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Multispiral Computed Tomography as a Universal Screening Method for Stable Coronary Artery Disease and Non-Coronarogenic Heart Diseases

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Abstract.

Coronary bed condition in patients with different clinical forms of ischemic heart disease and painless myocardial ischemia was investigated in order to visualize atherosclerotic changes in coronary vessels during screenings.

The results of multispiral computed tomography in 29 patients with different forms of coronary arteries disorders (stable coronary artery disease, unstable angina, painless myocardial ischemia) and in patients without severe coronary symptoms were analyzed in order to determine “calcium score” as a marker of atherosclerotic coronary vascular disease. Relation between the degree of increase in the coronary calcium score (CCS) (particularly in patients with hypertensive crisis in case history) and basic cardiodynamic characteristics was observed in patients with increased CCS. Reliable correlation between CCS and aortic stiffness index ($r=0.82$; $p\leq0.01$), between CCS and pulse pressure ($r=0.63$; $p<0.05$).

Problem statement and analysis of the recent research

Coronary artery disease (CAD) constitutes 67.6% in the structure of mortality due to cardiovascular diseases in adults in Ukraine (54.5% of them are the working age population) and is a major cause of disability [4]. Early diagnosis of stable coronary artery disease (SCAD) is important for timely patients' treatment, prevention of severe complications and mortality reduction [2,3]. In this regard, radial diagnostics becomes increasingly relevant. It allows visualization of atherosclerotic changes in coronary vessels during screenings [1,6]. Coronary calcium score (CCS) obtained during multispiral computed tomography (MSCT) provides an opportunity to assess the risk of atherosclerosis destabilization and development of fatal and nonfatal cardiovascular events [5].

The objective of the research was to evaluate coronary bed condition using MSKT, to verify and visualize atherosclerotic changes in coronary vessels and to complement regional clinical protocol of care for patients with stable coronary artery disease.

Materials and methods of the research

29 patients (12 women and 17 men) at the age of 38-82 were involved into the research. 16 patients were diagnosed with CAD (10 individuals with SCAD and 6 persons with unstable angina). 7 out of 13 other patients did not have severe coronarogenic symptoms (Agatston score<400 units). Non-anginal chest pain was observed in 6 patients. MSCT was performed with the use of 160-slice dynamic volumetric 4-D computed tomography scanner Toshiba Aquilion Prime in the radiology department at Ivano-Frankivsk Central City Clinical Hospital (the Head Doctor – T.R. Masliak, the Head of the Radiology Department – I.M. Sokolovskyi).

The obtained data were analyzed according to the standardized quantitative estimation system of coronary calcification based on X-ray absorption coefficient and calcification area (mm2) with the count of special index "Score". During the data processing the results of coronary calcification were expressed by means of coronary calcium score (CCS). General CCS was calculated as the sum of indices on all tomographic slices. Patients' blood pressure measured in the morning and in the evening was also taken into account. Pulse pressure (PP) was determined as a difference between systolic blood pressure (SBP) and diastolic blood pressure (DBP). Aortic stiffness index was defined as ratio part between PP and stroke volume (SV) according to ultrasound examination of the heart (PP/SV, millimeters of mercury/ml).

Statistical processing of the results was performed with the use of software, namely spreadsheet "Microsoft Excel" and application package "Statisticav.8" (StatSoft, USA). Probability of average values difference was determined using paired Student's t-test. Correlation analysis was performed with the calculation of Pearson correlation coefficient "r".

Results of the research and their discussion

Coronary calcification of different severity was confirmed in 23 (79%) out of 29 patients while data processing with the use of "Smart score". In the process of CCS analysis by A. Agatston method (1990) [7], indicators of coronary calcification from 2 to ≥ 460 units were detected. Taking into account these values, coronary calcification indicators were distributed into 4 groups: normal (1-10 units), moderate (11-100 units), average (101-400 units) and high coronary risk (>400 units Agatston). In addition, normal CCS level was observed in 30% of patients (I degree calcification), moderate one was found in 22% of patients (degree II), average on was detected in 35% of patients (degree III), high level of coronary calcification was defined in 13% of patients. Coronary calcification symptoms were not detected in 6 out of 7 patients with without symptomatic CAD.

Quantitative analysis of calcification in coronary arteries provided an opportunity to objectify the detection of atheromatous plaques in the vessels of coronary bed (Fig. 1).

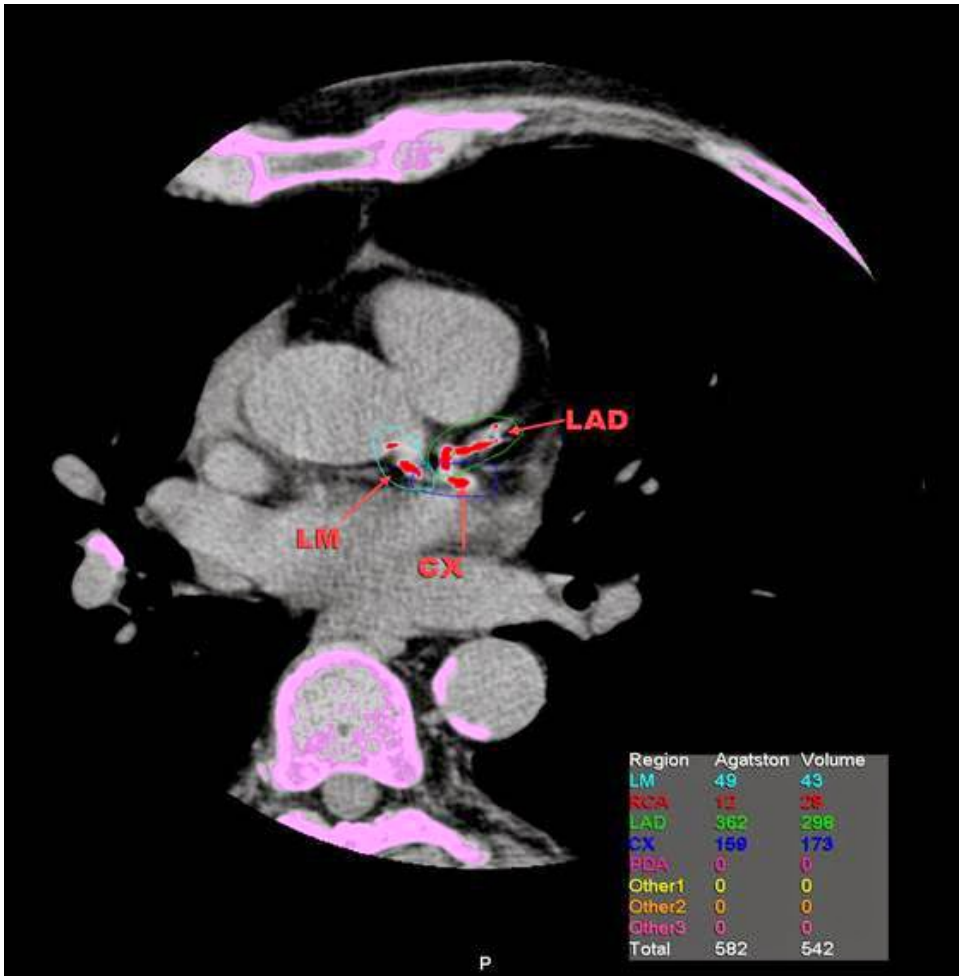

Fig. 1. Calcification in the coronary bed vessels

The study of disease location detected signs of left main coronary artery (LMCA) calcification in 6 (26%) individuals, calcification of anterior interventricular branch (AIVB) of left coronary artery (LCA) in 8 (35%) patients, three coronary arteries (LMCA, AIVB of LCA, right coronary artery) calcification in 9 (39%) persons. SCAD destabilization was most frequently observed in patients with AIVB of LCA disease ("artery of sudden cardiac death") and three vessels damage as well as critical left main coronary artery stenosis. Taking into account patients' age characteristics, natural increase in CCS indicators in the affected coronary arteries was determined in individuals at the age of over 50 (mostly in men - 82%). Increased CCS was observed in 1 patient at the age of under 40 (5.8% of men), in 6 patients at the age of under 50 (11.7% of men), in 16 patients at the age of over 50 (14 men, 2 women) (Fig. 2).

Conclusions

1. Multispiral computed tomography with coronary calcium score provides an opportunity to single out patients with coronary artery atherocalcinosis, to establish the risk of fatal coronary events in patients with a level of CCS>400 units.
2. Coronary calcium score increases with age, in cases of coronary blood flow destabilization, which is important for the prediction of cardiovascular events (the development of acute coronary syndromes, transient ischemic attacks).
3. Due to its capacity, multispiral computed tomography should be considered a screening method for stable coronary artery disease and non-coronarogenic heart diseases.

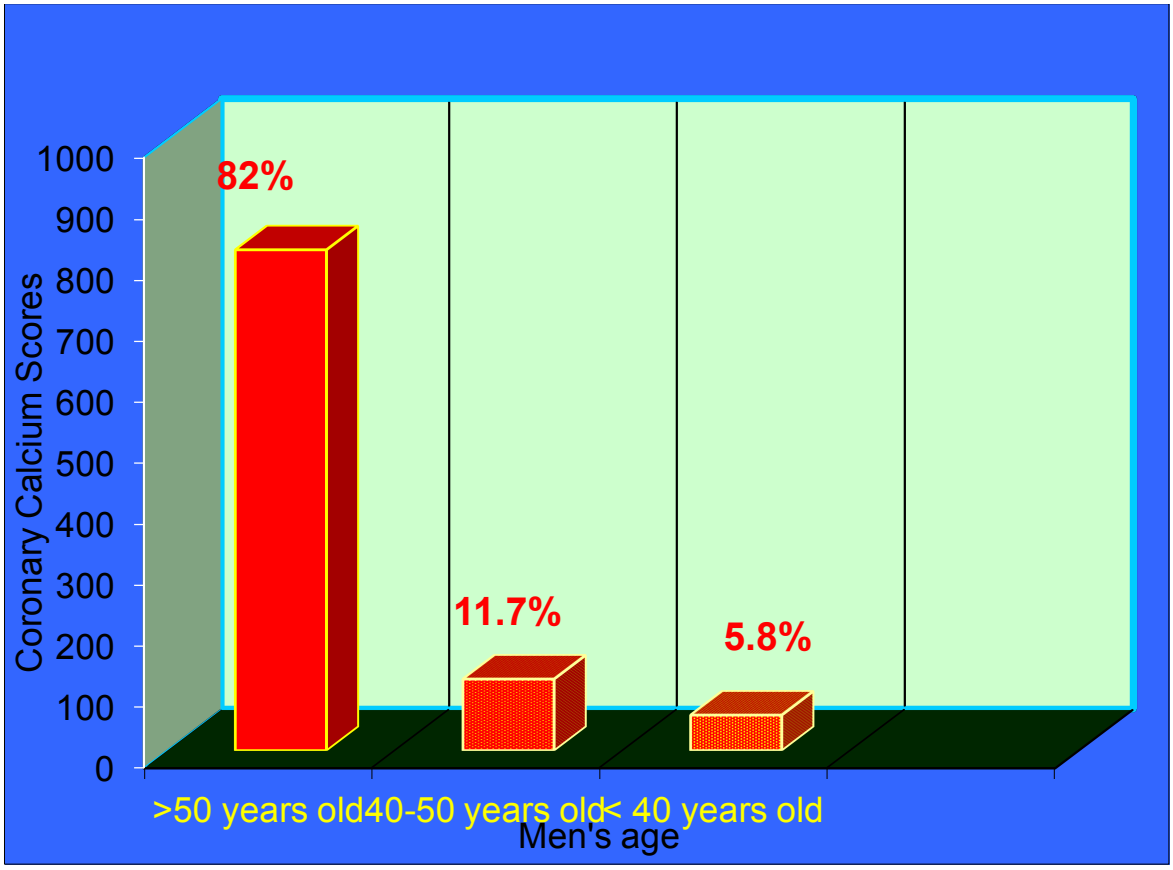

Fig. 2. The dependence of CCS increase rate on the patients' age (men).

Prospects for further research

Further research involves the second stage of MSCT therapeutic efficacy investigation aimed at verification of ischemic myocardial injury area and visualization of fraction coronary reserve before and after the application of different myocardial revascularization strategies: thrombolytic therapy (Metalyse) (TLT), TLT with further percutaneous coronary intervention (PCI) and infarct-dependent coronary artery stenting (TLT + PCI with stenting and coronary artery bypass surgery using autoarterial mammary coronary bypass and autovenous aortocoronary bypass.

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