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Meeting abstract

1119 Direct comparison of the signal-to-noise ratio for 3D and 2D balanced SSFP cine imaging

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Introduction

3D balanced SSFP cine has been increasingly investigated using breath-holds and with free-breathing, as an alternative to 2D cine, because of its increased SNR and excellent slice registration. Therefore, we sought to accurately measure the SNR of 2D and 3D cine, in order to quantify the increase in SNR. The 3D/2D SNR ratio, with all other things held constant (voxel size, TR, flip angle, numbers of views, bandwidth, etc), is expected to equal the square-root of Nz, with Nz the number of partition encodings. However, this increase may not be realized, as there is some signal enhancement due to inflow for 2D imaging, which is not present in 3D images [1].

Methods

All scanning was performed on a 1.5 T Philips Achieva scanner, equipped with a 5-element cardiac coil. Free-breathing dual navigator (NAV)-gated [2,3] 2D and 3D sequences were used to acquire short-axis stacks of the heart, in four healthy subjects. NAV-gating was needed for the 3D fully sampled scan, and therefore used in the 2D scan to match scan parameters. The scan parameters were

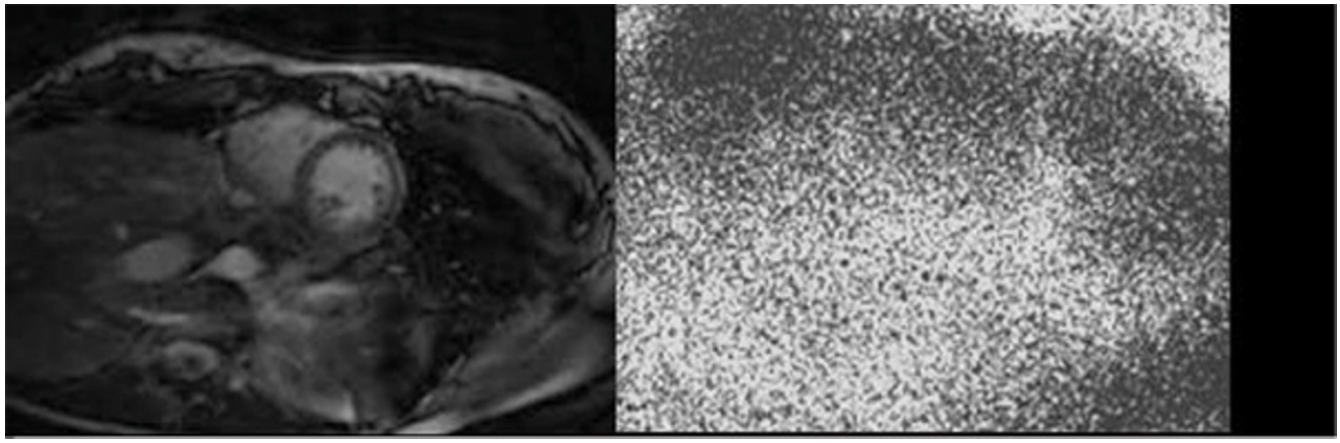

Figure 1
A single slice from the 3D NAV-gated cine scan, and the corresponding noise slice. ROIs in the LV cavity, myocarial septum, and anterior chest wall fat are used to measure signal and noise.

Table 1: SNR for 2D and 3D balanced SSFP cine imaging, measured in begin-systole, in a midwall slice.

	SNR			
	Blood	Myocardium	Fat	Theoretical
2D	102	45	159	
3D	227	93	506	
3D to 2D Ratio	2.2 ± 0.4	2.5 ± 0.87	3.4 ± 1.1	3.6

identical except for a TR which varied by as much as 300 us (longer for 2D). The parameters were: Cartesian balanced SSFP ECG-triggered sequence with 12 phases, TR/TE/θ = 3.0–3.3 ms ms/1.5 to 1.6 ms/50°, FOV = 320 mm, 10 mm slice thickness, with either 10–12 slices or 13 partition-encodings. Both sets of images cover the whole left ventricle. The data were acquired twice in each scan, once without any RF excitations, using a vendor-provided method for measuring noise. All heart-beats were accepted for data acquisition during the "noise" scan. SNR was measured directly in ROIs placed on fat, blood, myocardium, as the signal in each ROI, divided by the standard deviation of noise in each ROI (Fig. 1). Measurements were performed in a midwall slice, at the beginning of systole. For confirmation, a phantom study was also performed to validate the expected SNR ratio in a setting with no moving spins (e.g. no inflow).

Results

The phantom experiment using the two sequences and the noise scan provided an 3D to 2D SNR ratio of 3.7 (543/145), which is in accord with the predicted SNR gain (square-root of 13 = 3.6). The SNR results from the ROI analysis performed on the images are shown in Table 1.

Conclusion

This study demonstrates that the SNR of 3D cine is not greater than 2D cine by √Nz, and that the SNR gain is less than theoretically predicted. This may be due to inflow signal enhancement for 2D scans. Even myocardium has a muted SNR gain. The fat, which is not affected by inflow, has a 3D to 2D SNR ratio closer to the expected value. This study is important, since the potential SNR increase afforded by 3D imaging is a strong motivation for employing 3D cine.

References

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