Cancer Imaging with PET; Clinical Potential and Scientific Background

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It is well known that most of the cancer cells have increased metabolism of glucose as well as amino acids and DNA. Various metabolic substrates labeled with ^{11}C, ^{18}F, or ^{13}N have been studied for tumor imaging. Among these, ^{18}F-2-deoxy-2-fluoro-D-glucose(FDG), a glucose analogue, is the most important and useful for tumor imaging. FDG uptake represents accelerated transport of glucose and increased activity of hexokinase, a key enzyme in glycolysis in tumor tissue. ^{11}C-L-methionine (Met) is also useful for tumor imaging. Met uptake represents amino acid transport, trans-methylation and protein synthesis in tumor tissue. FDG or Met tumor uptake showed strong correlation to the proliferation of cancer cells both in laboratory studies and in clinical studies.

Differential diagnosis of solitary pulmonary nodule is one of the best studied clinical topics using FDG-PET in the world. More than 500 patients' studies have been reported from USA, Europe, and Japan. The diagnostic accuracy varied among institutions from 86% to 100%, averge 93%. All agreed that PET is superior to CT for this purpose. However, several false positive FDG uptakes have been reported in active inflammation such as tuberculosis, aspergillosis also in sarcoidosis.

Tumor tissue is consisted of cancer cells and non-neoplastic tissue (stroma). Stroma includes macrophages, neutrophils, lymphocytes, and granulation tissue consisted of fibroblast, collagen fiber, and capillary. All these tissues consume glucose, at various levels. Especially high FDG uptake is seen in activated macrophage and young granulation tissue. That is a cause of false positive FDG uptake by inflammation, sarcoidosis, early post-radiotherapy inflammation. Several new researches using dynamic FDG PET to improve the diagnostic accuracy in differential diagnosis of cancer from inflammation have been on going. Compared to FDG, Met distribution in tumor tissue is more specific for viable cancer cells. Met may be a suitable tracer for monitoring cancer therapy.

PET is also useful for the differential diagnosis, staging and detection of recurrence of cancer in the mediastinum, brain, head and neck, breast, adrenal, pancreas, colon, ovary and others. Whole-body scanning technique is especially useful for the detection of unexpected metastasis, and staging. PET provides useful information to improve patients management in oncology.