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EP-0180

Feasibility of Multi-Week PET Studies with a Single Injection of ^{89}Zr-phosphate on a Clinical PET/MRI

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Aim: ^{89}Zr-labelled *p*-isothiocyanato-desferrioxamine (^{89}Zr-DBN) is a promising new cell labeling agent that has the potential to label and track a variety of cells over multiple days (Bansal ***et al. EJNMMI Res*** (2015) 5:19). In order to better understand the inflammatory process after myocardial infarction, we are developing methods to track ^{89}Zr-DBN labeled monocytes over multiple weeks. The aim of this study was to assess the feasibility of multi-week ^{89}Zr studies on a clinical PET/MRI using a single injection of ^{89}Zr-phosphate, measuring the uptake and longevity of the tracer in target organs. **Subject & Methods:** A 24.5 kg bred-for-research hound was injected intravenously with 80 MBq of ^{89}Zr-phosphate (3D Imaging LLC). Whole-body PET/MRI (Siemens Biograph mMR) was acquired under anesthetic at 3 hours and 4, 8, 12, and 16 days after injection. Acquisitions consisted of 5-6 bed positions (20 cm each), with 15-30 minutes/bed position. After 20 days, a head and neck PET/MRI acquisition (45 minutes/bed position) preceded measurement with a whole body shadow shield gamma detector. Regions of interest included whole-body, lungs, liver, kidneys and bone (vertebrae, sacrum, sternum, ribs, scapula) and were defined using a threshold in the PET image with additional reference to anatomy in the MRI (3D Slicer). All experiments were approved by the local animal care committee. **Results:** At 3 hours, 97% of the injected dose (ID) was measured in the whole-body scan, with activity concentrated in the lungs, liver, and blood. Whole-body activity decreased to 73% ID by day 4 and stayed relatively stable thereafter: (71 ± 2)% ID when averaged over days 8-16. Uptake in different regions was also stable by day 8, with SUV = 3.3 ± 0.2 (liver), 3.2 ± 0.3 (lungs), and 10.6 ± 1.5 (bone) when averaged over days 8-16. After 20 days, whole-body activity was approximately 1 MBq, yet bones in the head and neck were still clearly visible. **Conclusion:** Longitudinal studies with ^{89}Zr benefit from a long half-life (78.4 hours) but are limited by lower injected dose and less PET-visible activity. With its increased sensitivity and additional anatomical information, the mMR is well-suited to long-term ^{89}Zr studies. With a branching ratio of 0.2275, 1 MBq ^{89}Zr is equivalent to a PET scan of 0.24 MBq ^{18}F. Despite this ultra-low dose, we were still able to delineate bones in the head and neck at day 20, demonstrating the feasibility of multi-week PET studies using ^{89}Zr-labelled cells.

EP-0181

PET/MRI technique role in Alzheimer disease

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Introduction: Hybrid or multimodal imaging has provided excellent opportunities to meet the needs inherent in the management of neurodegenerative diseases, especially in Alzheimer Disease (AD) context. Recent PET/MRI equipment for simultaneous data acquisition attempts to address this challenge. The aim of this review was to compile the main advantages related with PET/MRI along with the detection of the main challenges which remain to be resolved for a full clinical validation of the technique in Neuroimaging field are identified. **Methods:** A literature review was performed, following a PICO methodology with the question: "What is the role of PET/MRI technique in the diagnosis of neurodegenerative diseases, specifically in context of Alzheimer's disease?". Based on the formulated question, keywords and key phrases were identified for scientific database research: "Alzheimer", "neurodegenerative disease" "brain" and "PET/MRI" (disambiguation terms applied). The SCOPUS platform was used as digital repository of research. Only "article review" publications since 2010 in English language were considered. Articles feasibility was verified based on exclusion criteria: access to full version publications, verification of redundant items and empirical analysis of abstracts based on their relevance to the research question. **Results:** Based on the methodology and the inclusion criteria used, a total of 60 publications were initially obtained, which after applying the exclusion criteria dropped to a final number of 41 scientific publications. The results obtained were stratified into five categories: PET/MRI Equipments - Design and Components, Attenuation Correction in PET/MRI, image data reconstruction, PET/MRI in Clinical Neuroimaging, PET/MRI exam Protocols. **Discussion and Conclusion:** AD has been extremely influenced by the results and imaging capabilities achieved by neuroimaging techniques. PET/CT has been successfully applied in clinical practice with superior results to dedicated PET or CT options. However, the ability of MRI to obtain higher spatial resolution levels especially in soft tissues (especially critical factor in the context of the brain region) as well as the non-use of radiation made evident the need to include this technique as a new component to be included in a multimodality solution. PET/MRI bridge the limitations of PET/CT at the brain level and improving the results achieved through a simultaneous real-time combination of quantitative neurophysiological information from PET and accurate MRI morphological information, with greater radiological safety. PET/MRI technique presents high potential for diagnostic and follow-up studies. Despite the advantages, several challenges arise and PET/MRI adoption in AD imaging still need technical and clinical validation of its promising imaging characteristics.

EP-0182

Effect of attenuation and its correction in brain PET/MR imaging: a phantom study