SPECTRAL ANALYSIS ITERATIVE FILTER METHOD FOR VOXEL-WISE QUANTIFICATION OF PET TRACERS WITH IRREVERSIBLE UPTAKE IN NOT BRAIN TISSUES

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INTRODUCTION

Spectral Analysis Iterative Filter (SAIF) is a Spectral Analysis (SA) based method originally developed for the quantification of L-[1-^{11}C]Leucine PET brain data [1]. The method implements a filtering procedure which aims to reduce the impact of the noise and to describe the tracer time-activity curve in tissue in terms of an optimal subset of kinetic components. As the other SA techniques, SAIF allows also to quantify physiological macroparameters, as the irreversible uptake of tracer in the tissue (K_i, ml/g/min), and it can be applied both to homogenous and heterogeneous tissues (no a priori assumptions required).

This study aims to verify the extendibility of SAIF for the voxel-wise quantification of not brain tissues investigated with irreversible uptake PET tracers.

MATERIAL AND METHODS

Two different datasets were analyzed at voxel level: [^{18}F]FDG in skeletal muscle [2] (5 subjects) and [^{18}F]-FLT in breast cancer [3] (3 subjects). For each tracer voxel-wise analysis was performed with both standard SA and SAIF methods and results compared to other voxel-wise methods, i.e. Weighted Non-Linear Least Squares (WNLLS) applied to compartmental model and Patlak plot.

As performance index, mean relative differences (MRD) of voxel K_i estimates between methods has been evaluated. The agreement of parametric maps and rate of estimates in not physiological range (voxel failure rate, VFR) were computed.

RESULTS

Analysis of [^{18}F]FDG data showed high correlation (R^2>0.97) and consistency between all the compared methods (Fig, Panel A), even if Patlak tends to overestimate spectral analysis results (MRD ~10%) which overestimated voxel-wise WNLLS estimates as well (MRD ~11%). SAIF resulted to be more robust with a VFR <1%, whereas more than 40% of SA estimates had to be eliminated because not physiological (Fig, Panel C).

In [^{18}F]FLT, high correlation (R^2=0.99) was detected for all the methods. The higher discrepancy in mean of voxel-wise results was measured between Patlak and WNLLS (Fig, Panel B) in healthy breast (MRD -15%) and in tumor regions (MRD -10%). Both SA and SAIF reported MRD <10% in healthy breast and <3% in tumor regions. In general the higher the tissues uptake, the lower the difference between methods. SAIF demonstrated to be the most robust method with VFR <20% in healthy breast and <1% in tumor (Fig, Panel D). This result was not achieved by standard SA and Patlak plot. WNLLS

demonstrated to be the most sensible to the noise in the data (VFR >50% in healthy breast and >20% in tumor). The different behaviour in these regions is justifiable by the higher uptake of the tracer in tumor than in healthy breast (~3 times more).

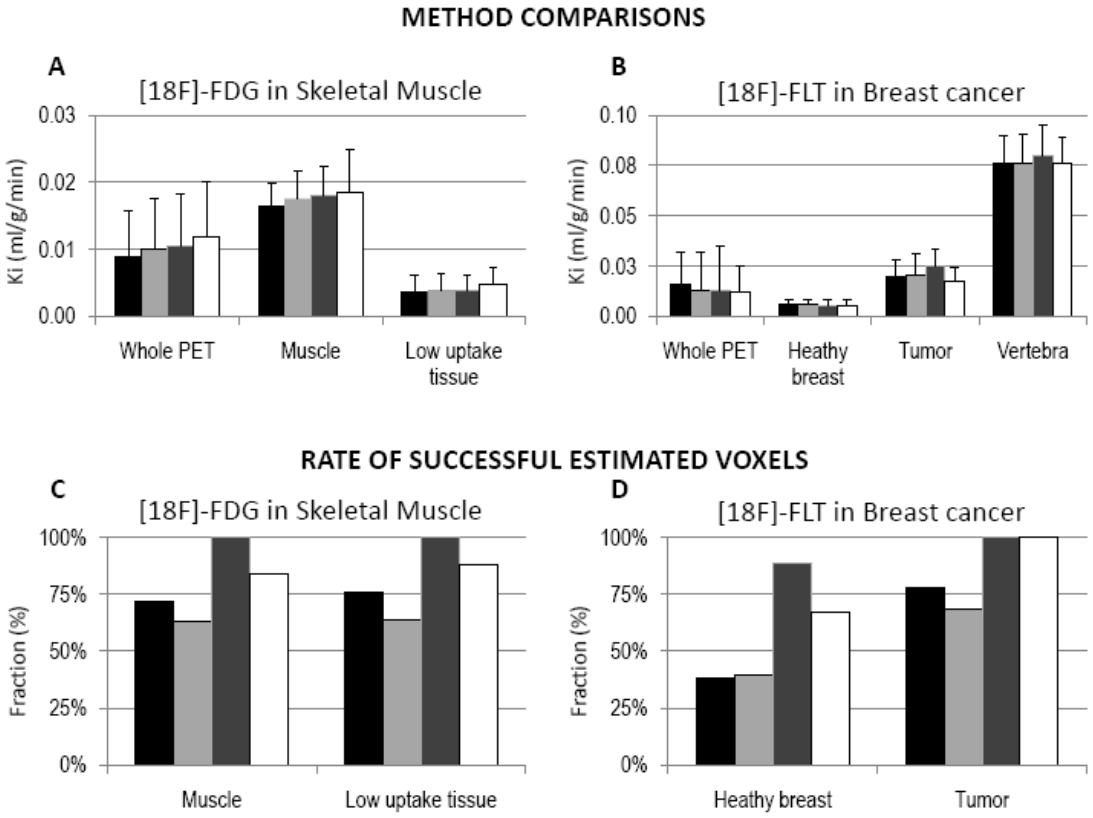
CONCLUSIONS

Our results confirmed the possibility to use SAIF as a valid alternative for the voxel analysis of PET tracer with irreversible tissue uptake. SAIF showed to be more robust to the noise in the data compared with all the other methods including the Patlak plot and not filtered spectral analysis. The method is ready for clinical application.

REFERENCES

[1] Veronese M et al., *JCBFM* 2010
[2] Bertoldo A et al., Am J Physiol Endocrinol Metab 2001
[3] Kenny LM et al., Cancer Research 2005

FIGURE



The figure shows the results of voxel-wise quantification with the proposed methods (black bars: WNLLS; light-gray bars: standard SA; dark-gray bars: SAIF; white bars: Patlak plot) for [^{18}F]FDG applied to skeletal muscle (panel A and C) and for [^{18}F]FLT applied to breast cancer subjects (panel B and D). Panel A and B compare the means of voxel-wise Ki estimates within regions of interest. Panel C and D report the fractions of successfully estimated voxels over all region voxels.