parameters.

Conclusions

In conclusion, based on the results of this study we can suggest that the young patients with SCA compared to the patients from the MARTOR group are characterized by hypervolemia, vasoconstriction, hypoinotropism and hipocronotropism, high arterial stiffness and a vascular age significantly higher compared to the biological age, which can explain the early onset of the coronary atherosclerosis.

The majority of young patients with SCA have personal history of CVD, which suggests a predisposition to an early onset of CVD. The high proportion of smoking patients suggests that this risk factor is additionally affecting the early vascular aging process and the onset of CVD.

Documenting the presence of increased arterial stiffness through all evaluation parameters proves that these patients are undergoing a process of early vascular aging.

The presence of hypervolemia and vasoconstriction in this category of patients, correlated to the high arterial stiffness suggests that the hemodynamic changes are in fact the consequence of the early vascular aging. A possible explanation could be the high sodium intake.

Smoking cessation, reducing salt intake, sugar, and atherogenic fat, along with drug therapy that normalizes both the hemodynamic profile and arterial stiffness may be an optimal therapeutic strategy to prevent ACS in young patients.

Conflict of interests (financial or non-financial)

The authors confirm that there are no conflicts of interest.

List of abbreviations used

ACS = acute coronary syndromes; CVD = cardiovascular disease; IHD = ischaemic heart disease

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