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Opinion

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The Role of Positron Emission Tomography/Magnetic Resonance Imaging

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Introduction

PET/MRI (positron emission tomography/magnetic resonance imaging) is the most sophisticated method in the field of imaging diagnosis, as well as one of the forerunners of a new modality in the area, molecular imaging. Combining PET's molecular data with MRI's morphological and functional data allows for a comprehensive and detailed assessment of the patient. The concept of hybrid technologies, or technologies that combine different diagnostic methods, was first established in Geneva in 1991, when Townsend et al. developed a PET unit with gaps between its detectors, allowing the integration of another imaging method: computed tomography (CT), as suggested by Swiss cancer surgeon Rudi Egeli. Despite this, it was only in 1998 that it was approved for clinical usage in Pittsburgh, where it provided diagnostic-quality sequential PET and CT scans. About 300 patients were scanned with PET/CT, and the positive results prompted the construction of a PET/CT equipment for commercial usage. The concept of hybrid technologies, or technologies that combine different diagnostic methods, was first established in Geneva in 1991, when Townsend et al. developed a PET unit with gaps between its detectors, allowing for the integration of another imaging method: computed tomography (CT), as suggested by Swiss cancer surgeon Rudi Egeli.

Technical Concepts of Image Acquisition

When PET data is gathered while MRI sequences are being performed in the same location, it is considered to be really simultaneous. It all starts with the capture of MRI localizer images, as it does with other sectional approaches. It attempts to define the imaging coverage region and acts as a foundation for both PET and MRI acquisition sequence programming. When a PET acquisition is started, a sequence is promptly acquired for each bed to optimise magnetic field homogeneity [1].

Clinical Applications

Head and Neck Neoplasms

Preoperatively analysing the tumor's interaction with neighbouring tissues, finding infiltration of the prevertebral fascia, and finding perineural spread, MRI has a well-established role in local staging of head and neck neoplasms.

Furthermore, in patients with cervical lymph node metastases, MRI outperforms CT in detecting occult primary neoplastic sites. In terms of imaging quality, aside from MRI's well-known superiority in spatial resolution, it's linked to a decreased prevalence of artefacts caused by metal dental artefacts, which might obstruct assessment when utilising CT.

Lung Cancer

PET/CT is the gold standard for non-small cell lung cancer staging, providing high diagnostic accuracy for the detection and delineation of primary tumours; CT images are taken during deep inspiration. PET/CT is also the gold standard in evaluating lung neoplasms because of its ability to detect localised lymph node disease and distant metastases [2]. Even though the positive predictive value of PET imaging is minimal, it has a strong negative predictive value. 38 When analysing lung neoplasms, the introduction of novel sequences and radiopharmaceuticals, such as FLT, a cell proliferation marker, might be crucial, especially when evaluating therapy response and prognostic prediction.

Breast Cancer

In women, the most common malignant neoplasm is also linked to a high mortality rate. Breast cancer staging is usually done with an MRI for local evaluation and a PET/CT for lymph node disease and, most importantly, distant metastases in more advanced instances.The second is the rate of detection of metastatic lesions, i.e. PET/increased MRI's sensitivity when combined with FDG makes it more suitable for hepatic, cerebral, and bone evaluation, but it is still limited for lung lesions detection.

Abdominal Neoplasms

Primary (hepatocarcinoma and cholangiocarcinoma) and secondary (cholangiocarcinoma) neoplasms typically affect the liver (metastases, mainly colorectal carcinoma). As a result, hepatic evaluation has emerged as one of the most important PET/MRI niches, capable of combining evaluation with functional sequences (diffusion and perfusion) as well as the use of a hepatobiliary contrast agent.

References

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