LABORATOIRE D'INSTRUMENTATION PET & NEUROIMAGERIE

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Quantification of three-dimensional brain positron emission tomography images

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SALLE DE DEMONSTRATION I I
HUG, DEPARTEMENT DE RADIOLOGIE, ETAGE P, AILE SALEVE

PRESENTE PAR

MARIE-LOUISE MONTANDON

SERVICE DE MEDECINE NUCLEAIRE, HUG

The major focus of this work is the development of improved methods for physical quantification of tracer activity distribution in the brain using three-dimensional (3D) brain positron emission tomography (PET) by means of sophisticated image analysis and processing tools combining both functional (PET) and anatomical (MRI) imaging and the assessment of their relevance in both clinical and research settings.

The first study investigated the feasibility of using coregistered segmented MRI for attenuation correction in brain PET without the need for acquisition of an additional transmission (TX) scan. The MR images were realigned to preliminary reconstructions of PET data using an automatic algorithm and then segmented by means of a fuzzy clustering technique which identifies tissues of significantly different density and composition. The method was evaluated and validated on patient data where TX and MRI brain images were available. To further validate the developed method in a clinical environment, an exhaustive comparative evaluation of the effect of the attenuation map on absolute and relative quantification in functional brain PET imaging using 6 different attenuation correction methods was made. In the same context, the implementation and applicability of TX atlas-guided attenuation correction in clinical cerebral 3D PET was investigated. Patient-specific attenuation map was derived by non-linear warping of a TX template supplied within SPM2 software package. This template is coregistered to a specially designed ^{18}F-[FDG] template. The voxel-based analysis showed minor but statistically significant differences between atlas-guided and TX-based attenuation correction methods for 4 regions of the brain. Finally, to clarify the issue of whether scatter correction and iterative reconstruction produces significant changes in ^{18}F-[FDG] distribution of reconstructed brain PET images, the effect of model-based scatter correction in 3D brain PET studies was examined using SPM analysis in healthy volunteers instead of conventional region of interest-based evaluation. The results indicated that iterative reconstruction did not result in significant changes, while significant differences in ^{18}F-[FDG] distribution exist when images are reconstructed with and without explicit scatter correction for some cerebral areas. This needs to be acknowledged for adequate interpretation of 3D brain PET images after applying scatter correction.