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(G*) On the rationale for a standardized pre-clinical segmentation technique in PET pharmacokinetic

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Introduction: A great challenge in quantitative dynamic positron emission tomography (PET) imaging is to determine the exact volumes of interest (VOI) with which one wants to work. They have a tremendous impact on the time-activity curves that are used to extract the pharmacokinetic coefficients. Since PET images are functional and not anatomical, using a bijective relationship with a computed tomography (CT) co-image is neither the sole nor the best possibility. In recent years, many publications have come with ingenious methods to work directly with the PET images, ranging from machine learning algorithms to manual toil to define regions. These techniques have different uses, mainly in the hope of enabling easier and more efficient tumor delimitation. In the case of dynamic images, the temporal aspect of the imaging procedure changes the methods that can be implemented. Furthermore, the need to delimitate specific and precise functional sites render the whole operation computationally and physically challenging, especially in the absence of a common and well-established methodology.
Methodology: In this project, a novel approach using a gradient-based segmentation was used on pre-clinical dynamic PET images on rats. Fourteen different animals were used under similar pre-clinical conditions. The developed segmentation technique uses properties of the image itself, relying on already known properties of the radio-drug used in order to segment automatically the kidney of the animal. The work was conducted using the mini-PET scanner at the Montreal Neurological Institute, according to the ethical guideline from the University of Montréal and the Canadian Tri-Council.
Results: From the preliminary data, the proposed method has a relevant rate of success on clinical images in delimitating the volumes of interest. The respective time-activity curves follow the general pattern of the manual delimitations done by experts, yet with non-negligible differences. So far, the proposed technique offers good result on 8 of the 14 rats, as compared to 12 rats when using a manual segmentation. The greatest strength of the algorithm is its ability to reproduce the same results notwithstanding the operator. The technique can also quantify movement in the organ of interest and work in spite of a great amount of Gaussian noise.
Keywords: Nuclear Medicine, pre-clinical dynamic PET imaging, pharmacokinetic

Author: LAPORTE, Philippe (Université de Montréal)

Presenter: LAPORTE, Philippe (Université de Montréal)

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