Molecular Imaging with Targeted Contrast Agents

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Despite considerable therapeutic advances over the past 50 years, cardiovascular disease is the leading cause of death worldwide. This is mainly a result of the increasing prevalence of atherosclerosis, owing to the ageing population, the improved survival of patients with atherosclerotic cardiovascular disease and, above all, the widespread under-recognition and undertreatment of individuals with risk factors for atherosclerosis.

Atherosclerosis is characterized by the thickening of the arterial wall to form an atherosclerotic plaque, a process in which cholesterol deposition, inflammation, extracellular-matrix formation and thrombosis have important roles. Symptoms occur late in the course of disease and are usually caused by the narrowing of the lumen of the artery, which can happen gradually (as a result of progressive plaque growth) or suddenly (as a result of plaque rupture and, subsequently, thrombosis). The resultant decrease in blood supply can affect almost any organ, although coronary heart disease and stroke are the most common consequences.

Traditionally, diagnosis of atherosclerosis was possible only at advanced stages of disease, either by directly revealing the narrowing of the arterial lumen (stenosis) or by evaluating the effect of arterial stenosis on organ perfusion. However, new imaging approaches allow the assessment not only of the morphology of blood vessels but also of the composition of the vessel walls, enabling atherosclerosis-associated abnormalities in the arteries (including the coronary arteries) to be observed, down to the cellular and molecular level in some cases. Some of these approaches are now in clinical use or are being tested in clinical trials, whereas others are better suited to basic and translational research. Here, we discuss recent advances in imaging cardiovascular atherosclerotic disease, including revealing both the primary changes, in the blood vessel wall, and the secondary changes, in the structure and function of the heart. We focus first on advances with noninvasive multimodality imaging with magnetic resonance imaging (MRI), positron emission tomography (PET) computed tomography (CT). Then we discuss the use of these new imaging nanoparticulates not only for imaging but also for drug delivery and treatment of atherosclerosis.