EDITORIAL

Imaging and Radiation Therapy Planning

Management of cancer is fundamentally based on surgery, chemotherapy and radiation therapy. In 1896 radiation was first used for the treatment of cancer which is just one year after discovery of X-ray by Wilhem Roentgen. In current days radiation treatment can be broadly classified as external beam radiation therapy (teletherapy), brachytherapy and targeted radionuclide treatment. External beam radiation therapy (EBRT) is the most commonly used modality for curative or palliative options for management of solid tumors. Basic principle of EBRT is the delivery of high doses of radiation (photons or electrons or protons) to the tumor with minimal possible radiation induced injury to the neighboring and intervening structures. In early years of radiotherapy the magnitude of side effects was enormously high and primarily was due to limited cross sectional details required to spare or keep the vital structures away from radiation field. However, thanks to Hounsfield who in 1972 invented computerized tomography (CT) which provided a better insight to tumor geometry, its relation with surrounding structures and also made it possible to calculate the radiation dose in 3 dimensions (3D). In current clinical practice, CT based radiation planning is the standard of care and this is due to its ability to calculate the tumor dose despite of limited tissue contrast. This low tissue contrast is the major drawback of CT which poses difficulty for delineating the gross tumor volume (GTV). But robust development in linear accelerators and CT scanners has paved the path of more sophisticated and target specific 3D-conformal radiotherapy, image guided radiation therapy (IGRT), intensity modulated radiotherapy (IMRT) and volumetric modulated arc therapy (VMART) which are the main cuisines of radiation oncology suite. Magnetic resonance imaging (MRI) is a powerful non-radiation based cross sectional imaging modality which has much better soft tissue contrast than CT and for this reason has high diagnostic strength for benign and malignant lesions. However, MRI still comes at a secondary position for radiation therapy planning and this is due to its image artifacts, lack of tissue density information, and relatively small field of view (FOV). Tissue density information requires electron interaction with tissue which happens in CT but recently a common approach has been used by assigning a bulk density to the MR image using an atlas-based, electron-density mapping method but this needs further research.

In year 2000, introduction of hybrid imaging in the form of PET/CT, has revolutionized the cancer management not only for staging and restaging but also in radiation therapy planning, early response evaluation and it role as a very strong prognostic tool. This multi-dimensional role of PET/CT is due to availability of high magnitude of functional or metabolic information (PET) with high resolution anatomical details (CT). In radiation therapy planning of various solid tumors, PET/CT has become a preferred choice of radiotherapist due to better anatomical localization of tumor (CT) and selecting the metabolically active or viable tumor (PET) which results in smaller gross tumor volume (GTV), clinical target volume (CTV) and planning target volume (PTV). Obviously the outcome is better patient survival with minimal side effects resulting from sparing the vital structures away from the treatment fields. In PET imaging, various radiolabelled substrates can be used to get metabolic information like glucose metabolism (^{18}F-deoxyglucose; ^{18}FDG), tumor proliferation (^{18}F thymidine; FLT) or hypoxia (^{18}F flouromesoniadazole; FMISO or fluorine-18-fluoroazomycin-arabinoside; ^{18}F-FAZA). However, ^{18}FDG is the most commonly used radiotracer due to its availability and cost. The most important limitation of using PET/CT for treatment planning is reproducibility of tumor position in linear accelerator as well and this can only be ensured when patient is imaged and tumor is marked using the same bed (pellet) and immobilization devices as used in radiotherapy suite.

Keeping in view the phenomenal growth in imaging and radiotherapy fields, we anticipate an expanding role of imaging (both anatomical and functional) with better outcome of radiation treatment. However, to use these advance gadgets, we need to develop a better and stronger liaison among medical oncologists, radiologists, nuclear physicians, radiotherapists and medical physicists.

Maseeh uz Zaman,[1] Nosheen Fatima,[2]

[1] *Department of Radiology, Aga Khan University Hospital (AKUH), Karachi, Pakistan*

[2] *Department of Nuclear Medicine, Dr Ziauddin Hospital, Karachi, Pakistan*

Submitted 4 November 2015, Accepted 4 November 2015