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Coronary Angiography by CT Accuracy for the Chronic Coronary Disease Diagnosis

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Abstract: ***Objective: The main cause for ischemic heart disease is the coronary atherosclerosis (1,2). The positive diagnosis for stable ischemic heart disease starts with the probability of obstructive coronary atherosclerotic. This study sought to investigate the clinical, biological and imaging characteristics associated with diagnostic accuracy of detecting obstructive coronary artery disease defined by coronary angiography result. Methods: We screened patients underwent angiography by computed tomography. Thru the post processing analysis we obtain the Agatston calcium score, the presence, the magnitude and the localization of significant atherosclerotic coronary lesions. Results: We enrolled 133 patients. The calcium score and the presence of atherosclerotic coronary lesions was significantly different between men and woman. The presence of any isolated cardiovascular risk factor wasn't associated with atherosclerotic coronary artery disease, but all the three available scores of prediction had positive correlation with the calcium score and the presence of the coronary lesions. Conclusions: The best method to predict the presence of coronary atherosclerotic lesions was the Canadian Society of Cardiology Probability Score, which has the most complex pretest evaluation taking into consideration several cardiovascular risk factors. Elevated calcium score and the number of atherosclerotic coronary involvement at the angiography by computed tomography correlated with performing coronarography, with the positive diagnosis at invasive angiography and with angioplasty and stent placement. Evaluation thru angiography by computed tomography is an accurate method, and should be used for patients with medium-high pretest probability of ischemic heart disease and not for patients with isolated cardiovascular risk factors.***

Keywords: atherosclerosis, myocardial ischemia, calcium score.

1. Structured Abstract

Ischemic heart disease is the main leading cause of death worldwide, responsible for 16% of the world's total deaths (1). The main cause for ischemic heart disease is the coronary atherosclerosis (1, 2). The positive diagnosis for stable ischemic heart disease starts with the probability of obstructive coronary atherosclerotic. This study sought to investigate the clinical, biological and imaging characteristics associated with diagnostic accuracy of detecting obstructive coronary artery disease defined by coronary angiography result. We screened patients underwent angiography by computed tomography. Thru the post processing analysis we obtain the Agatston calcium score, the presence, the magnitude and the localization of significant atherosclerotic coronary lesions. The best method to predict the presence of coronary atherosclerotic lesions was the Canadian Society of Cardiology Probability Score. Elevated calcium score and the number of atherosclerotic coronary involvement at the angiography by computed tomography correlated with performing coronarography, with the positive diagnosis at invasive angiography and with angioplasty and stent placement. The presence of any isolated cardiovascular risk factor wasn't associated with atherosclerotic coronary artery disease.

2. Introduction

Ischemic heart disease is the main leading cause of death worldwide, responsible for 16% of the world's total deaths (1,2). Since 2000, the largest increase in deaths has been for this disease, rising by more than 2 million to 8.9 million deaths in 2019 (2).

The main cause for ischemic heart disease is the coronary atherosclerosis (3–5). The unstable ischemic heart disease has usually a clinically marked resonance, manifested by acute coronary syndromes (1). Meanwhile the stable coronary artery disease presented as chronic coronary syndromes, shows clinical variability and often atypical symptoms, this leading to the underdiagnosis of the myocardial ischemia (1, 6, 7). Moreover the severity of atherosclerotic loading of coronary arteries is not always a positive correlation with the symptoms intensity (5, 8, 9).

The positive diagnosis for stable ischemic heart disease starts with the probability of obstructive coronary atherosclerotic disease which is determined by the prevalence of the disease in the studied population, modified by clinical features of an individual patient (9–11). There are many score models of estimation of the pretest probability and clinical likelihood of coronary artery disease in order to choose the most appropriate invasive or non-invasive diagnosis method (1, 6, 7). The European predictive model of the pretest probability is based on data gathered by Genders et al, which is an updated data from the Diamond and Forrester model and includes age, sex, and nature of symptoms (1, 6,7). In addition to these factors the NICE (National Institute for Clinical Excellence) Clinical Guideline 95 score takes into consideration the presence of others cardiovascular risk factors like the total cholesterol value (7). Moreover the Canadian Cardiovascular Society guidelines promote the estimation of obstructive atherosclerotic coronary lesions based on several factors like chest pain features, gender, age modified by different associated conditions as diabetes mellitus, hypertension, dyslipidemia (6). Ischemic heart disease non-invasive diagnosis can be established by detection of provoked myocardial ischemia (reflected by electrocardiographic changes during a stress test) or new regional wall motion abnormalities but also by identifying anatomical coronary artery stenosis using tomography with contrast or new technics like magnetic resonance and positron emission tomography (1,12). When selecting the best initial test for, clinicians may consider patient characteristics, potential contraindications to testing, limitations of each modality, local availability, and local expertise (1, 13).

Angiography by computed tomography is non-invasive method with high diagnostic performance for the detection and extension of coronary atherosclerosis. Angiography by computed tomography (ACT) has been included in American and European recommendations as a valuable noninvasive option in the diagnostic evaluation of patients having low-to-intermediate probability for coronary artery disease (1,6,7,14,15). This study sought to investigate the clinical, biological and imaging characteristics associated with diagnostic accuracy of detecting obstructive coronary artery disease defined by coronary angiography result.

3. Methods

a) **Study population:** We screened patients underwent angiography by computed tomography assessment in our

center between November 2016 and July 2019, in a retrospective analysis. Patients with complete 2D transthoracic echocardiography evaluation, medical personal history information and blood samples results were included in the study. The study protocol was approved by the Ethics Committee of our center (ethics committee decision number: 6881/01.10.2021) and complied with the Declaration of Helsinki (16). Exclusion criteria were the history of contrast allergy, history of or contrast-induced nephropathy, tachyarrhythmia, second/third-degree atrioventricular block, severe aortic stenosis, body-mass-index of over 40 kg/m2.

b) **Angiography by computed tomography assessment:** All images were acquired using a commercially available computed tomography scanner (Aquilion 64, Toshiba Medical Systems, Tochigi, Japan). Thru the post processing analysis we obtain the Agatston calcium score, the presence, the magnitude and the localization of significant atherosclerotic coronary lesions. An Agatston calcium score of 100 to 300 means moderate plaque deposits**,** while a score greater than 300 is a sign of very high to severe disease and heart attack risk. Regarding the magnitude of the atherosclerotic lesions, each segment was interpreted visually and the severity of lumen narrowing was scored, then rated semi-quantitatively into 5 groups: normal (no luminal stenosis), minimal (< 25% stenosis), mild (25% - 49% stenosis), moderate (50 - 69% stenosis), severe (70% - 99% stenosis) and occluded (10,12,15,17). Moreover thru the ACT evaluation we obtained also structural and functional left ventricle data as: end systolic and end diastolic left ventricle volumes (ESV, EDV), left ventricle ejection fraction (LVEF-CT), myocardial mass, stroke volume and cardiac output.

c) **Echocardiography analysis:** Patients included in the present study were evaluated by 2D transthoracic echocardiography using a 2012 HITACHI-ALOKA ProSound Alpha 7 Ultrasound Machine in Lublin, Poland. We involved in our study echocardiographic information like: left ventricle ejection fraction – 4 chambers modified Simpson, wall contractility disturbance, the presence of valvulopaties.

d) **Blood sample analysis:** In the final analysis were included also biological results from blood samples collected in the same day with the ACT assessment. Thus we obtain information from the full blood count (hemoglobin, platelets number), low density lipoprotein (LDL), high density lipoprotein (HDL) and triglycerides values.

e) **Statistical analysis.** Continuous variables unless otherwise stated are reported as medians with interquartile ranges and compared using the Kruskal-Wallis test. Categoric data are presented as counts and percentages with comparisons conducted by the Pearson chi-square or Fisher exact test. Continuous variables were described as means +/- standard deviation.

4. Results

A) Study population

We enrolled 133 consecutive pts with a mean age of 56 +/- 13 years, 39% males. The main indication of evaluation by ACT was atypical angina (71 pts, 53%). 26% (34 pts) of the group hadn't any type chest pain neither shortness of breath but presented several cardiovascular risk factors, whereas 16% (21 pts) had typical angina and 5% (7 pts) present only dyspnea physical effort related.

B) ACT results

The calcium score and the number of affected vessels according to the ACT result was higher in men compared to women, while there were no differences by gender for the total cholesterol and LDL cholesterol values, neither for the positive personal history of hypertension, diabetes mellitus, obesity. The mean calcium score was significantly different by gender, women had a mean score of 66+/-21 while men had a mean calcium score of 357+/-100, $p<0.001$. The calcium score was above 100 for 5% (7 pts) of the group participants while a high value, above 300 was identified in 15% (20 pts). Regarding the number of affected vessels, thru the ACT were diagnosed with significant (>50%) stenoses 20% (27) patients at the left anterior descending artery, 12% (16 pts) at the circumflex artery and 12% (16 pts) for the right coronary artery. Invasive coronarography was performed for 10 patients (7.5%), and for 9 (6.8%) of them was made angioplasty with stent implantation.

C) Independent association between patient-level factors and ACT diagnostic accuracy

Their three scores of probability for ischemic heart disease had a positive correlation with the calcium score and the number of affected vessels. The calcium score was significantly correlated with the Canadian score $p<0.001$, $r=0.4$, but also with the NICE score having a correlation coefficient of 0.3, $p=0.001$ and with the European score with $r=0.2$, $p=0.009$. Regarding the study of independent cardiovascular risk factors the best correlation with the calcium score was for the hypertension $r=0.2$, $p=0.007$ whereas the number of affected vessels was best related with the personal history of dyslipidemia. The calcium score was not influenced by isolated factors like personal history of smoking, dyslipidemia, obesity or autoimmune diseases. The diagnosis of coronary stenoses of over 50% on the right coronary artery, left anterior descending artery, circumflex artery was significantly associated with a calcium score of over 400. Moreover, a calcium score value over 400 was significantly correlated with conducting a coronarography and also with performing angioplasty and stent placement. Also the result regarding number of affected vessels at ACT compared with invasive coronarography had a positive correlation ($r=0.653$, $p<0.001$).

5. Discussion

Atherosclerotic coronary artery affectation is the main leading cause for ischemic heart disease which remains the main cause of mortality and morbidity all over the world**.** The higher incidence for men of the ischemic heart disease is maintained, according to the latest prevalence data and is confirmed also in our analysis. Even if the suspicion and the clinical pre-test probability of ischemic heart disease has no differences by gender, the atherosclerotic coronary affectation is confirmed with a higher rate in men. Recommendation of the American and European cardiology societies put the diagnosis of chronic coronary syndromes thru ACT as the first stage of evaluation in patients with low to moderate pre-test probability. There are three main clinical scores for establish a pre-test probability that might

be used in order to in order to choose the most appropriate diagnosis method (1,6,7). All of the three scores take into consideration the presence of cardiovascular risk factors and the symptoms specificity but the most complex is the Canadian one by integrating the typical angina features and many cardiovascular risk factors (6). In our study also the strongest association between the suspicion of atherosclerotic coronary artery disease and its confirmation thru the ACT result was made thru the Canadian model of prediction. Regarding the presence of symptoms, the majority of the included patients had atypical angina. Among this group, with typical angina, we obtain the highest calcium score compared with the rest of the patients (no symptoms, isolated typical angina or dyspnea). Thus we can conclude that isolated specific symptomatology for myocardial ischemia and heart failure didn't correlate with the presence of atherosclerotic coronary artery disease. Even if the number of the patients with personal medical history of arterial hypertension had a weak positive correlation with the calcium score at the ACT, we didn't obtain any other strong statistical correlation between isolated cardiovascular risk factors and presence of coronary atherosclerotic disease confirmed by ACT. Therefore ACT is not indicated as a screening method for coronary artery disease with isolated cardiovascular risk factors or specific symptoms, but is an adequate diagnosis method for those with moderate to high probability of ischemic heart disease according to the current risk scores of probability.

6. Study Limitations

One important limitation of our study is the small number of subject included in the analysis. However the stated hypotheses have statistical significance and starting with the present analysis it can be developed further investigation. Another important limitation is related to the lack of information regarding the comparison of the ACT result with invasive coronarography for the entire included group or another investigation.

7. Conclusion

According to the results of our study, the best method to predict the presence of coronary atherosclerotic lesions was the Canadian Society of Cardiology Probability Score, which is taking into consideration many parameters like the presence of typical angina associated with several other conditions like dyslipidemia, diabetes mellitus, and hypertension. Elevated calcium score and the number of atherosclerotic coronary involvement at the ACT correlated with performing coronarography, with the positive diagnosis at invasive angiography and with angioplasty and stent placement. The presence of any isolated cardiovascular risk factor wasn't associated with atherosclerotic coronary artery disease.

Conflict of interest: None

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