Contrast assessment of Synthetic Magnetic Resonance Imaging in clinical practice

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Introduction. Synthetic Magnetic Resonance Imaging[1] is based on a single MR quantification scan after which a whole range of conventional images can be recreated. A fast quantification method may replace a set of conventional T1W, T2W and FLAIR images, thereby saving examination time. The approach also removes the scanner dependency and may form a robust basis for computer aided diagnosis. The aim of the study was to correlate the contrast and contrast to noise ratio (CNR) of a set of conventional images with synthetic images, acquired in less than half the scan time.

Methods. Conventional T1W, T2W and FLAIR images were acquired in 5:11, 3:42 and 6:01 minutes, respectively (total 14:54 minutes) at an in-plane resolution of 0.7, 0.9 and 0.9 mm respectively. The quantification sequence[2] was acquired in a scan time of 5:48 minutes with an in-plane resolution of 1.0 mm. The scanner was a 1.5T Achieva (Philips, Best, The Netherlands). Synthetic images were created using SyMRI Brain Studio (SyntheticMR AB, Sweden).
Scanned were 22 patients (8 Multiple Sclerosis, 7 ischemic and 7 unclear diagnose), aged 20–84 years. Regions of interest were positioned in cerebrospinal fluid (bilaterally in the anterior horn of the lateral ventricles), grey matter (bilaterally in the thalamus, the occipital cortex and the frontal cortex), and white matter (bilaterally in the centrum semiovale and for the corpus calosum one in the genu and one in the splenium), in total 12 roi's per patient. In 15 patients a roi was placed on a visible white matter lesion. The contrast between roi's was calculated as the signal difference divided by the sum of the signals, the CNR was calculated as the signal difference divided by the median standard deviation of all 12 roi's.

Results. Linear regression showed that the synthetic T1W images had 21% better contrast (with a 95% confidence interval of 15-28%) but 7% worse CNR (CI: 1-14%) than the conventional T1W images. For the synthetic T2W images this was 16% better contrast (CI: 13-20%) and 16% better CNR (CI: 14-19%) and for FLAIR a 19% worse contrast (CI: 13-24%) and 38% worse CNR (CI: 24-42%). If only WM-GM and WM-lesion contrast was taken into account these values were +32/+2, +22/+20 and +25/-21, respectively.

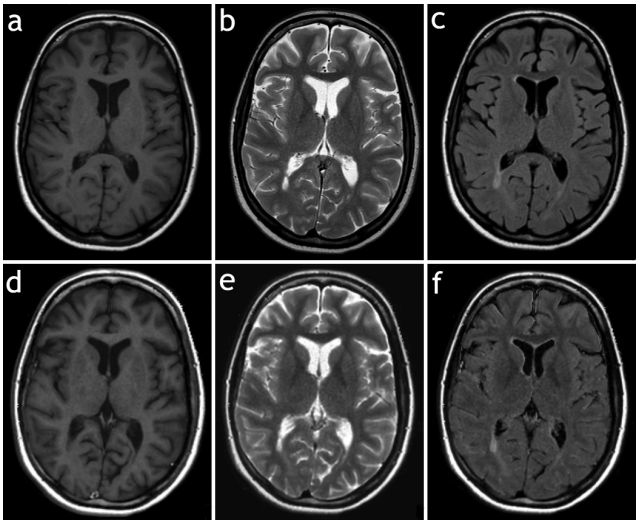

Fig. 1. *Example of an axial slice of the brain of a conventional T1W (a), T2W (b) and FLAIR (c) image. On the bottom row the corresponding synthetic images (d-f) are shown. All three synthetic images have been reconstructed using the same scan. The total scan time of the conventional images was 14:54 minutes, of the synthetic images 5:48 minutes.*

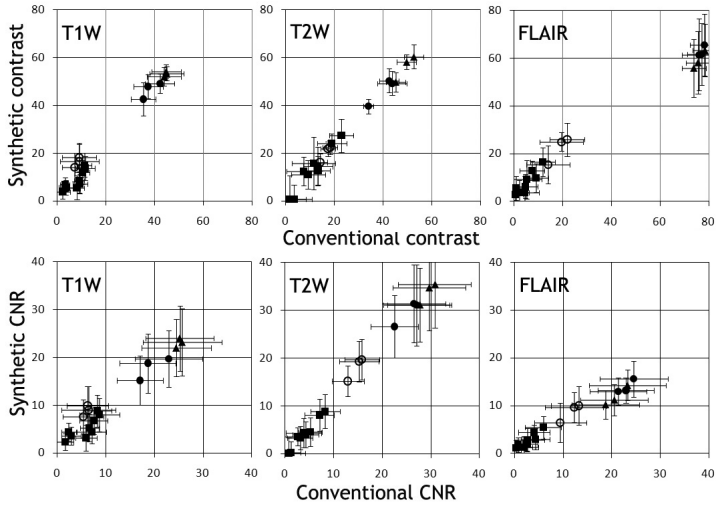

Fig. 2. *Contrast between regions of interest in WM and GM (squares), between CSF and GM (dots), between WM and CSF (triangles) and between WM and lesions (circles) for conventional and synthetic T1W, T2W and FLAIR image (in %). The error bars indicate the standard deviation. Similar for CNR on the bottom row.*

Conclusion. Although the contrast of synthetic MR images should be identical to the corresponding conventional MR images it was generally better for this particular quantification sequence. The noise, on the other hand, was worse leading to a comparable CNR. The synthetic FLAIR images underachieved mainly due to the noise in the CSF. The scan time of the synthetic approach was substantially shorter, at 40% of the time required for the conventional acquisitions.

1. Riederer SJ, Lee JN, Farzeneh F, Wang HZ, Wright RC. Magnetic resonance image synthesis. Acta Radiol Suppl 1986;369:466-468.
2. J.B.M. Warntjes, O. Dahlqvist Leinhard, J. West and P. Lundberg, Optimization for Clinical Usage of Rapid Magnetic Resonance Quantification on the brain., Magn Reson Med 60; 320-329(2008).