ORAL PRESENTATIONS

Applications of strategically acquired gradient echo imaging to neurodegenerative diseases

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Background

One major thrust in radiology today is image standardization with a focus on rapid, quantitative, multi-contrast data collection and processing.

Methods

Strategically acquired gradient echo (STAGE) imaging[1-4] is one such method that uses multiple flip angles and multiple echo times. It can provide 8 qualitative and 7 quantitative images as well as transmit field B1 transmit field and B1 receive field maps in 4-6 minutes or less on a 3T magnetic resonance (MR) scanner. STAGE provides qualitative images in the form of proton density-weighted images, T1 weighted images and T2* weighted images. STAGE provides quantitative data in the form of proton spin density (PSD), T1, T2* and susceptibility maps as well as segmentation of white matter, gray matter and cerebrospinal fluid via simulated double inversion recovery (sDIR) images. STAGE has been tested using the NIST phantom and yields intrasubject errors of only 1-2% and intrasubject variation of 2 to 5% (depending on the size of the structure being evaluated, with larger structures having less error). Contrast-to-noise ratio (CNR) measurements show that the T1WE images are comparable to the conventional T1W MP-RAGE images. Today these quantitative measures are providing new biomarkers for imaging a variety of neurodegenerative diseases (Figure 1).

Results

During the last few years, we have focused on measuring iron content and neuromelanin (NM) in the substantia nigra (SN) for comparing idiopathic Parkinson's disease (PD) with healthy controls and patients with other movement disorders. We have found that the volume of NM, the iron content of the SN, the volume of the SN and the N1 sign all together can provide an area under the curve of 95% in distinguishing PD from healthy controls.[5] We have developed a template of the midbrain to allow for automatic detection and quantification of these properties. We use tSWI to enhance the N1 sign visibility. We have also used STAGE to study multiple sclerosis (MS) lesions. QSM can be used to map changes in white matter susceptibility and potentially correlated with demyelination. We provide a composite image using tSWI combined with fluid-attenuated inversion recovery (FLAIR) to highlight those lesions that are purely inflammatory from inflammatory demyelinating lesions. Recently we have begun to study the use of absolute water content as a measure of lesion atrophy. Higher water content means a higher likelihood of tissue damage. This also explains why the presence of "black holes" seen in T1W images of MS patients tends to correlate with the expanded disability status score.

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Conclusions

In summary, STAGE provides a comprehensive clinical imaging protocol that, combined with diffusion-weighted imaging (DWI) and FLAIR, can yield a standardized 10-minute (3T) o 15-minute (1.5T) imaging protocol of the entire brain across all manufacturers.

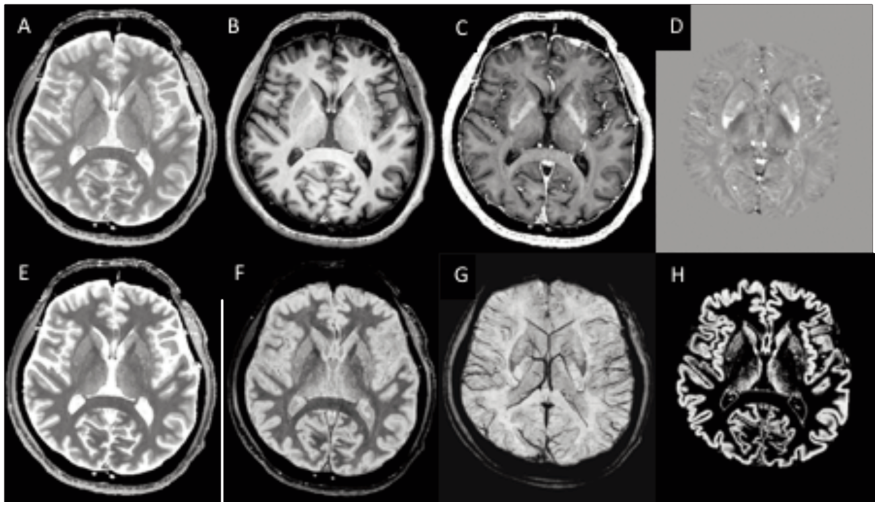

Figure 1. A) PSD map, B) T1W enhanced; C) R2* map; D) QSM; E) T1 map; F) PSD weighted; G) SWI; and H) simulated double inversion recovery (sDIR) for gray matter. Resolution 0.67 x 1 x 1.34mm³, 3 echo data, total time 4min48sec per flip angle.

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