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Direct reconstruction of sinograms to parametric images of ^{18}F-fallypride binding in monkey brain

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Introduction: We introduced a method to reconstruct dense parametric images directly from dynamic sinogram data (Kamasak et al., 2005). Here, we apply direct reconstruction (D-RECON) to parametric (K_1, k_2, k_3, k_4) images characterizing the uptake and retention of the D2/D3 neuroreceptor tracer, ^{18}F-fallypride, acquired with dynamic PET on a rhesus monkey. Convergence of the iterative reconstruction algorithm is aided by spatial regularization of the kinetic parameters. Routine use of D-RECON would make better use of acquired data, facilitate brain-wide investigations with high affinity tracers, and reduce data storage requirements. D-RECON could provide clinicians with images containing only physiologically pertinent information for diagnosis and exclude possible "nuisance" information.

Methods: Data were collected on an EXACT HR+ scanner and corrected for attenuation, scatter, normalization, and dead time. Fourier rebinning (FORE) was performed, yielding 2D sinograms (Defrise et al., 1997). Sinograms underwent D-RECON using the previously published algorithm (Kamasak et al., 2005). D-RECON incorporates a two-tissue compartment model into iterative reconstruction based on the MAP framework. Spatial regularization was applied as a constraint on each iteration of D-RECON; a regularization parameter, σ_{ki}, for each kinetic parameter, k_i, was required. Here, σ_{ki} were chosen empirically, assuming that dissociation of tracer from receptor (k_4) and efflux to plasma (k_2) would be less variable spatially than receptor binding (k_3). Results using different regularizations were compared to conventional regional estimates of k_i, made previously via multiple-injection experiments in the same monkey (Christian et al.).

Results: Parametric images of the monkey brain are shown. Images of k_2 and k_4 are very smooth because of high regularization. With high regularization in k_2 and k_4, D-RECON reproduced a dynamic range of binding potential (BP = k_3/k_4) by region that is consistent with conventional estimates (Christian et al.). Ratio of BP in striatum to cortex was approximately 33:1 for both methods.

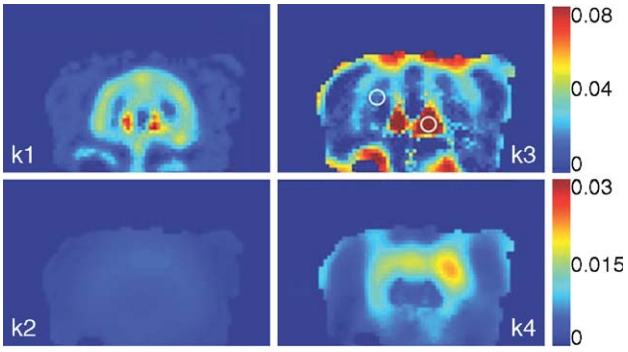

Fig. 1. Coronal view of parametric images through the striatum of a monkey. Tracer was ^{18}F-fallypride. Circles on cortex and striatum in k_3 image indicate regions used for comparison.

Discussion: Using simulated sinograms, we had previously established the superior error performance of D-RECON vs. other methods of parametric image generation (Kamasak et al., 2005). We have now produced parametric images from experimental sinograms of ^{18}F-fallypride uptake. A regularization scheme chosen to be consistent with our expectation of parameter variability reproduced the range of BP values that we measured with ROI-based analysis. Determining the proper regularization is a calibration of the algorithm that should be performed prior to routine use. Once in routine use, D-RECON should facilitate quantitative investigation of tracer behavior throughout the brain without having to manage emission images, place ROIs, or contend with ROI-generated curves.

References:
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