SNR: Performance assessment of MRI including parallel imaging techniques

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INTRODUCTION:

Performance assessment of MRI systems is crucial for ensuring a scanner performs at its optimal level. MagNET currently performs type test, acceptance tests and other daily quality assurance tests. Parameters tested include: signal-to-noise ratio (SNR), uniformity, ghosting, slice width, slice position, geometric distortion and spatial resolution [1]. SNR is the single most important measurement factor. The purpose of this work was to evaluate parallel imaging techniques using SNR tests. These tests provide a good indication of the overall scanner performance and are affected by the coil design amongst other hardware factors.

METHODS:

Performance assessment was evaluated on three different MR systems. K-space based parallel imaging methods were evaluated for systems A and B. System C employs image-based parallel imaging methods. For each, the standard head coil was tested followed by testing of the 8-channel head coils for different parallel imaging factors.

SNR was evaluated using two identical sets of images acquired for the same scan plane. The protocol followed was a SE sequence with parameters being: TR=30ms, TR=1000ms, NSA=1, FOV=250mm, Matrix=256x256, parallel imaging factors=0,2,4,6 depending on availability. A flood field test object (figure 1) containing salt was placed in the centre of the coil. The subtraction of the two images was used for analysis of SNR [2].

Figure 1: Flood field test object

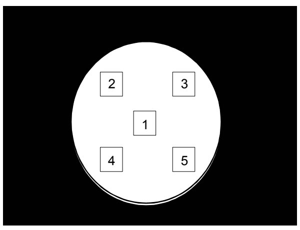
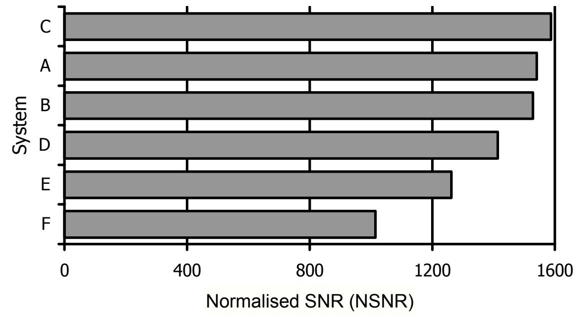


Figure 2: ROI placement

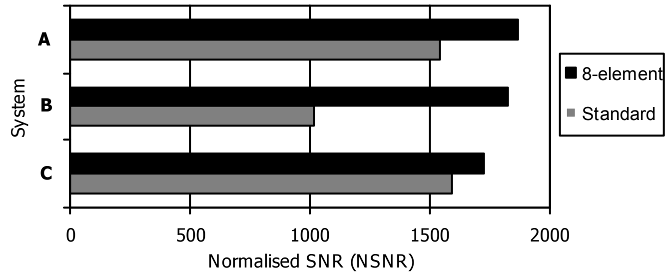
RESULTS:

Signal intensity of five regions on interest (ROI) from one image and the standard deviation of the same five ROI's were used to calculate SNR (figure 2). As system noise is spatially dependant, the average of the signal intensity and standard deviation was taken. SNR was then normalized for voxel size, scan time and sampling bandwidth [2].

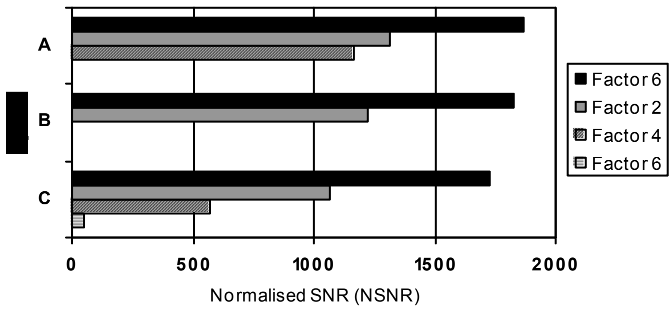
Results acquired from MagNET's type test for SNR are shown in graph 1. System's A, B and C corresponds to the three systems tested in this study. Graph 2 represents the SNR results from measurements taken of a standard head coil compared to the SNR values from the parallel imaging head coil for each system. The effect of varying parallel imaging factors on SNR is shown in graph 3. SNR is inversely related to increasing parallel imaging factors.



Graph 1: Type test SNR comparison data [3]



Graph 2: SNR results from both a standard head coil and a parallel imaging head coil [3]



Graph 3: SNR versus parallel imaging factors [3]

DISCUSSION:

Although parallel imaging techniques are advantageous in that they enable faster image acquisition and improved spatial resolution, SNR is of concern along with the presence of image artifacts. Consequently, in order to ensure the system hardware is performing optimally, daily performance assessment is essential. Of utmost importance is the evaluation of SNR and uniformity parameters. The results achieved indicate that standard performance assessment tests are adequate for evaluating parallel imaging techniques.

REFERENCES:

[1] De Wilde J, Price D, Curran J et al. *Standardization of performance evaluation in MRI: 13 years' experience of intersystem comparison.* Concepts in Magnetic Resonance, Vol 15 (1), 2001

[2] Lerski R, De Wilde J, Boyce D and Ridgway J. *Quality control in Magnetic Resonance Imaging.* IPEM Report No. 80

[3] De Wilde J, Price D, Renaud C et al. *1.5T MRI comparison report.* Version 4. MHRA 03025, 2003