AbstractID: 2239 Title: Developments in PET/CT: from concept to practice

Accurate anatomical localization of functional abnormalities seen on PET scans is well known to be challenging owing to the lack of detailed, high resolution anatomy. For tracers such as ^{18}FDG, limited anatomical information is available from non-specific uptake in muscles, brain, heart, liver, colon and other organs, while excretion through the urinary system helps to visualize the renal collecting systems and bladder. Localization relative to such low resolution anatomical landmarks may nevertheless assist the interpretation even though a detailed anatomical framework such as provided by CT would be an evident improvement. Thus, visual fusion of the anatomical and functional image sets has often been considered sufficient to extract additional information. In cases where more accurate localization is required, software fusion can be used to align the two sets of images. Sophisticated algorithms have been developed using affine and deformable transformations to align disparate image sets from different modalities. Outside the brain, however, software fusion is difficult, and often unsuccessful owing to the many degrees of freedom accessible to the human body when imaged by two different modalities on two different occasions.

This situation improved dramatically with the recent introduction of the combined PET/CT scanner, an approach that solves the fusion problem through hardware rather than software. Since the patient remains positioned on the same bed for both imaging modalities, temporal and spatial differences between the two sets of images are minimized. Spatial differences include not only overall patient positioning and movement but also the involuntary and uncontrollable motion of internal organs. Since the introduction of the first PET/CT prototype in 1998 there have been a number of different designs from the major vendors of medical imaging equipment. All designs comprise a CT scanner placed in tandem with a PET scanner with little or no mechanical integration of the two modalities. A common patient couch, however, enables combined PET/CT imaging to be performed with an axial translation of the bed. Since patient movement is minimal and the CT and PET scans are acquired close in time, accurate alignment of the two image sets is automatic. Even though combined PET/CT scanners have been in clinical operation for less than three years, they have already evolved through a number of generations with performance enhancements in both the CT and PET components. The principal features of these designs will be reviewed, and the strengths and weaknesses of the different aspects emphasized. Particular consideration will be given to a discussion of CT-based attenuation correction. From the rapid progress seen in the past three years, it is evident that PET/CT technology will continue to evolve in the future and some potential direction for PET/CT scanners will be anticipated.

Learning objectives:

1. Current designs in combined PET/CT scanners
2. Introducing PET/CT into clinical practice
3. Future developments in PET/CT technology