EL3. Brain PET, Present and Future

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Positron emission tomography (PET) permits visualization of blood flow, metabolism, receptor binding capacity and other brain functions *in vivo*. Cortical focal symptoms caused by the remote effect of a small deep infarction are explained by diminished blood flow and metabolism in the responsible cortical areas, which are free from organic lesion and appear normal in x-ray CT and MRI. Alzheimer's disease is detected as temporoparietal hypometabolism with ^{18}FDG in the early stage when minimal atrophy is present in the morphological images. Active brain tumors accumulate ^{11}C-methionine, which helps distinguish tumor recurrence from radiation necrosis.

Using various tracers, the brain functions are characterized from various aspects. Misery perfusion occurring in acute stroke or TIA is demonstrated as increased oxygen extraction fraction (OEF), while decreased OEF is observed in luxury perfusion. Parkinson's disease is characterized by decreased striatal uptake of ^{18}FDOPA reflecting impaired presynaptic dopaminergic neurons, and is differentiated from other types of Parkinsonism which involves postsynaptic neurons and shows diminished uptake of dopamine D_2 ligand. In hypometabolic areas of Alzheimer patients, the glucose metabolism is more reduced than the oxygen metabolism. In other areas, the ^{18}FDG tracer kinetic analysis indicate that the rate of glucose phosphorylation denoted as k_3 is more decreased than K_1, the glucose intake into the brain. With new tracers being developed, new aspects of brain functions will be visualized and pathophysiology of the disorders will be elucidated.

The $H_2{}^{15}O$-PET activation technique allows repeated measurement of the regional cerebral blood flow under different subject conditions. Comparison of the stimulated state with the baseline state delineates the brain areas involved in the stimulation. Applying the technique to normal subjects, the normal functional anatomy, which has been speculated from lesion studies and physiological experiments, is reevaluated and confirmed. In patients with focal brain demage it reveals functional reorganization in the recovering process. This technique, together with functional MRI and MEG, will further reveal the functional organization of the living human brain, especially regarding higher cortical functions.

Recent advancement in computer technology has materialized new techniques of image analysis and display. The PET images as three-dimensionally registered to and superimposed on the MRI of the same subject, which visualizes the relationship between morphology and function. The images are even anatomically standardized to the atlas for intersubject comparison and averaging. The surface rendering and volume rendering techniques create perspective views of the brain surface with deep structures overlaid.