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Purpose: Positron Emission Tomography (PET) images show physiological and biological information through the *in vivo* distribution of radioactive, positron-emitting agents. PET imaging shows focal and distributed regions of cancer and metastases. Initial PET uses oncology to include diagnosis and staging, which are important for determining treatment decisions. Current PET uses no longer include radiation planning followed by PET-based assessment of treatment. Hybrid PET-CT devices are beginning to be used as radiation treatment simulators.

Method and Materials: F-18-labeled Fluoro-deoxyglucose (F-18FDG) is the most commonly used PET imaging agent. FDG shows regions of active glucose metabolism, such as local cancer, metastases, non-cancer inflammation, and normal glucose use. Non-FDG agents can be more specific in cell targeting (binding), and can image different aspects of tumor biology, like hypoxia (FMISO, Cu-ATSM) and cell proliferation (FL T).

Results: PET imaging has coarse spatial resolution compared to CT and MR. PET's clinical use is valued because of its great sensitivity for cancer detection. Voxel intensity and image fidelity depend on equipment design, patient size, anatomic site, and imaging study parameters. PET-CT units enable CT-based attenuation corrections and inclusion of CT information in a registered PET-CT dataset. The Standardized Uptake Value (SUV) is a normalized intensity measure or quantitative indication of disease, and can be used to identify diseases possibly fortuitously, with certain limitations. While FDG remains the most promising agent for tumor detection, other biological agents (e.g., FMISO, Cu-ATSM for hypoxia imaging or FL T for cell proliferation imaging) might be more appropriate for target delineation and treatment assessment.

Conclusion: This course reviews PET-CT hybrid scanning devices, uses of FDG and non-FDG PET for oncology imaging, and quantitative aspects of PET-based radiation target definition and treatment assessment. Example images demonstrate the potential contributions and limitations of FDG and non-FDG PET oncology imaging. This review course is intended for both imaging and radiation oncologists.

Educational Objectives

1. Describe FDG PET imaging and oncologic indications
2. Review the uses and limitations of PET images in radiation treatment
3. Describe the SUV and other threshold parameters for target delineation
4. Review non-FDG PET imaging of tumor biology
5. Discuss quantitative aspects of PET imaging for treatment assessment