Nuclear Medicine in Oncology: PET/CT, Molecular Imaging, and Radiotargeted Therapy

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Modern nuclear medicine is making a major impact in oncology, both through enhanced clinical importance in day-to-day practice, and by providing ever more exciting research tools for cancer investigation.

The recent introduction of PET/CT into nuclear medicine practice, is a case in point. PET itself is the greatest innovation in nuclear medicine over the past 2 decades. In the US, its full power is just beginning to be felt in the clinical practice of oncology, with approved indications in Non Small Cell Lung Cancer; Head and Neck Cancer; Lymphomas; Esophageal Cancer; Melanoma and Breast Cancer. Evidence is accumulating that supports important clinical indications for PET in selected patients with sarcomas, prostate cancer, thyroid cancer, and a variety of pediatric tumors. PET/CT is enhanced PET, because of the increase in patient through-put, and the interpretation advantages provided by knowing the anatomic location of PET scan abnormalities. We estimate that about 25% of patients have a more confident interpretation of pathologic vs benign findings, when PET/CT is used, in comparison to PET alone. We can expect major growth in this area.

Molecular imaging in oncology can be defined as the non-invasive imaging of the key biomolecules and related biochemical events that are responsible for the altered genotype and phenotype of malignancy. At MSKCC methods have been developed that provide imaging of gene expression based on the use of the reporter gene, herpes virus thymidine kinase, and the reporter substrate Fluoroiodoarabinosyluridine (FIAU). When labeled with Iodine-124, this nuclide can be used for non-invasive PET imaging of gene expression of therapeutic gene strategies, imaging of companion gene expression, and imaging of viral replication, in vivo. This strategy has been used primarily in animal models, to study cancer biology. In addition, we have adapted this approach to selectively label immune cells, in order to monitor in vivo trafficking of adoptive immunotherapy.

Radiotargeted therapy is a growing component of nuclear medicine practice. In addition to our mainstays, Iodine-131 therapy of thyroid cancer and hyperthyroidism, and the treatment of bone pain, monoclonal antibody therapy has been given new life in the successful development and clinical application of anti-CD20 antigen radiolabeled antibody inlymphoma. An NDA has been awarded by the US FDA to Zevulin, an Yttrium-90 labeled labeled anti-CD20, for therapy of lymphoma. The revolution in molecular biology will undoubtedly offer fresh opportunities for making Radiotargeted therapy better. Promising work is proceeding with humanized antibodies, antibody fragments, and other antibody forms. The multi-step targeting approach is particularly promising for solid tumors. Also, new radiolabels such as positron emitters for better diagnosis and quantitative dosimetry, and alpha emitters like Bismuth-213 have been shown to be potent

anti-tumor agents and practical for use in early clinical trials.

Success breeds success, and as PET/CT, Molecular Imaging and Radiotargeted therapy reach the stage of reimbursement for approved clinical procedures, we can expect an acceleration of technology development that will lead to a cycle of improved techniques leading to greater clinical benefit, leading to further improvements. All of us in nuclear medicine should be optimistic about the future of our field, and the chances for further improvement in our ability to diagnose and treat the cancer patient with nuclear medicine techniques.

References

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