NEW HORIZON

Hybrid Imaging

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" *Structure with out function is a corpse and function with out structure is a ghost"* Stephen Wainwright (1).

Hybrid imaging is the new form of synergistic imaging which combines two or more imaging technologies into a more powerful single form (2). Many hybrid imaging modalities are purely used to depict anatomy, but it's real potential is to show (in vivo) the molecular processes within their anatomic context. The presently used hybrid imaging modalities are computed tomography (CT)/ angiography, MR imaging/angiography, ultrasonography (US)/ magnetic resonance (MR) imaging, single photon emission computed tomography (SPECT)/ CT, positron emission tomography (PET)/ CT and PET/MR imaging. It is said that "today's research is tomorrow's practice" (3), and therefore importance must be given to hybrid imaging for advancing the emerging field of molecular imaging. Molecular imaging is today an an important tool for preclinical as well as clinical research at many tertiary care centres across the globe. It is a fast means to transfer discoveries made in the research laboratories into clinical practice by implementing molecularly targeted medicine. Its role is particularly important in the practise of many disciplines, including oncology, cardiology, neurology, psychiatry and pharmacology (HH).

Molecular imaging uses many different modalities, including US, CT, MRI, MR spectroscopy, PET, SPECT and optical imaging. In our institution we have been fortunate to use molecular imaging in the form of diffusion-weighted MR imaging and MR spectroscopic imaging for quite some time. Diffusion weighted MR imaging uses water molecules and MR spectroscopy uses metabolites already available in the human body. All other molecular imaging techniques presently practised, use a exogenous probes to provide imaging signal or contrast. These probes consist of a affinity component that interacts with the target and the signalling component that provides image contrast on imaging. Radiolabeled probes are used for PET or SPECT imaging, and the signaling component contains a chelate with paramagnetic atom in MR imaging and fluorochrome in optical imaging. Compositions of these probes may differ, but their primary job remains to distinguish normal tissue from abnormal/ pathologic tissue. PET is at present the most powerful and versatile imaging tool among the modalities used for fusion imaging. What makes it unique among the modalities, is not only physics of PET imaging which gives sensitivity and quantitativeness to imaging, but also the vast range of available PET radionuclides including fluorine 18 [18F], carbon 11 [11C], nitrogen 13, iodine 124 [124I], copper 64 [64Cu], gallium 68 [68Ga], and zirconium 89. The hybrid PET/CT has a number of important clinical applications. PET/CT usage is increasing day by day, not only from greater usage of 18F fluoro-deoxyglucose (FDG,) but also from the introduction of of new radiotracers. The new radiotracers range from metabolic substrates, neurotransporters and drugs. These tracers exploit the metabolism of normal/ pathologic tissue function to monoclonal antibodies, peptides, and molecules that have exquisite specificity for detecting surface/ subsurface molecules expressed in disease processes. The numbers of radiolabeled tracers used in research and patient care is increasing despite the lack of commercial availability.These new radio tracers will also enable disclosure of hidden properties of human disease pathology and help patient care.

There is initial euphoria regarding the medical aspects of PET/MRI for evaluation of various diseases. Right now there are less than 50 machines in use in the world and they're mainly at research institutions.In our country very few tertiary care corporate hospitals have taken lead and installed the PET/ MRI scanners . Because of

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the prohibitive costs involved, the PET/MRI imaging technology cannot enter routine clinical practice, moreover more clinical studies are needed to establish diagnostic accuracy, so that it can influence the routine therapeutic management in future. The most important step in the treatment of patient in present times is the diagnostic work up of the patient, it is understandable that radiologist would be very excited about the PET/CT modality, it improves tumor detection by allowing radiologists to see a morphological & metabolic aspects of lesion with very high sensitivity and high accuracy. This will also aid in the monitoring of therapy of oncology patients, with out the risk of radiation risks of PET/CT modality. There are still questions regarding the access of PET/ MRI scanner to patients because money will be the driving factor behind PET/MRI's availability. Radiologists will have to eventually prove the benefits of the technology and Considering the best diagnosis/ best treatment principle, the technology will become accessible to larger section of population in future and the prices of the technology will eventually go down. There would still be questions about the expertise of the radiologists and the additional experience will be required for optimal use of the technology. Till such times when PET/ MRI become the essential tool of work up of the routine patients, There will be dominant role of PET/ CT in oncology as well as the its newer applications in neurology, infection and / inflammation and cardiology. Because of the increasing role of PET/ CT in healthcare, it has become important for the radiologists and nuclear medicine physicians to establish new ways of communication, collaboration and research with in the institutions. Joint efforts are need of the hour for the radiologists and nuclear medicine physicians to rational use of hybrid imaging for good quality imaging and clinically relevant interpretation. Training of the already practising & future radiologists, physicians and technologists is also an important step for the future use of these technologies in these departments. Leaders of academic societies of radiology & nuclear medicine must work together for standardisation of the hybrid imaging at the national & international levels. This will promote rapid exchanges of information , which will be helpful in clinical practice and future research. The development of new tracers in essential for the progress of molecular imaging. The testing of the biosafety & biodistribution requires a team efforts. It is expected that PET tracers will change the ways disease processes are understood and managed today. Recent research in patients with dementia with amyloid plaque (4, 5) shows that PET imaging helps to detect some cases of dementia earlier than other imaging modalities. Neurologists, cardiologists and oncologists in many countries are cross training in nuclear medicine because of the ever increasing role of the PET/CT imaging in their specialities. The future of molecular imaging will also depend on the availability of trained mainpower including radiation paharmacists/ chemists, nuclear physicists, nuclear physicians and radiologist. The training of the future radiologist / physicians who will practise hybrid/ molecular imaging would require training in nuclear medicine, molecular biology and diagnostic radiology. Therefore there is need to have better coordination & understanding between the nuclear medicine & radiology communities of our country, so that knowledge form both specialities can be combined to have working relationship and pave the way for creation of a hybrid for future doctors desirous of pursuing a career as hybrid imaging specialists.

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