Quantitation in Biomedical Imaging with PET and MRI

H. Iida, N.J. Shah, T. Hayashi, and H. Watabe, eds.

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Both PET and MRI offer functional and physiologic information on various organs, not only at the cellular level but also at the molecular level. Given this age of technological developments, both modalities have been put to use for the quantitative assessment of metabolic processes within the cell. Because of these developments, these modalities have successfully been used for the assessment and management of diseases and for the development and design of therapeutic drugs. This book—the proceedings of an international workshop held in Osaka, Japan—represents the thoughts and experiences of leading scientists within the quantitative field.

Quantitation in Biomedical Imaging with PET and MRI deals with PET and MRI basic methodology, the application of quantitative PET and MRI measurements in the clinical setting, and the technological advantages of one modality vis-à-vis the other modality. The book is appropriately divided into 3 sections dealing with basic PET quantitation, basic MRI quantitation, and the application of both PET and MRI techniques for measuring physiologic processes. Multiple teams of scientists and researchers from leading centers around the world contributed their experience to this book.

The first article is an appropriate introduction discussing the role of PET in human and animal studies in drug development. The crux of the article is PET measurement of the distribution of drugs and their mechanisms of action. The article also deals with the quantitation of tumor metabolism as a marker of chemotherapy response. Given that the development of new drugs is time consuming and expensive, these techniques are demonstrated to be important for improving drug innovation programs despite lack of worldwide expertise.

Another interesting article explores kinetic analysis of neuroreceptor binding. Most quantitative dynamic PET studies of radioligands use a 3-compartment model to describe free, nonspecifically bound, and specifically bound pools. This classic model has been powerful in PET studies, allowing quantitative estimates of regional receptor concentration, exogenous drug occupancy, and changes in endogenous transmitter release; however, this model is difficult to characterize with radioligands that display slow kinetics, because the duration of a PET acquisition is limited. In this article, the authors discuss the simultaneous estimation of common variables across multiple regions for the characterization of these slow ligands regularly used in neuroreceptor modeling.

The development of motion correction techniques for PET studies is the subject of 2 articles—one involving an optical tracking system for PET brain studies and another involving motion correction for quantification of myocardial blood flow. Typically, between 10 and 40 min are required to obtain a PET scan. During this time, the patient has to remain stationary. Any shifting or repositioning of the patient can lead to loss of image quality and loss of quantitative information, thus leading to significant error. Several software packages are available to correct for this loss, but these rely on processing data after the initial acquisition. Both these articles discuss techniques used during the acquisition of PET data to produce higher-quality images and better quantitation.

In the section on basic MRI quantitation, the potential of absolute quantitation of physiologic parameters using hyperpolarized ^{129}Xe as a new contrast agent in MRI is thoroughly discussed. Two articles focus on the use of this hyperpolarized noble gas as a promising MRI tracer for flow and dynamic processes of the lungs. An insightful article explores the use of ^{129}Xe as a contrast agent in the characterization of temperature and oxygenation within the brain.

The third section, on the application of quantitative PET and MRI, centers on various methods for the assessment of cerebral blood flow and glucose consumption. Although semiquantitative brain blood flow and metabolism may be useful for analyzing absolute changes in parameters induced by both physiologic and pathologic changes, a quantitative method is essential. Quantitative techniques and models for both PET and MRI are discussed in this section.

The editors' aim in this book was to share their expertise and ideas on the valuable discussion of quantitation

introduced during the workshop in Japan. *Quantitation in Biomedical Imaging with PET and MRI* is a technical book recommended for scientists and researchers in the areas of basic science research, instrument design, pharmacokinetics, and drug discovery. Physicians with academic interest may also benefit from this book in the assessment and management of disease status with therapeutic applications.

Robert Matthews
Nand Relan
Stony Brook University Hospital
Stony Brook, New York