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EDITOR'S COMMENT

Crown years for non-invasive cardiovascular imaging (Part II): 40 years of nuclear cardiology

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The year 2013 is a remarkable year in cardiovascular medicine from a historical point of view. It can be considered a crown year for non-invasive clinical cardiovascular imaging as we can look back on 60 years of echocardiography, 40 years of nuclear cardiology, 30 years of cardiovascular magnetic resonance imaging, and 30 years of cardiac computed tomography. In a previous Editor's Comment 60 years of echocardiography were described (Part I). In this Editor's Comment (Part II) we will briefly look back to the roots of nuclear cardiology and its main achievements.

Nuclear cardiology 40 years

Although the history of nuclear cardiology techniques for assessing myocardial blood flow and cardiac function actually dates back to more than 40 years ago, a true milestone for nuclear cardiology was reached in 1973. At that time, Barry Zaret (Yale University, USA) published the first clinical paper on scintigraphic myocardial perfusion imaging using potassium-43 (K-43) imaging of myocardial perfusion at rest and during exercise in 43 subjects [1]. In 13 of 15 patients with previous myocardial infarction studied at rest, regions of decreased radionuclide accumulation corresponded to the anatomic location of the infarct. In 16 of 19 patients with angina pectoris, regions of decreased K-43 accumulation were observed during exercise but not at rest. In 1975, Frans Wackers (Amsterdam, the Netherlands) published the first clinical application of thallium-201 (Tl-201) imaging in 10 normal patients and 11 patients with acute myocardial infarction [2]. Tl-201 imaging allowed for the first time the visualisation of perfusion defects at the location of the infarct site. In 1977, Gerald Pohost (Boston, USA) demonstrated redistribution of Tl-201 into ischaemic myocardium during transient coronary occlusion in dogs and after exercise stress in man [3]. Sequential imaging after a single dose of Tl-201 at the time of exercise therefore provided a means for distinguishing between transient perfusion abnormalities or ischaemia and myocardial infarction or scar. The above-mentioned landmark studies have laid the basis for clinical exercise myocardial perfusion imaging.

Over the past 40 years, nuclear cardiology underwent several major steps both in the USA and Europe. First, planar imaging was replaced by single photon emission computed tomography (SPECT) and, to a lesser degree, by positron emission tomography (PET) [4–6]. Second, new myocardial tracers invaded the field. In addition to Tl-201, metabolic tracers such as iodinated free fatty acids appeared on the market to explore fatty acid metabolic pathways in the myocardium [7–9]. Over time, Tl-201 lost its status as a primary myocardial perfusion marker to technetium (Tc)-99m-sestamibi and Tc-99m-tetrofosmin [10, 11]. In the late 1980s, PET imaging of absolute blood flow was shown to be feasible using nitrogen (N)-13 ammonia [12]. In combination with fluorine (F)-18-deoxyglucose (FDG), the use of N-13 ammonia enabled the assessment of myocardial viability in patients with coronary artery disease [13]. In the 1990s, novel radiopharmaceuticals such as 123-iodine metaiodobenzylguanidine (MIBG) for neuronal imaging were developed, only recently approved by the FDA [14]. Recently, rubidium-82 PET myocardial perfusion imaging proved to be superior to Tc-99m SPECT imaging in patients with known or suspected coronary artery disease [15]. Third, patient-friendly protocols were proposed (pharmacological stress, immediate reinjection, stress-only, and dual

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isotope imaging) in order to shorten the imaging procedure and reduce radiation exposure [16–22]. Fourth, a major advancement in nuclear cardiology was the introduction of gated SPECT in 1994 allowing the simultaneous evaluation of myocardial perfusion and function [23]. Lastly, a lot of subsequent developments have been related to major technical advances: progress in instrumentation, new software for image display and analysis, and the overall enhancement of quality and accuracy of nuclear imaging [24]. The acquisition of quantitative data has led to a better understanding of the physiological mechanisms underlying cardiovascular diseases beyond discrete epicardial coronary artery disease to coronary vasomotor function in the early stages of the development of coronary atherosclerosis, hypertrophic cardiomyopathy, and dilated non-ischaemic cardiomyopathy [25–27]. Progress in molecular and hybrid imaging are equally important areas of growth in nuclear cardiology. Parallel to these advances, many clinical studies have been performed over time to establish the unique diagnostic and prognostic value of nuclear cardiology imaging [28].

To summarise, over the past 40 years nuclear cardiology has gained a fixed niche in the domain of non-invasive cardiovascular imaging, particularly as an economic standalone technique for assessing myocardial perfusion and metabolism [29–31].

N.B. This Editor's Comment is far from complete; more detailed descriptions of the achievements in nuclear cardiology can be found elsewhere [32–35].

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