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Modern Techniques in Cranial Computed Tomography

Autor: Holger Haubenreisser
Institut / Klinik: Institut für Klinische Radiologie und Nuklearmedizin
Doktorvater: Prof. Dr. T. Henzler

Cranial computed tomography (CCT) is the first-line imaging modality of choice to rule out intracranial hemorrhage in cases of trauma and other acute neurological emergencies. Approximately two thirds of all CT examinations include an examination of the cranium. Traditionally, CCT examinations are reconstructed with relatively high image slice widths (approximately 3–5 mm) when using FBP reconstruction, as thinner slices are associated with linear increases in image noise and thus reduced image quality. Further, these studies are usually acquired using a sequential acquisition mode as these has traditionally been the method to achieve optimal image quality.
The overall aim of this thesis was to demonstrate the benefits of integrating modern, CT techniques such as iterative reconstruction (IR) algorithms in a clinical CCT workflow. The primary focus of the investigation was the improvement of subjective and objective image quality of CCT examinations. The cranium was chosen as the examination region of interest, as this region consists of anatomic features that make imaging challenging. This thesis consists of two individual study arms.
The first arm (Study Arm A) aims to demonstrate the improvement of image quality when using a 2^{nd} generation IR algorithm over traditional FBP algorithms, using an intra-individual comparison with identical acquisition parameters. The ultimate goal was to investigate the feasibility of reconstructing thinner images while maintaining constant image quality.
The second arm (Study Arm B) aims to intra-individually compare image quality of a 3^{rd} generation DSCT spiral cranial CT to the traditionally used sequential 4-slice single source CT while maintaining identical intra-individual radiation dose levels. We aimed to demonstrate that combination of image quality improvements due to IR coupled with a modern detector should allow for the introduction of spiral CCT techniques into routine clinical brain imaging.
40 patients were included in Study Arm A, and 35 patients were included in Study Arm B. Patients in both study arms received spiral CCT examinations on a 2^{nd} (Arm A) or 3^{rd} (Arm B) generation dual source CT system. Images were reconstructed with a 2^{nd} (Arm A) or 3^{rd} (Arm B) generation IR algorithm. Both objective and subjective image quality assessments were performed for both Study arms.
For Study Arm A, IR was found to improve image quality sufficiently that it was possible to perform thin slice (1-2mm axial) reconstructions using the same raw data set, at a similar noise level to thick slice (5mm) reconstructions when using filtered back projection. Study Arm B showed that it is possible to combine iterative reconstruction with a new generation CT system to acquire spiral images that are comparable or better than standard acquisitions performed on a routine CT system in sequential acquisition mode.
In conclusion, this thesis shows how IR can positively impact clinical routine CCT examinations, thus allowing for the CCT examination to be tailored to the specific clinical setting. This can have the effect of reducing false positives, or to generally improve diagnostic confidence, as well as to move quicker examination techniques into standard clinical practice.