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Effects of decay correction in autoradiography method

Introduction

This document reviews autoradiography –method and the effect that decay correction can have on flow results when the PET image data is static.
With static image we have to assume that the activity is constant throughout the whole scanning period. In reality this is of course not true and thus the assumption may lead to incorrect decay correction and thus biased flow estimates.

Autoradiography –method

Autoradiography –method assumes that the partition coefficient ($p=K_1/k_2$) is known. The blood curve and a two-compartment model are used to simulate tissue time activity curves (TAC) with different perfusion values. All the simulated tissue TACs are integrated over a specified time and the integral values are compared to integrated PET image curves pixel-by-pixel. Perfusion estimate for each pixel is set based on the similarity of integral value in that pixel and integral value of a simulated tissue curve.
More about the method at
http://www.turkupetcentre.net/analysis/doc/tracer/arg_h2o.html.

Differences between analysis on static and dynamic images

There are some differences between perfusion results from dynamic and static images. This is assumed to results from the decay correction as described in the introduction.

When correcting static images for decay, the assumption is that activity has been constant for the whole scanning period and the decay correction is done according to formula

$$A_{t^*} = A_t \frac{e^{\lambda t_1}\lambda(t_2 - t_1)}{1 - e^{-\lambda(t_2 - t_1)}},$$

where A_t is the measured activity (over the scanning period) and A_{t^*} is the activity (over the same period) that is corrected for decay. For static image, the time points t_1 is the start time and t_2 the end time of scanning period.
For a dynamic image, the decay correction is done with this same formula separately for each frame. Time points t_1 and t_2 are in this case the start and end times of the frame. More about decay correction at
http://www.turkupetcentre.net/analysis/doc/decay.html.

Autoradiography simulates dynamic TACs and thus for static data the decay corrections between simulated and measured curves are not consistent. To solve this problem a correction method was implemented. This means that in case of static images the simulation of tissue curves is done a bit differently with following steps:

1. dynamic TACs are simulated
2. the decay correction is removed
3. the TAC is averaged over the scanning period
4. averaged value is corrected for decay
5. decay corrected value is multiplied with the length of the scanning period to receive the integral that is compared with measured data integrals.

In practice the correction is done when option –static=y is given to program `arlkup`. Without the option, the program does the decay corrections as normally to dynamic data.

References

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