Preface

Special Techniques and Technical Advances in PET/Computed Tomographic Imaging

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Editor

Functional imaging, in particular, PET, is a unique imaging tool showing both molecular function and metabolic activity information that are not available with other modalities. The introduction of PET/computed tomography (CT) in the late 1990s helped clinicians to couple molecular information with anatomic information. Fluorodeoxyglucose (FDG) is an analogue of glucose with a missing hydroxyl group at the 2' position, which is substituted with positron-emitting fluorine 18, the most widely used radiotracer for PET imaging. FDG-PET/CT imaging enables clinicians to assess cancer biology and perform staging, restaging, and treatment monitoring of cancers.

However, the interpretation of FDG-PET/CT studies is challenging because of the complex physiologic variants, and unusual patterns of FDG uptake. Because FDG is not a tumor-specific tracer, it can accumulate in a variety of benign processes, including benign tumors, and inflammatory, posttraumatic, and iatrogenic conditions. In addition, there is physiologic uptake of FDG in brain, brown fat, muscles, heart, liver, and the genitourinary system. Thus, to overcome these challenges, different special techniques have been introduced in PET/CT imaging. The use of different dynamic maneuvers such as puffed cheek or open mouth view allows better delineation of tumor margin in head and neck carcinoma. PET/CT enteroclysis is gaining popularity

in imaging of the small and large bowels. Efficacy of diuretic FDG-PET/CT studies in the evaluation of genitourinary malignancies is well established in the literature. Dual-time-point imaging (DTPI) and delayed-time-point FDG-PET/CT imaging help in differentiating between malignancy and inflammatory conditions. The use of contrast media during the CT portion helps in better characterization and delineation of the lesion. Metabolic biopsy using FDG-PET/CT yields better results compared with the conventional imaging-guided biopsy. This issue of *PET Clinics* has been prepared in the hope that it will help in the understanding of different special techniques and technical advances in PET/CT imaging, which can help to overcome the diagnostic challenges, resulting in better patient management.

Drs Hanna, Jones, and Chauhan described an overview of conventional imaging-based intervention in clinical practice. With better availability and improving technology, image-guided interventions are increasing in popularity and frequency. Imaging-guided interventions and biopsy and tumor ablations have become key tools in the oncologic practice. Radiologists performing the procedures should be aware of choosing appropriate imaging modality, appropriate instrumentation and techniques, and complications associated with it. PET/CT imaging can help identify the areas of metabolically active

tumor, which can then be specifically targeted for the purpose of biopsy, which would result in a better diagnostic yield.

Drs Kumar, Mukherjee, and Mittal mentioned special techniques in PET/CT imaging for the evaluation of head and neck cancer. FDG-PET/CT plays a significant role in the management of patients with head and neck carcinoma. However, the interpretation of FDG-PET/CT studies in the head and neck is challenging because of the inherently complex anatomy and unusual patterns of FDG uptake after radiation therapy and surgery. In addition, there is physiologic uptake of FDG uptake in brown fat, muscles, vocal cords, and lymphatic system in the head and neck region. In such cases, the use of different dynamic maneuvers, like open-mouth and puffed-cheek techniques, and pharmacologic interventions, such as propranolol and diazepam, may provide useful information about the lesion.

Drs Das, Manchanda, Panda, Sharma, and Gupta shared their experience with a review of literature about recent advances in imaging of small and large bowel using various imaging techniques. The diagnosis of bowel abnormality is challenging in view of the nonspecific clinical presentation. Cross-sectional imaging plays a pivotal role in the evaluation of small and large bowel. With the introduction of hybrid PET/CT and PET/MR imaging scanners combining the advantage of anatomic and functional techniques, there has been a paradigm shift in the imaging of various bowel pathologic abnormalities. Advents of new techniques such as PET/CT enterography and PET/CT colonography bowel imaging have reached a new zenith.

Drs Agarwal, Roy, and Kumar described the role of diuretic 18F-FDG-PET/CT in evaluation of genitourinary malignancies. The interpretation of FDG-PET/CT is often challenging for pelvic pathologies because of the physiologic bowel and urinary tract activity. Intense radiotracer activity in the urinary tract interferes with image interpretation and leads to false negative results in diagnosis and detection of local recurrence and regional lymph node metastases. It is imperative to minimize unnecessary urinary bladder activity to improve the diagnostic yield of PET/CT. Delayed images after forced diuresis with oral hydration give excellent image resolution and have the advantage of imaging the distended bladder with high lesion-to-background contrast.

Drs Higuchi, Suzuki, and Gotoh evaluated the role of PET/CT in radiofrequency ablation (RFA) for malignant pulmonary tumors. Microwave ablation and RFA are local ablative procedures in

which thermal, or heat, energy is used and tissues are destroyed by thermocoagulation. RFA is a promising alternative to both surgery and radiotherapy for tumor elimination in patients with primary or metastatic lung malignancy. FDG-PET/CT plays an important role by assessing treatment response and detecting recurrences earlier than conventional imaging. Assessing treatment response also helps in prognostication following RFA.

Drs Cerci, Tabacchi, and Bogoni shared their experience in metabolic biopsy using PET/CT guidance. PET/CT-guided biopsy offers a feasible new approach of potential value in optimizing the diagnostic yield of biopsies. PET/CT-guided biopsy is especially indicated in patients with only a metabolic lesion but no anatomic correspondent lesion and where there is associated necrosis. PET/CT imaging can help identify the areas of metabolically active tumor, which can then be specifically targeted, which would result in better diagnostic yield. PET/CT-guided biopsy might be performed in oncologic patients with metastatic disease in whom tumor transformation/mutation is suspected and in patients with new multiple lesions not known to have malignancy or who has had a prolonged remission or more than one primary malignancy.

Drs Houshmand, Salavati, Segtnan, Grupe, Højilund-Carlsen, and Alavi group, who pioneered in DTPI, described DTPI and delayed-time-point FDG-PET/CT imaging in various clinical settings. FDG is not a tumor-specific tracer; it can accumulate in a variety of benign processes, including benign tumors, and inflammatory, posttraumatic, and iatrogenic conditions. To improve the specificity of FDG for differentiation of malignant and benign lesions, DTPI and delayed-time-point imaging techniques have been introduced. In DTPI and delayed-time-point imaging, the acquisition of the PET studies is done at one standard time point and repeated after a certain amount of time. In addition, the decrease in the background activity in delayed-time points leads to enhanced lesion detection. DTPI has been shown to be useful in both malignant and nonmalignant diseases, such as in the prognostication of patients with lung cancer, diagnosis of primary breast cancer, and detection of atherosclerotic plaques.

Drs Dhull, Rana, and Nazar described the role of various contrast media being used in PET/CT imaging. Contrast agents, also called contrast materials or contrast media, are now an integral part of the diagnostic radiology. State-of-the-art diagnostic PET/CT scan with intravenous or oral contrast gives excellent anatomic details as well

as information on tumor vascularization and reduces the need for additional contrast-enhanced diagnostic imaging modalities. Contrast agents (especially positive oral contrast agents) in PET/CT may lead to overestimation of PET attenuation factors. However, this increase/overestimation of standardized uptake value is clinically insignificant.

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