Routine Brain and Spine MRI protocols for patients with DBS equipment *in situ* consistent with B1+rms -limited MR Conditional product label

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Background. Increasing numbers of patients worldwide with *in situ* deep brain stimulation (DBS) systems are likely to require MRI at some stage of their lives, possibly for indications completely independent of their DBS therapy. Until recently patients with DBS devices could only be scanned using a transmit/receive head coil and very low SAR sequences (<0.1 W/Kg) which can be very challenging for clinical examinations. Recently two of the DBS manufacturers have released MR-conditional product labels for some of their deep brain stimulation (DBS) devices limiting B1+rms whilst using body transmit coils. B1+rms-limited product-label compliant versions of routine brain and spine protocols were created by adjusting sequence parameters while aiming to maintain image quality, and tested in healthy volunteers. We additionally report our experience using these protocols in patients with implanted DBS devices.

Methods. New routine brain and spine MRI protocols were designed with the following criteria: 1. B1+rms≤2.0μT at 1.5T in whole-body transmit mode, 2. Minimal changes to parameters that affect image quality and resolution and 3. Each sequence to be less than 6 mins. Healthy volunteers (12 for brain and 6 for spine) were scanned using both the conventional and the new B1+rms-limited protocols. Qualitatively, the signal-to-noise ratio (SNR), contrast-to-noise ratio (CNR), image sharpness and artefacts were rated by experienced neuroradiologists. Additionally for the brain scans, quantitative SNR and grey matter/white matter CNR were obtained based on regions from anatomical labelling using a geodesic information flow approach[1]. To date, 26 patients with *in situ* DBS have been referred for routine MRI.

Results. There was a 28.7%-56.6% increase in total scan time with B1+rms -limited *vs.* conventional routine brain and spine protocols. For the B1+rms-limited sequences, head specific absorption rate (SAR) varied between 0.5-1.1 W/kg for the brain protocol, and the whole-body SAR varied between 0.3-0.8 W/kg for the spine; as expected, the B1+rms was approximately the same across subjects. For the majority of subjects the image quality of the B1+rms-limited scans was either equivalent to, or exceeded, that of our routine protocols. Quantitative SNRs and GM/WM CNRs for the routine brain and B1+rms-limited sequences were similar. We successfully scanned 20 DBS patients with our protocols, while 6 were refused MRI due to electrode impedances exceeding MRI label limits.

Conclusion. Our analysis showed the new sequences produced images of similar or marginally better image quality than the conventional protocols used in our centre. Monitoring/limiting B1+rms instead of SAR has an additional advantage of values remaining constant irrespective of patient size, so there is no requirement to adjust sequence parameters for each patient. The new protocols will allow the growing number of patients with *in situ* DBS systems to undergo neurological MRI examinations.

References. [1.]M. J. Cardoso, et al., Geodesic Information Flows: Spatially-Variant Graphs and Their Application to Segmentation and Fusion, 2015 IEEE Transactions on Medical Imaging, vol. 34, no. 9, pp. 1976-1988

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