Nuclear Medicine

This branch of medicine sits on the fence between diagnosis and treatment. Historically nuclear medicine began in 1946 when radioactive iodine was used to treat thyroid cancer. Since then nuclear medicine has also evolved into the field of medical imaging. In contrast to traditional radiology which uses radiation from an external source and passes it through the body, nuclear medicine creates an image by measuring the emission of radiation from a radioactive source within the body. This radioactive source is administered to the patient, perhaps injected, ingested or inhaled. This imaging method differs from many of the other techniques in that it provides information on physiological function.

The radioactive substances (radiopharmaceuticals) utilise radioisotopes that emit positrons or photons. Positron emitters such as $^{18}\text{F}$ are used in PET scanning (positron emission tomography). Photon emitters such as $^{99m}\text{Tc}$ are used for SPECT imaging (single photon emission computed tomography). In this context the photon refers to gamma rays (back to the electromagnetic spectrum and ionising radiation again!).

By combining the functional information provided by nuclear imaging and the anatomical detail from more conventional methods, fused imaging such as PET-CT or PET-MRI has become very highly desirable but inevitably expensive. PET and SPECT scanners or fused scanners such as PET/CT look very much like the MRI scanner shown in the previous section.

Investigate Further

$^{18}\text{FDG}$ is a glucose analogue and is the most commonly used radiopharmaceutical for PET imaging. What are the principles of its use?

Optical Imaging

Optical imaging refers to the use of light waves from fluorescent or bioluminescent sources. Fluorescent molecules will emit light around a specific wavelength (the emission wavelength) when stimulated by light at a different defined wavelength (the excitation wavelength). Bioluminescent sources also emit light generated by a chemical reaction. It is the basis of the glow produced by fireflies for example. The major limitation of this technique in medicine is that fact that light waves are low energy (go back to the electromagnetic spectrum) and get absorbed easily by body tissues. As a result the penetration of the light through the body is limited and the depth to which this can be used is restricted. Longer wavelengths fair better, with near-infra-red wavelengths performing better in this respect. Such methods are being investigated for imaging mucosal surfaces using endoscopy for example and it is very active area of ongoing research. For more information take a look here:

In the Future

The ideal imaging method would produce three dimensional high resolution images, packed with functional information and avoid ionising radiation altogether. Medicine is a long way from achieving that!

Molecular imaging is at the forefront of medical research especially in the field of oncology for the detection of cancer and in terms of monitoring response to treatment. It is very much at the heart of the ever popular idea of “personalised medicine”.

Summary

Radiology is an outdated term that continues to be used for the speciality of medical imaging which no longer relies solely on the use of hazardous ionising radiation. Medical imaging is a rapidly growing area which receives great focus in the medical research arena. It now reaches beyond anatomical imaging and into the field of function. Medical imaging and molecular imaging in particular, will play an enormous role in the future development of concept, and hopefully the delivery, of personalised medicine. Whether you fancy a career as a doctor, a medical physicist, medical engineer or a radiographer, there will be plenty of research opportunities for you to contribute to the future for us all!