Quantitative assessment of biological functional parametric images using PET and SPECT

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PET and SPECT are unique modalities, and capable of providing information of biological processes in vivo as volumetric images. The technique is essentially based on the quantitative assessment of transiently changing bio-distribution of radiolabeled ligands in the body, and the application of mathematical formulations that describes the kinetic behavior of radiolabelled ligands that are designed to enhance the biological functions-of-interest There have been a number of technical advances to provide highly quantitative measurement of regional radioactivity concentrations with improved spatial resolution, sensitivity, counting rate performance, etc. Kinetic modeling is an essential area, taking into account for pharmacokinetics of tracers, at the same time with a careful attention to overcome possible limitations and systematic errors. The fact that functional parameters are significantly biased attributed to the insufficient spatial resolution relative to the structure of the target tissue element, and has been a recognized a major error.

Our research team has extensively worked to establish a novel methodology, aiming to provide information that is highly sensitive to, and accurately characterizing disease conditions in clinical settings. Improvement in the transient resolution, and to shorten the study duration enabled the assessment of multiple functional imaging, and also the detection of transient changes in physiologic functions within reasonable study duration. A rapid technique for regional metabolic rate of oxygen with cerebral perfusion and regional blood volume contributed to the diagnosis of ischemic status in patients with cerebral vascular diseases, even acute stroke. Not only the novel mathematical modeling, but also a dedicated cyclotron with an improved automatic synthesis/QC system has made essential contributions. SPECT which is widely available in clinical institutions, is also a useful tool, and is able to provide quantitative functional images, which are reproducible among different institutions using existing devices. These approaches appeared to be useful in multicenter clinical trials.

Multi-modal imaging is also essential in clinical diagnosis. Recent efforts enabled a hybrid high-field MR/PET with improved temporal resolution in PET, which is becoming a new trend in the future clinical study.