Technical and psychological aspects regarding patient preparation, and - performing high quality brain PET - scanning in patients with brain tumours, dementia and epilepsy

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General procedures

Patient preparation

Performing high quality positron emission tomography (PET) scans in patients is always a very complex challenge for the nuclear technologist. One has to focus on both technical and psychological aspects at the same time. Every case is different as the psychological requirements of each patient vary greatly. However, in patients who are having a brain PET examination the psychological aspects are often more complex since the patient may have cognitive deficits leading to altered intellectual functions. Prior to the arrival of the patient in the department it is essential to prepare oneself for which cognitive deficits the patient might have. Is the patient demented? Does the patient have intellectual alterations do to a brain tumour? Is the patient suffering from Epilepsy? Furthermore, it is also important to have prepared and defined the technical parameters of the examination and thereby having the optimal conditions for the attention to the patient. This enables the technologist to establish and maintain a confident collaboration with the patient during the examination leading to a high quality brain PET scan with increased diagnostic impact for the patient.

Scanning procedure

Before starting the scanning procedure patients should be encouraged to void the bladder for maximum comfort during the study. In order to avoid movement artefacts, the patient should be positioned as comfortable as possible on the scanner bed and the head should be maximal supported. Furthermore, the patient should be instructed of the importance not to move during scanning, and a continued supervision of the patient should take place during the whole scanning procedure. The scanning parameters of the PET/computer tomografi (CT) or PET scanner should be standardized depending of the radiopharmaceutical, the dose to the patient, the sensitivity and resolution of the scanner, and the need for the quality of the scan for the optimal diagnostic impact. Attenuation correction should be performed by either low dose CT on PET/CT scanners or performing a transmission scan using external transmission sources ([68Ge]/[137Cs]) in PET scanners.

Image post processing

Image reconstruction and post processing should be performed according to standardized protocols for the PET/CT or PET scanner. It is important to notice that different reconstruction and correction procedures lead to systematic differences in the resulting images. Fusion with, and information from morphological images such as magnetic resonance imaging (MRI) scans and diagnostic CT scans is very important for an increased diagnostic impact of the functional PET study. Since morphological information from a MRI study is superior to a CT scan, the image fusion with a MRI scan is optimal.

[18F]FDG

In the brain, glucose metabolism provides approximately 95% of the energy supply required for brain function. Under physiological conditions glucose metabolism is closely connected to neuronal activity. Therefore changes in neuronal activity induced by disease are reflected in alteration of glucose metabolism. The tracer 18-fluoro-2-deoxyglucose ([18F]FDG) is suitable for imaging regional cerebral glucose consumption with PET because it accumulates in the neuronal tissue. Since [18F]FDG PET is currently the most accurate in-vivo method for investigation of the regional human brain metabolism it has become widely used in Europe to study the diseased brain for diagnostic purposes in dementia, brain tumours and Epilepsy. When preparing a patient for a [18F]FDG PET examination the technologist has to focus on several aspects. Patients should fast for at least 4 hours before the

examination to allow for optimal cerebral FDG-uptake not influenced by increased plasma glucose levels. If the patient has a history of diabetes the blood glucose level should be checked prior to the [18F]FDG administration. Blood glucose should not extend 8.0 mmol/l. Patients should not be influenced by medication which might alter the metabolism of the brain or decrease the uptake of [18F]FDG in the Brain. The cannula for i.v. administration should be placed at least 10 minutes before the [18F]FDG administration, and the Patient should be positioned comfortably in a quiet dimly lit room with closed eyes from approximately 5 minutes before FDG administration and during the uptake phase of [18F]FDG for at least 20 minutes. For Patients with epilepsy EEG recording might be necessary prior to, and during the [18F]FDG uptake phase.

[11C]PIB

The radiopharmaceutical [11C]Pittsburgh Compound-B ([11C]PIB) binds with high affinity and specificity to amyloid structures in the brain. Since patients with Alzheimer's disease accumulates amyloid in the brain a ([11C]PIB) PET scan can provide important supplementary information in diagnosis of dementia subtypes in addition to the [18F]FDG scan. When preparing a patient for a ([11C]PIB) examination the technologist have to be aware of that the patient often have some kind of memory disorder. Allow the patient to be attended by a relative or a friend who makes the patient feel safe and who in addition may provide important information of how to guide the patient through the examination. Since the halflife of the radionuclide [11C] is only 20 minutes it is very important that the preparation of the patient has finished before the radiopharmaceutical is released by the radiopharmacy.

[15O]H2O

PET scans of regional cerebral blood flow (r-CBF) is performed by the radiotracer [15O]H2O. The scans can be done both as quantitative and non-quantitative measurements. Since the half life of the radiotracer is only approximately 2 minutes, the set up for [15O]H2O scans is rather complex. A cyclotron has to be available for the total scanning procedure for online production of [15O]. Furthermore, for repetitive measurements a system for automatic water injection is required in order to reduce the radiation exposure to the medical-technical staff. For quantification of the r-CBF simultaneous arterial blood samples are required in order to obtain an input function. Also in this case an automated blood sampling system is preferable due to radiation safety to the staff. For clinical purposes quantitative r-CBF scans is useful for studying the vascular reserve capacity of the brain by doing a DIAMOX-test and repetitive non-quantitative r-CBF activation studies may be needed for mapping of cognitive areas in the brain prior to brain surgery for epilepsy or brain tumours.

References

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