Radiation Dose Reduction in Dynamic, Contrast-Enhanced Cerebral Computed Tomography

Ph.D. Dissertation

by

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Abstract:

Dynamic, contrast-enhanced cerebral imaging protocols including Computed Tomography Angiography (CTA) and CT Perfusion (CTP) are vital diagnostic tools to assess neurovascular disease. However, radiation dose delivered to patients in time-resolved CT protocols is high and potential risk associated with the ionizing radiation dose exists. Thus, minimizing radiation dose is highly desirable for time-resolved CT imaging. In order to reduce the radiation dose delivered during dynamic, contrast-enhanced CT applications, the CT formulation of HighlY constrained back PRojection (HYPR) imaging is applied to dynamic cerebral CT imaging. Radiation dose reduction techniques of acquiring a reduced number of projections for each image and lowering the tube current used during acquisition are explored. HYPR image reconstruction is used to produce image sets at a reduced patient dose and with low image noise. Additionally, spatial resolution in the axial plane to eliminate the partial volume effect in CTP imaging is examined using HYPR image processing. Numerical phantom experiments and retrospective analysis of *in vivo* canine studies and human subject scan data are used to assess the accuracy and quality of HYPR reduced dose image sets and validate our approach. Experimental results demonstrate that a factor of 6-8 times radiation dose reduction for time-resolved CTA, a factor of 4 times radiation dose reduction for CTP and axial resolution improvements of a factor of 4 are possible when the HYPR algorithm is applied to time-resolved cerebral CT imaging protocols.