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Cardiovascular diseases: Detecting dangerous plaques in time

(Vienna, November 5, 2015) With 5 million deaths per year cardiovascular diseases (CVD) are the leading cause of mortality in Europe. In western countries over a third of the adults die from coronary artery disease and another 25 % from stroke. Unstable plaques in arteries , which play a significant role in CVD,often remain undetected until a dangerous stage has been reached. "Novel nuclear imaging techniques now enable us to identify these 'time bombs' much earlier and raise hope to be able to prevent them from becoming a threat to the patient's life," says Dr. Fabien Hyafil, expert of the European Association of Nuclear Medicine (EANM).

Although treatment of CVD has improved considerably over the past decades, preventive measures still often fail. In order to improve this situation innovative diagnostic approaches are essential. The vast majority of heart attacks, strokes, and peripheral vascular diseases is caused by atherosclerosis. This condition develops over time with the progressive accumulation of lipids, inflammatory cells and connective tissue within the inner layer of arterial walls leading to a local thickening of the vascular wall called atherosclerotic plaque. The increase in plaque size is progressive with aging but is accelerated through smoking, high levels of cholesterol in blood, arterial hypertension or diabetes. Once atherosclerotic plaques extend into the lumen (the inside conduit of arteries where blood circulates), the blood flow passing through arteries will be reduced. In the heart, the amount of oxygen transported to the cardiac muscle by blood will not be sufficient anymore during exercise in the regions downstream of the stenotic plaque and this might result in angina pectoris. In some of the arterial plaques an inflammatory reaction will develop in contact with their fatty content. These plaques will grow much faster and might ultimately rupture and expel their fatty content into the arterial lumen in a way similar to an abscess. Plaque rupture stimulates clot formation in the vessel and can cause life-threatening conditions such as myocardial infarction or stroke. If the clot completely occludes the artery perfusing the heart, downstream of this occlusion no oxygen can reach the heart anymore thus causing the sudden development of an acute myocardial infarction, a local destruction of the cardiac muscle. As far as the arteries supplying the brain are concerned, they usually are not occluded completely by the clot. However, the clot might break off and obstruct arteries in the

downstream circulation thus provoking a stroke. As for the treatment of CVD one of the important challenges that remain is the ability to identify the patients presenting with these dangerous, unstable atherosclerotic plaques, which might soon lead to myocardial infarction or stroke.

A tool for preventing life threats

Recent developments in molecular imaging, namely PET imaging, now allow for the detection of biological processes in the wall of vessels. Positron emission tomography (PET) imaging requires the injection of a very small amount of radioactively labelled substances into the vein, so-called tracers by which molecular or biological processes can be targeted. After injection, the tracer will diffuse andaccumulate in tissues containing this specific molecule or biological process and emit a signal, which can be located very precisely through the PET imaging system. ^{18}F-fluorodeoxyglucose (FDG) is a radioactively-marked sugar, taken up by cells with high-energy consumptions such as inflammatory cells. After injection of FDG, PET imaging allows for the identification of atherosclerotic plaques with high inflammatory activity, a marker of unstable plaques. Furthermore, several clinical studies have shown that patients with the highest FDG uptake in their arteries were more likely to develop a cardiovascular event within the next 4 years. There was also evidence that FDG uptake in atherosclerotic plaques rapidly decreases after initiation of lipid-lowering drugs such as statins, which favour the healing of unstable plaques. Vascular FDG-PET imaging therefore is a promising tool to monitor the efficacy of new anti-atherosclerotic drugs. It is becoming largely used by the pharmaceutical industry to identify the most effective drugs for the treatment of patients with CVD. “This technique will improve our understanding of the role of vascular inflammation in the destabilization of atherosclerotic plaques”, says EANM expert Dr. Jan Bucerius. More recently, another tracer for PET imaging, sodium ^{18}F-fluoride, has been found to bind to tiny, bone-like structures named micro-calcifications. These micro-calcifications cause small but continuous lesions in atherosclerotic plaques that progressively weaken them, ultimately leading to plaque rupture. In addition to FDG, sodium ^{18}F-fluoride also holds promise for the identification of dangerous plaques in patients.

“Several tracers to be used with PET imaging have now become available to identify dangerous, unstable plaques in arteries. This technique might therefore help us to identify more accurately patients at risk of acute myocardial infarction or stroke and to develop strategies to prevent these dramatic events by starting a timely preventive treatment ”, says Dr. Hyafil. And Dr Bucerius points out: “One of our major goals is to introduce these promising non-invasive imaging techniques into clinical routine as soon as possible”

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