《招待講演２》

Imaging of Tumors Using PET

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Abstract for Plenary Lecture:

Positron Emission Tomography (PET) has been increasingly applied to the imaging of patients with cancer in the past several years with many advances in this field having been made in Japan. The recognition that most cancers have accelerated rates of glucose metabolism as well as amino acid and DNA synthesis, means that a variety of positron emitter labeled radiopharmaceuticals are available that can probe and image the altered metabolism of cancers. These and other metabolic alterations in cancers can be particularly well-detected by PET because of the extremely high sensitivity of the electronically-collimated PET cameras which are much more sensitive (10–50 fold) than single photon instruments. In addition, relatively high radioactivity doses of positron emitting radiopharmaceuticals can be safely administered, due to their short half life. These metabolic and physical factors make PET a very sensitive quantitative metabolic imaging method for cancers. While PET images metabolism, it also supplies precise anatomic data regarding the location of tracer uptake. By fusion of the PET images with anatomic studies such as CT or MRI, both tumor anatomy and physiology are well demonstrated in a single hybrid "anatometabolic" image.

PET is making a rapid transition from a purely research tool to one that has both research and increasing clinical applications. In research, PET can assess fundamental aspects of tumor biology, ranging from quantifying glucose or amino acid consumption, to assessing tumor blood flow or vascular volume, or assessing receptor/ligand interactions, or assess therapeutic drug delivery among many others. PET can also assess tumor oxygenation and oxygen consumption. PET allows for quantitative assessments of tumor responses to treatment and may play an important role in planning future treatment regimens. A variety of positron emitting radiopharmaceuticals have been explored in PET imaging of cancer. The applications of PET for tumor biology are growing rapidly.

While the use of PET in cancer research is increasing, the number of clinical applications of PET in cancer imaging is increasing at a very rapid rate. The reason for this increase is that CT and MRI, while powerful methods, are imperfect. They characterize tissues as cancer or not based on size. Size is a poor differentiation between malignant and benign, particularly in lymph nodes, so that false positive and false negative results occur. Similarly CT and MRI have difficulty separating scarring from viable tumor following therapy. CT and MR also perform poorly in the post operative patient with distorted anatomy, and in detecting small lesions in the abdomen. PET has demonstrated clinical potential in each of these situations where CT and MRI have difficulty.

PET is well-established in brain tumor imaging, with the level of ^{18}F FDG uptake correlated with tumor grade and residual FDG uptake following

treatment suggesting residual/recurrent tumor. Similar observations with other PET tracers such as ^{11}C methionine have been made. In many institutions with PET available, this scan is the method often applied to follow brain tumor treatment.

Clinical applications of PET are increasingly established in lung cancer, where PET with several tracers can quite accurately characterize solitary pulmonary nodules as malignant or benign, and where PET staging of the mediastinum appears to be significantly more accurate than CT. Recently, it has been proposed that PET is the non-invasive imaging procedure of choice in staging lung cancer.

Similarly, in melanoma, lymphoma, and head and neck cancers, (among others) PET can detect small tumors not detected by CT imaging. In breast cancer, lymph node groups unassessable by standard imaging methods and breasts with silicone implants can be imaged with PET. In breast cancer, PET may also be able to reduce the frequency of biopsy, by its ability to segregate benign from malignant lesions with reasonable accuracy. In colorectal cancers, non-invasive separation of malignant lesions from scars following treatment appears quite reliable.

Applications of PET in imaging liver tumors, pancreatic cancers, tumors of the GU system, gynecological neoplasms, endocrine tumors, musculoskeletal tumors, and several other cancers are rapidly expanding. Assessment of treatment response, tumor staging, lesion characterization and clarification are all being explored in clinical studies.

This plenary lecture will review the imaging of tumors with PET and will update the audience as to the current status of this rapidly evolving area of basic research and clinical study.