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# Cardiovascular Molecular Imaging

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Molecular imaging is defined today as the visualization, characterization, and measurement of biological processes at the molecular and cellular levels in humans and other living systems, and molecular imaging agents are probes used to visualize, characterize, and measure biological processes in living system.

Most of us in the cardiovascular imaging field look at the routine use of molecular imaging in cancer research, clinical trials, and medical practice.[1] However, recent developments in cardiovascular biology and biochemistry, coupled with remarkable advances in imaging technologies, are beginning now to make molecular imaging a vital preclinical and clinical tool in the field of atherosclerosis, thrombosis, vascular biology, and cardiovascular medicine.[2]

In this issue of the *ATVB*, we present a series of concise review articles on in vivo molecular cardiovascular multimodality imaging. These articles present overview of some the opportunities in the areas of atherosclerosis, thrombosis, inflammation, angiogenesis, apoptosis, diabetes, and cellular therapy. The series also covers the challenges that cardiovascular molecular imaging faces to fulfill its promise in the clinical practice.

The series begins with “Molecular Imaging in Atherosclerosis, Thrombosis, and Vascular Inflammation” by Choudhury and Fisher.[3] They provide a comparative analysis of the different imaging modalities that have been used. They emphasize how an understanding of the biology of atherosclerosis and its complications can inform optimal design of the different elements of the contrast agents. They address the potential and limitations of current contrast approaches in respect of translation to clinically usable agents and speculate on future applications. Cormode et al[4] cover, in “Nanotechnology in Medical Imaging: Probe Design and Applications,” the use of nanoparticles and the important elements and factors involved in the design of targeted molecular imaging probes. They focus on lipid-based nanoparticles because of the ease in synthesis and manipulation to include different imaging labels, targeting vectors, and therapeutic agents. They give several examples of the most advanced applications of these nanoparticles different disease processes.

Macrophages have been recognized as key elements in atherothrombotic high-risk/vulnerable plaques. Tjun Y Tang and coworkers from the Cambridge group,5 in “Iron Oxide Particles for Atheroma Imaging,” discuss the use of Ultrasmall superparamagnetic iron oxide (USPIO) contrast agents and noninvasive MRI for the assessment of atherosclerotic plaque inflammation. This article reviews the basic science behind the use of USPIO contrast agents in macrophage MR imaging both at the experimental and clinical research level. The theme of



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None.

inflammation continues with “Inflammation Imaging in Atherosclerosis” by Rudd et al from the Mount Sinai group.[6] This review demonstrates the clinical translation of highly sensitive nuclear techniques such as positron emission tomography (PET) and fluorodeoxyglucose (F18-FDG) and single photon emission computed tomography (SPECT) for the evaluation of in atherosclerosis in humans. The review also shows that even techniques such as computed tomography (CT), which in the past has not been given much consideration for molecular imaging because of its poor sensitivity, has shown potential for inflammation imaging using iodine-based nanoparticles in atherosclerotic rabbits. Jaffer and coworkers7 cover in “Optical and Multimodality Molecular Imaging: Insights Into Atherosclerosis” the growing role of in vivo optical molecular imaging in atherosclerosis and highlights its ability to visualize atheroma inflammation, calcification, and angiogenesis. In addition, like in the Cormode et al review,4 they discuss advances in multimodality probes, both in the context of multimodal imaging as well as multifunctional, or “theranostic,” nanoparticles.

Cellular transplantation therapy has been gaining interest for the treatment of cardiovascular disease and diabetes mellitus. Kraitchman and Bulte, in “In Vivo Imaging of Stem Cells and Beta Cells Using Direct Cell Labeling and Reporter Gene Methods,”[8] show that molecular imaging can provide a means to determine the efficacy of these therapies. This review shows that direct labeling of stem, progenitor, and beta cells continues to provide important insights into the underlying mechanisms of action and in determining the optimal dosing and cell type. Finally, in “Imaging of Cell Death in Atherosclerosis”[9] by Laufer et al, the biology of cell death and the role of molecular imaging of apoptosis are discussed in detail. They show the possible development and translation of apoptosis markers, such as Annexin A5, into clinical research imaging probes using SPECT imaging in carotid disease patients.

*ATVB* is committed to the field of cardiovascular molecular imaging as highlighted by this series, by recent review articles such as the one on cellular imaging technologies for the dynamic study of labeled immune cells in intact tissue environments,[10] and by upcoming reviews that will cover, for example, ultrasound molecular imaging, myocardial molecular imaging, and drug delivery. We hope that this series stimulates the submissions of original contributions and reviews to *ATVB*.

In summary, this series of review articles by established leaders in the field will serve as both a valuable resource in the rapidly evolving fields of vascular biology and cardiovascular molecular imaging and as guideposts for future work.

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