Hybrid imaging in cardiovascular medicine; edited by Drs. Yi-Hwa Liu and Albert J. Sinusas

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Noninvasive cardiovascular imaging, initially limited to CXR, planar Tl-201 imaging, and M-mode echocardiography, currently includes numerous advanced technologies: SPECT (NaI and CZT), PET, MRI, CT/CTA, and multiple echocardiographic modalities (TTE, TEE, ICE). After a period of “one stop shopping” zeal, it became apparent that combination of different imaging modalities, i.e., “hybrid imaging”, provides a more comprehensive interrogation of anatomic, physiological, and molecular data resulting in optimal diagnostic, prognostic, and therapeutic recommendations.

Since the turn of the century, there have been tremendous technological advancements, global availability, and adoption of several hybrid imaging modalities in varied clinical settings, especially SPECT-CT, PET-CT, and to some extent PET-MRI. All major vendors now manufacture these hybrid imaging systems. The combined PET-CT system has become the convention of cardiac PET. Clinical translation of other hybrid imaging techniques (e.g., SPECT-MR, x-ray-optical, x-ray-echocardiography, or ultrasound-photoacoustic imaging) has however lagged.

During the past decade, most technical aspects of multimodality imaging have been addressed, but the prediction of rapid application of available combined technologies has been slower to materialize. Logistic,

economic, clinical, and educational issues have not received needed attention.

“Hybrid Imaging in Cardiovascular Medicine” (CRC Press, Taylor and Francis Group, 454 pages with index, \$ 249.95 hard cover and \$ 224.96 e-Book) is the first attempt to summarize state-of-the-art of multimodality hybrid imaging with emphasis on the cardiovascular system and diseases. It is one of many planned volumes in the series of “Imaging in Medical Diagnosis and Therapy” (CRC Press, A. Karellas and B. R. Thomadsen are series editors).

While the reviewed book is mainly focused on multimodality cardiovascular imaging, the applications of hybrid imaging described are not limited to cardiovascular disease. Thus, the book’s target audience is broad and includes basic scientists, medical physicists and engineers, medical specialists with interest in cardiovascular imaging, and engineering/science graduate students that have a focus toward instrumentation development, medical physics, and imaging science.

Fifty-one contributing co-authors (Drs. Yi-Hwa Liu and Albert J. Sinusas are the editors) represent North American, Australian, and European expertise in the field. The book is divided into four parts with several chapters in each part. Each part is well organized and provides an outline at the beginning of each chapter:

Part 1 is mostly technical and includes nine chapters that deal with principles, instrumentation, techniques, and applications of various hybrid imaging modalities including SPECT-CT, PET-CT, SPECT-MRI, PET-MRI, CT-MRI, x-ray-optical, x-ray fluorescence-echocardiography, photoacoustic, and intravascular imaging. Each chapter is authored by the respective modality specialists and has been written with

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attention to detail and accompanied by illustrations and case examples.

Part 2 discusses multimodality cardiovascular imaging probes that have been mostly evaluated in pre-clinical setting but show promise for clinical translation, e.g., liposomes and nanoparticles. These two chapters also discuss potential clinical applications including imaging of apoptosis, inflammation, atherosclerosis and vulnerable plaque, aortic aneurysm, and cell tracking. The emerging field of theranostics which combines diagnostic, therapeutic, and monitoring applications is discussed.

Part 3 addresses quantification of hybrid cardiovascular imaging. In six chapters, each group of authors discusses technical aspects of hybrid MPI-CT and MRI such as motion correction, respiratory motion, co-registration, and attenuation correction as well as intravascular imaging. Each group of authors also attempts to predict the most likely future (and some current) clinical utility of the individual combinations. Need for automation of processing and quantification is addressed in this part.

Part 4 summarizes in three chapters future directions and radiation safety aspects of multimodality imaging, a perceived challenge to the combination of multiple radiation-rich modalities.

“Hybrid imaging in Cardiovascular Medicine” is not a textbook of hybrid imaging. It is rather a collection of current “state-of-the-art” summaries by leaders in the field with an extensive list of up-to-date references. Nevertheless, the book can be used as a guide for a

graduate-level course in hybrid imaging as suggested by the editors. Overall the writing is easy to understand and is made easier by the accompanying high-quality illustrations, images, and tables. Criticism includes small font and image size of the printed book version. The authors and the editors should be congratulated on this valuable reference in an emerging field that clearly required enormous effort to produce.

The transition from “the proof-of-concept” to clinical application of hybrid imaging has and will be complicated. Current separation of cardiovascular imaging experts (cardiology, radiology, nuclear medicine), a complicated reimbursement system, valid imaging indications and identifying appropriate patients that will benefit (Appropriate Use Criteria), equipment sharing (cardiology, radiology), training guidelines, subspecialty training and certification, are some of the challenges that have to be overcome.

Support for technical innovation (automation, machine learning) and for definition of beneficial indications for cardiovascular hybrid imaging is imperative. Hopefully, the next edition of “Hybrid Imaging in Cardiovascular Medicine” will bring us closer to the desirable goal.

Disclosures

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