Master’s Thesis in Engineering Physics

Optimization of image reconstruction of $^{123}$I DAT SPECT with a LEGP collimator

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Abstract

The purpose of this study was to optimize the reconstruction protocol for $^{123}$I DAT SPECT with LEGP collimators for an Infinia Hawkeye SPECT/CT, using the resolution recovery algorithm Evolution Toolkit. Evolution Toolkit introduces an improved iterative reconstruction process and collimator-detector response (CDR) correction, previously unavailable in current reconstruction protocols. Images were collected from a large, on-going longitudinal clinical research project on Parkinson’s disease (PD) at Umeå University. $^{123}$I DAT SPECT image sets of forty subjects were selected – twenty with PD diagnosis and twenty healthy controls. Subjects were selected to have similar age 69.05±3.55 years (control) and 70.36±3.82 years (PD); projections acquired from the same camera system; and a similar acquisition distance: 15.39±0.55cm (control) and 15.50±0.85 (PD). By utilizing a digital Monte Carlo simulated phantom, the ideal number of reconstruction steps, and the optimal cut-off frequency for the Butterworth filter were obtained. The optimal cut-off frequency for the Butterworth filter was determined to 0.50 cm$^{-1}$ with a power of 8, and the optimal number of iterative reconstruction steps was determined to be 8 with 6 subsets. These results were acquired experimentally and were subject to visual review by an experienced nuclear medicine physician. Additionally, relative uptake ratio quantification of $^{123}$I DAT SPECT in the basal ganglia was obtained for each patient using the software Exini DAT™ (Exini Diagnostics AB) on the optimized (O) tomographic images and conventionally (C) reconstructed images. The reference area for each relative uptake ratio was the occipital lobe. The means of both sides for caudate (O: 7.22±1.04, C: 6.64±1.07), putamen (O: 5.47±0.93, C: 5.80±1.04), and striatum (O: 6.26±0.96, C: 5.21±0.97) of the control group were compared to the side with lowest uptake in the caudate (O: 4.30±1.36, C: 3.73±1.14), putamen (O: 2.08±0.79, C: 1.98±0.72) and striatum (O: 3.09±0.79, C: 2.78±0.90) respectively of the PD group. The PD group was found to have statistically lower uptake ratios than the control group in both reconstructions ($p<0.001$). A general increase of the mean and standard deviations of the optimized reconstruction was found.