Evaluation of the presence and characteristics of coronary atherosclerosis in non-contrast high-resolution computed tomography.

Mariusz Kruk, Institute of Cardiology, Warsaw, PL

Research project objectives are:

- To acquire new knowledge regarding the ability to evaluate the presence of non-calcified coronary atherosclerosis based on high resolution, non-contrast computed tomography.
- To acquire new knowledge regarding the ability to evaluate high risk characteristics of coronary atherosclerosis based on high resolution, non-contrast computed tomography.

Cardiovascular diseases develop clinically covert for a long time, and in most cases the first symptoms indicate already advanced disease. In about 50% of patients, the first clinical symptoms of atherosclerosis are myocardial infarction or sudden cardiac death. A significant part of the cardiovascular risk results from modifiable risk factors, therefore identification of the highest risk patients would enable effective preventive measures to be taken.

One of the best documented methods of cardiovascular risk evaluation is calcium scoring. It is based on low-dose low-resolution non-contrast coronary artery computed tomography examination. Despite its moderate correlation with coronary atherosclerosis volume, it is unable to recognize non-calcified atherosclerotic plaques (the majority of atherosclerosis is non-calcified, 10% of patients with significant stenosis have calcium index = 0), or to determine the high risk characteristics of atherosclerotic plaques (positive remodeling, presence of the lipid component, "napkin-ring" sign). Modern computed tomography techniques allow obtaining high resolution coronary CT images with a small dose of radiation (comparable to the calcium index exam). Computed tomography enables the differentiation of tissues based on their density measured in Hounsfield units (HU). In addition, the use of new analysis techniques in the field of "radiomics" enables a robust use of image information. Radiomics far exceeds human capabilities and traditional methods of diagnostic image description, therefore it brings along with new information completely novel analysis possibilities. This new analytical techniques can enable detection of non-calcified atherosclerotic plaques and high risk plaque features in coronary arteries in high-resolution, non-contrast CT scan images.

Methods: We plan to recruit 150 patients undergoing coronary CT angiography due to suspected coronary artery disease (CAD), including 125 subjects with at least one non-calcified high risk coronary atherosclerotic plaque seen on CT angiography and 25 without visible atherosclerosis. In these patients additional low-dose non-contrast high-resolution coronary artery exam will be performed. In all patients, based on the analysis of the reference contrast examination, segments containing non-calcified atherosclerotic plaque, including features of high-risk plaque, and coronary artery lumen stenosis, as well as segments without atherosclerosis will be identified on contrast datasets. In the derivative group (50 patients, about 100 analyzed atherosclerotic plaques, 200 segments without atherosclerosis) characteristics correlated to the presence of the abovementioned variables will be determined and subsequently validated in the next 100 patients (approximately 200 analyzed atherosclerotic plaques, 400 segments without atherosclerosis). Radiomic models of atherosclerotic plaques will be obtained by means of data mining techniques.

The impact of the expected results on the development of science: We expect, that based on the new analytical and image acquisition techniques we will be able to assess the presence of non-calcified atherosclerotic plaques based on non-contrast high-resolution coronary CT images. If this assumption is confirmed, our results may be a starting point for developing new screening methods for cardiovascular risk assessment.