SNR evaluation of 32 channel cardiac coils in DENSE MRI at 1.5 and 3T

A. Sigfridsson[1,2], H. Haraldsson[1,2], T. Ebbers[1,2], H. Knutsson[2,3], and H. Sakuma[4]
[1]Clinical Physiology, Linköping University, Linköping, Sweden, [2]CMIV, Linköping University, Linköping, Sweden, [3]Biomedical Engineering, Linköping University, Linköping, Sweden, [4]Radiology, Mie University, Tsu, Mie, Japan

Introduction:

Myocardial strain assessment based on Displacement ENcoding with Stimulated Echoes (DENSE) MRI is a powerful tool to study myocardial function. Unfortunately, low SNR caused by T_1 relaxation and excitation puts a limit on the number of cardiac phases that can be resolved. Several techniques to improve the SNR have been previously presented, with associated trade-offs. The regional coil sensitivity is also known to influence SNR, and may be improved by using different coil designs with little effect on the acquisition. In this work, we evaluate the SNR when using 32 channel cardiac coils compared to standard 5 or 6 channel coils at 1.5T and 3T.

Methods:

Five healthy volunteers were examined in 1.5T and 3T Philips Achieva MRI systems using both 32 channel coils and the standard cardiac coils, consisting of 5 and 6 elements at 1.5T and 3T, respectively. The examinations were consecutively performed by the same technologist in a randomized order with respect to both coils and field strength. Left ventricular short axes were acquired using the following parameters: field of view 350 mm, slice thickness 8 mm, matrix 128x120, SENSE factor 2, TFE-factor 3, EPI-factor 7, heart phase interval 50ms, TR 8.5-9.9 ms, TE 4.1-4.6. The variable flip angle was optimized for maximum constant SNR [1, 2]. In order to correct for background phase errors, three oblique directions were displacement encoded [3] using a displacement encoding strength of 0.35 cycles per pixel. The artifact from the T_1 relaxation was suppressed using a combination of CSPAMM [1] and *k*-space filtering [3]. Each direction was encoded in six cardiac cycles, resulting in a total breath hold time of 18 RR-intervals.

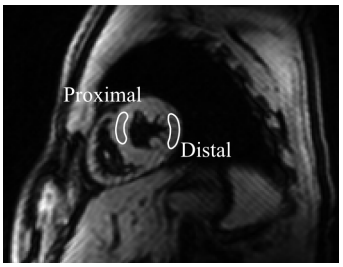

Figure 1. ROI placement for regional SNR analysis in ROIs proximal to and distal to the chest coil element.

Receiver noise was measured after the breath hold with RF and gradients turned off, enabling reconstruction of the per-pixel SNR [4]. Regional SNR was analyzed by averaging the SNR in manually selected ROIs; one proximal and one distal to the chest wall, where the closest coil element is located, as shown in Figure 1. Mean SNR was computed as the temporal average of the regional SNR.

Results:

The mean SNR for the acquisitions is shown numerically in Table 1 and graphically in Figure 2. The SENSE reconstructed images for one subject are shown in Figure 3. The 32 channel coils provided on average 49±29% higher SNR compared to 5 or 6 channel coils [p<0.01]. The SNR improvement was higher at 3T compared to 1.5T (63±26% and 36±26%, respectively [p<0.01]), and higher proximally than distally (72±19% and 27±16%, respectively [p<0.01]).

Mean SNR	5ch@1.5T	32ch@1.5T	6ch@3T	32ch@3T
Proximal	10.3±2.6	16.4±4.8	11.7±1.3	21.5±1.7
Distal	6.5±0.7	7.4±1.2	7.7±1.0	10.8±1.3

Table 1. Mean SNR for standard and 32 channel cardiac coil acquisitions in all subjects (mean ± standard deviation).

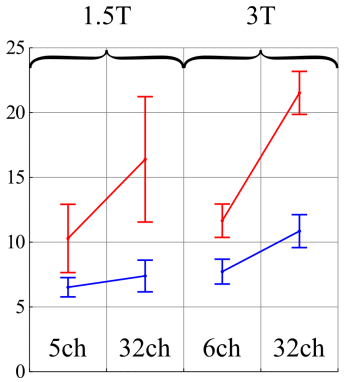

Figure 2. SNR (mean ± std. dev.) in the proximal (red) and distal (blue) regions at 1.5 and 3 T for the standard 5 and 6 channel coil and 32 channel coils.

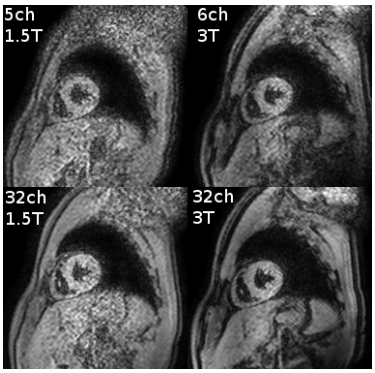

Figure 3. SENSE image reconstructions for both field strengths and all coils in one subject.

Discussion:

Significantly higher SNR was observed using 32 channel coils compared to using the standard 5 or 6 channel coils. A larger SNR improvement was seen in the proximal region, but a considerable improvement in SNR was also seen in the distal region even though the smaller coil elements in the 32 channel coil could suggest reduced depth sensitivity. This may be explained by the wider coverage of the 32 channel coils, resulting in a more forgiving coil positioning. The SNR improvement was more pronounced at 3T, possibly due to improved SENSE reconstruction at the higher field strength. The higher SNR obtained by using the 32 channel coils provides the opportunity to image a longer portion of the cardiac cycle and improve the quality of the functional studies using DENSE MRI.

References:

1. Fischer et al., MRM 1993;30(2):191-200.
2. Stuber et al., MAGMA 1999;9(1):85-91.
3. Kim et al., Radiology 2004;230:862- 871.
4. Kellman et al, MRM 2005;54:1439 -1447.