Everything You Wanted to Know about MR-PET

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Highlights:

- Simultaneous PET and MRI data acquisition allows the spatial and temporal correlation of the measured signals;
- Simultaneously acquired MR data can be used to improve the PET data quantification;
- Quantitative PET can be used to validate a number of MR techniques;
- Proof-of-principle studies to demonstrate the unique benefits of this novel technology have been performed.

Title: PET-MR in Neuro

Target audience: neuroscientists, neuroradiologists, technologists and other researchers with an interest in brain imaging and multimodality imaging.

Objectives:

This presentation will briefly review the current state-of-the-art in the field, describe some of the methodological improvements made possible via simultaneous data acquisition and discuss potential neurological and psychiatric applications.

Summary:

MRI and PET provide complementary anatomical, physiological, metabolic and functional information about the brain. The integration of these technologies permits acquisition of spatially and temporally correlated data showing the distribution of PET radiotracers and MRI contrast agents or MR-detectable metabolites, with registration to the underlying anatomy. The features of this new technology are particularly appealing to applications in neuroscience and translational neurologic/psychiatric research, considering that MR represents the first-line diagnostic imaging modality for numerous indications and that a great number of specific PET tracers are available today to assess functional and molecular processes in the brain.

In addition to the complementary information, simultaneous PET and MRI data acquisition opens up the possibility of improving the performance of one instrument by using the information obtained from the other modality. These opportunities range from physical improvements, to methods for improving the quantification of the PET data using the MR information (i.e. MR-assisted motion and partial volume correction, image based estimation of the radiotracer arterial input function), to the possibility of using dual labeled probes for "increasing" the sensitivity of the MR by guiding the data acquisition using the PET information. Furthermore, PET and MR techniques that have been proposed for the same purpose could be cross-validated and potentially improved.

Simultaneous PET/MR is expected to be a more quantitatively accurate tool than the two methods alone, and a number of diseases may yield their secrets best to highly quantitative methods. This advantage alone could positively impact all clinical and research applications that require improved quantification. Examples that will be discussed include understanding the mechanisms of action of novel therapeutic agents (e.g. anti-angiogenic agents in glioblastoma), the exact relationship between PET and MRI findings in neurodegenerative disorders and the interaction between neurochemistry/transmitter-mediated processes in the brain and their functional consequences in the healthy brain and in various disorders.