SECTION 8. ELECTRONICS AND TELECOMMUNICATIONS

DOI https://doi.org/10.30525/978-9934-26-612-6-12

POSSIBLE USE OF RADIATION IMAGING IN ISCHEMIC HEART DISEASE

МОЖЛИВЕ ВИКОРИСТАННЯ ПРОМЕНЕВОЇ ВІЗУАЛІЗАЦІЇ ПРИ ІШЕМІЧНІЙ ХВОРОБІ СЕРЦЯ

Mospan D. V.
Candidate of Engineering Sciences, Associate Professor, Associate Professor at the Department of Computer Engineering and Electronics, Kremenchuk Mykhailo Ostrohradskyi National University Kremenchuk, Poltava region, Ukraine

Мосьпан Д. В.
кандидат технічних наук, доцент, доцент кафедри комп'ютерної інженерії та електроніки, Кременчуцький національний університет імені Михайла Остроградського м. Кременчук, Полтавська область, Україна

Kokolii N. A.
Master's Student at the Department of Computer Engineering and Electronics, Kremenchuk Mykhailo Ostrohradskyi National University Kremenchuk, Poltava region, Ukraine

Коколій Н. А.
магістрант кафедри комп'ютерної інженерії та електроніки, Кременчуцький національний університет імені Михайла Остроградського м. Кременчук, Полтавська область, Україна

Koval D. K.
Master's Student at the Department of Computer Engineering and Electronics, Kremenchuk Mykhailo Ostrohradskyi National University Kremenchuk, Poltava region, Ukraine

Коваль Д. К.
магістрант кафедри комп'ютерної інженерії та електроніки, Кременчуцький національний університет імені Михайла Остроградського м. Кременчук, Полтавська область, Україна

Intravascular ultrasound is rarely used in domestic cardiology. When conducting it, a miniature ultrasound probe is used, placed on a coronary catheter. The signals obtained according to different acoustic impedances are

reconstructed into a layer-by-layer image in real time [1]. In this case, it is possible to clearly determine two boundaries in the coronary arteries: the blood-intima boundary and the external elastic membrane. The specified method allows for a morphological assessment of the features of atherosclerotic coronary plaques: to identify «soft» plaque, fibrous, calcified, necrotic and lipid components. Thus, the specified diagnostic method allows for a clear visualization of the vascular wall and calculation of the remodeling index [1]. The available results of clinical studies demonstrate its possibilities in assessing the effectiveness of drug therapy [2].

Coronary angiography is the most frequently used method in domestic cardiology practice using a radiopaque substance against the background of X-ray radiation, which allows identifying changes in the caliber of coronary arteries (stenosis/occlusion or aneurysm). This method, which is the «gold standard» for diagnosing myocardial ischemia, allows verifying coronary artery disease, as well as determining which option for further tactics can be chosen in each case: drug therapy or revascularization manipulation (balloon angioplasty with stenting or coronary artery bypass grafting). This method is the standard for assessing the actual coronary lumen and measuring intracoronary pressure to identify functionally significant stenoses and calculate fractional blood flow reserve. Coronary angiography is an invasive method, but it provides less convincing results regarding prognostic value [3]. It should be noted that the disadvantage of this diagnostic method is the inability to assess the condition of the vascular wall, which is quite important information, since ischemic heart disease is primarily a pathology of the vessel walls, and not a disease of its lumen.

It is in connection with the possibility of assessing the condition of the vascular wall and the need to verify ischemic heart disease that in the last 10 years, contrast-enhanced computed tomography, which is a non-invasive method for assessing the condition of the coronary arteries, has become increasingly widespread. The method is unique due to the possibility of obtaining comprehensive information about the morphology of the heart and the state of coronary circulation in a single study [4, 5].

Currently, cardiac CT is performed on modern multi-slice tomographs with multiple parallel rows of detectors (from 64 to 320), which have high temporal and spatial resolution. In tomographs of the latest generations with 320 rows of detectors and the use of mathematical technologies for obtaining 640 slices, it is possible to perform volumetric tomography of a 16-centimeter area of interest along the Z axis in one tube revolution. Such systems allow capturing the entire heart area in one cardiac cycle, which leads to a reduction in motion artifacts associated with changes in heart rate [6, 7]. Accurate qualitative and quantitative assessment

of the lumen of the artery, the vessel wall, as well as the weight and composition of the atherosclerotic plaque are the capabilities that this method provides when using modern equipment [7].

Currently, CT is a modern effective method for detecting atherosclerosis of the coronary arteries at an early, pre-clinical stage of the disease. The first stage is a native examination of the heart, which makes it possible to assess the degree of coronary calcification with the determination of the coronary calcium index. Detection of coronary artery calcification clearly indicates the presence of coronary atherosclerosis in the patient. Quantitative assessment of the degree of coronary calcification allows assessing the localization and severity of the lesion, as well as the risk of hemodynamically significant stenoses. Data on the presence and severity of coronary calcification should be correlated with the results of clinical examination, laboratory methods, as well as additional diagnostic methods [5].

Coronary artery calcification is always associated with the presence of an atherosclerotic process. Data from numerous histological studies indicate that atherosclerotic calcification develops from the second decade of human life, almost immediately after the stage of fatty plaque formation. The frequency of detection and the degree of severity of coronary artery calcification inevitably increase with age.

Currently, this method allows to detect coronary calcium deposits and to assess vascular stenosis using the Agatston index. This is a cumulative index that takes into account calcium aggregates over the entire area of the vessel, and not only in specific atherosclerotic plaques [4–7]. This indicator is very important, since it is mainly associated with risk stratification in asymptomatic patients. The amount of calcium approximately corresponds to the severity of atherosclerotic lesions of the coronary arteries, while its correlation with the degree of stenosis is practically absent. Even with severe calcifications, the presence of luminal stenosis is not always observed. On the contrary, a zero value of the Agatston index does not exclude coronary artery stenosis, especially in young patients and patients with acute symptoms. This feature can be described by the modulation index, which is a parameter of CT with contrast, which is used to determine the main direction of plaque growth relative to the inner or outer layers of the vascular wall, and is not amenable to assessment by the current method. In addition, atherosclerotic plaques often consist of both calcified and non-calcified components (mixed plaque), which allows for a high degree of confidence in predicting the development of complications of coronary artery disease, and is also easily quantitatively assessed (e.g., total plaque volume, volume of calcified and soft plaques) using more advanced computer tomographs of the latest generation, as already mentioned above [6, 7]. It can be argued that among all imaging methods

in the diagnosis of ischemic heart disease, it is CT with contrast that is a non-invasive method that allows for a «simultaneous» analysis of the entire coronary tree with low radiation and contrast load. Thus, this method may be optimal for early diagnosis and risk assessment of coronary heart disease.

Bibliography:

1. Серцево-судинні захворювання – головна причина смерті українців. URL: https://phc.org.ua/news/sercevo-sudinni-zakhvoryuvannya-golovna-prichina-smerti-ukrainciv-visnovki-z-doslidzhennya.

2. Мосьпан Д. В., Мосьпан В. О. Окремі аспекти застосування електроніки в медицині. *Prospects and priorities of research in science and technology* : Collective monograph. Czech technical University in Prague. Riga: Izdevnieciba «Baltija Publishing», 2020. Vol. 2. 320 p. ISBN 978-9934-26-008-7. DOI: 10.30525/978-9934-26-008-7.2-8.

3. Мосьпан В. О., Фомовська́я О. В., Юрко О. О., Артеменко В. О. Можливість тривалого самоконтролю стану з використанням мобільного кардіографу приєднанного до хмарних технологій. *Вісник КрНУ ім. Михайла Остроградського*. Кременчук : КрНУ, 2019. Вип. 6 (119). С. 162-172. DOI: 10.30929/1995-0519.2019.6.167-172.

4. Forte E. et al. Coronary artery aneurysms detected by computed tomography coronary angiography. *European Heart Journal. Cardiovasc Imaging*. 2017. № 1;18 (11). P. 1229–1235. DOI: 10.1093/ehjci/jew218.

5. Юрко О. О., Спатар О. О. Аналіз чинників електрокардіограм для побудови алгоритму синтезу тестових електрокардіосигналів. *Вісник КрНУ ім. Михайла Остроградського*. Кременчук : КрНУ, 2023. Випуск 4 (141). С.170–177. DOI: 10.32782/1995-0519.2023.4.21.

6. Перекрест А.Л., Кухаренко Д. В., Юрко О. О., Вадурін К. О. Комп'ютеризований практикум з моделювання фізичних процесів. *Вісник КрНУ ім. Михайла Остроградського*. Кременчук : КрНУ, 2022. Випуск 6 (137). С.29–35. DOI: 10.32782/1995-0519.2022.6.3.

7. Kukharenko, D., Gladkyi, V. et al. (2022). Possibility Analysis of preserving the ST segment shift when approximated by Gaussian pulses. *«International Conference on MODERN ELECTRICAL AND ENERGY SYSTEMS»*. Kremenchuk Mykhailo Ostrohradskyi National University, Ukraine, October 20-22, 2022. DOI: 10.1109/MEES58014.2022.10005749.