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Meeting abstract

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2026 Tradeoffs between spatial coverage and dynamic temporal resolution in quantitative first-pass perfusion imaging

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Introduction

First-pass contrast-enhanced perfusion MRI is a useful tool for the diagnosis of ischemic cardiac disease. Quantitative analysis of myocardial perfusion depends on measuring dynamic signal intensity changes of the LV blood and myocardium as a function of time. There is an inverse relationship between the number of slices imaged per unit time and the repetition time for those spatial locations. For example, a perfusion sequence that can image 3 slices per heartbeat could image 6 locations every other heartbeat.

Purpose

The purpose of this study was to show that high temporal sampling of the input function is important for perfusion quantification, but the myocardial sampling rate may be reduced and still achieve highly accurate measures of perfusion.

Methods

Dual-bolus (Gd-DTPA 0.005 and 0.1 mmol/kg) rest and dipyridamole stress myocardial perfusion MR imaging was performed on 10 normal volunteers on a 1.5 T Siemens scanner. Each perfusion study was acquired in a breath-hold and with single RR imaging interval. A segmented GRE-EPI sequence was used by the following parameters: 90° prep, 25° readout, TR 7.5 ms, TE 1.48 ms, 8 mm slice thickness, echo train length 4, acquisition matrix 128 × 80–96, FOV 360 × 270 mm. Time-signal intensity curves of the perfusion images were analyzed by dividing the myocardium into 6 sectors. Myocardial blood flow (MBF) was estimated from LV input and myocardial output time-signal intensity curves by a Fermi model constrained deconvolution. Using MBF quantified from LV and myocardial curves at 1RR temporal resolution as a reference standard, we compared MBF estimated from 2RR and 3RR under-sampled time-signal intensity curves.

Results

Figure 1 shows an example of the LV input curve at 1RR that was under-sampled to 2RR and 3RR temporal resolutions. The shape of the curve was distorted noticeably at contrast arrival and peak contrast enhancement time points. At 3RR under-sampling, the LV curve only has 2 points above half height and clearly underestimates the peak. Figure 2 shows under-sampling has less severe effects in the myocardial curves. Table 1 summarizes the results of MBF estimated from different under-sampled LV and myocardial time-signal intensity curves. Stress MBF is systematically underestimated for 2RR and 3RR curves compared to the 1RR reference ($p < 0.01$). However, if the LV curve is maintained at 1RR interval, under-sampling of the myocardial curve at 2RR and 3RR has much less effect on MBF estimates. Figure 3 compares the Bland-Altman plot of MBF estimates from different under-sampled 2RR and 3RR curves against the 1RR reference. The scatter

Table 1: Comparison of myocardial blood flow (MBF) estimates from under-sampled time-signal intensity.

MBF (ml/g/min) Mean ± SD	1RR_LV, 1RR_Myo	1RR_LV, 2RR_Myo	1RR_LV, 3RR_Myo	2RR_LV, 2RR_Myo	3RR_LV, 3RR_Myo
Rest	0.95 ± 0.22	1.02 ± 0.21	1.27 ± 0.73	1.01 ± 0.34	0.89 ± 0.33
Stress	3.34 ± 0.72	3.11 ± 0.81	3.20 ± 0.74	2.88 ± 0.84	2.71 ± 0.76

increases as the temporal resolution of the time-signal intensity curves decreases to 2RR and 3RR intervals.

Conclusion

Reduced temporal sampling of the LV blood signal intensity during myocardial perfusion imaging significantly affects myocardial blood flow estimates. Under-sampling the LV input curve to 2RR or 3RR intervals results in systematic underestimation of MBF and increased scatter of the errors. Since reduced temporal sampling of the time-signal intensity curves theoretically acts as a low pass temporal filter which suppresses dynamic contrast information, the effects are more significant for LV blood than the myocardial curves and are larger for stress than rest perfusions. However, combining 1RR temporal resolution in the LV and 2RR temporal resolution in the myocardium during perfusion imaging has minimal impact to MBF estimates and could effectively double the spatial coverage without sacrificing the accuracy of quantitative perfusion measures.

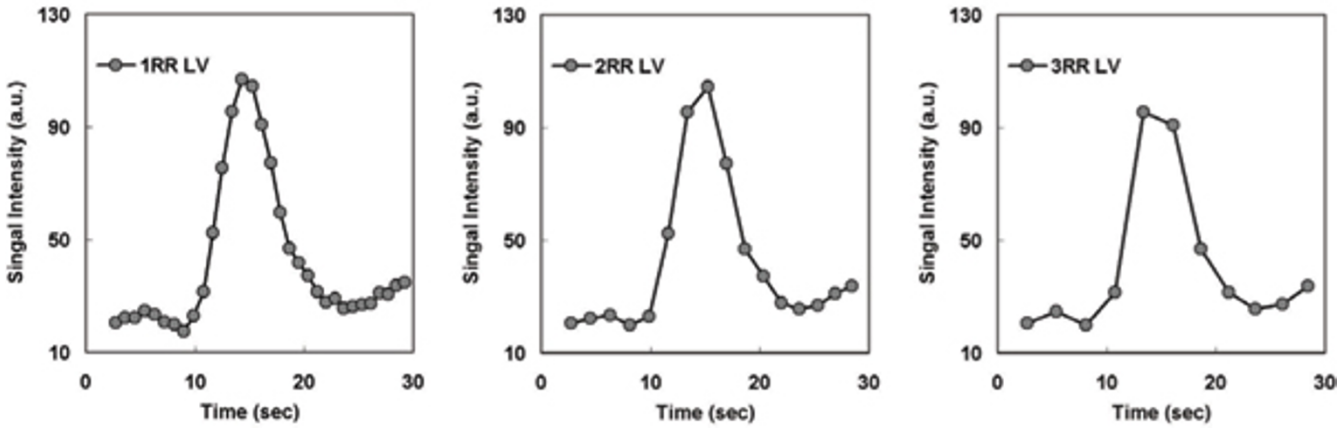

Figure 1

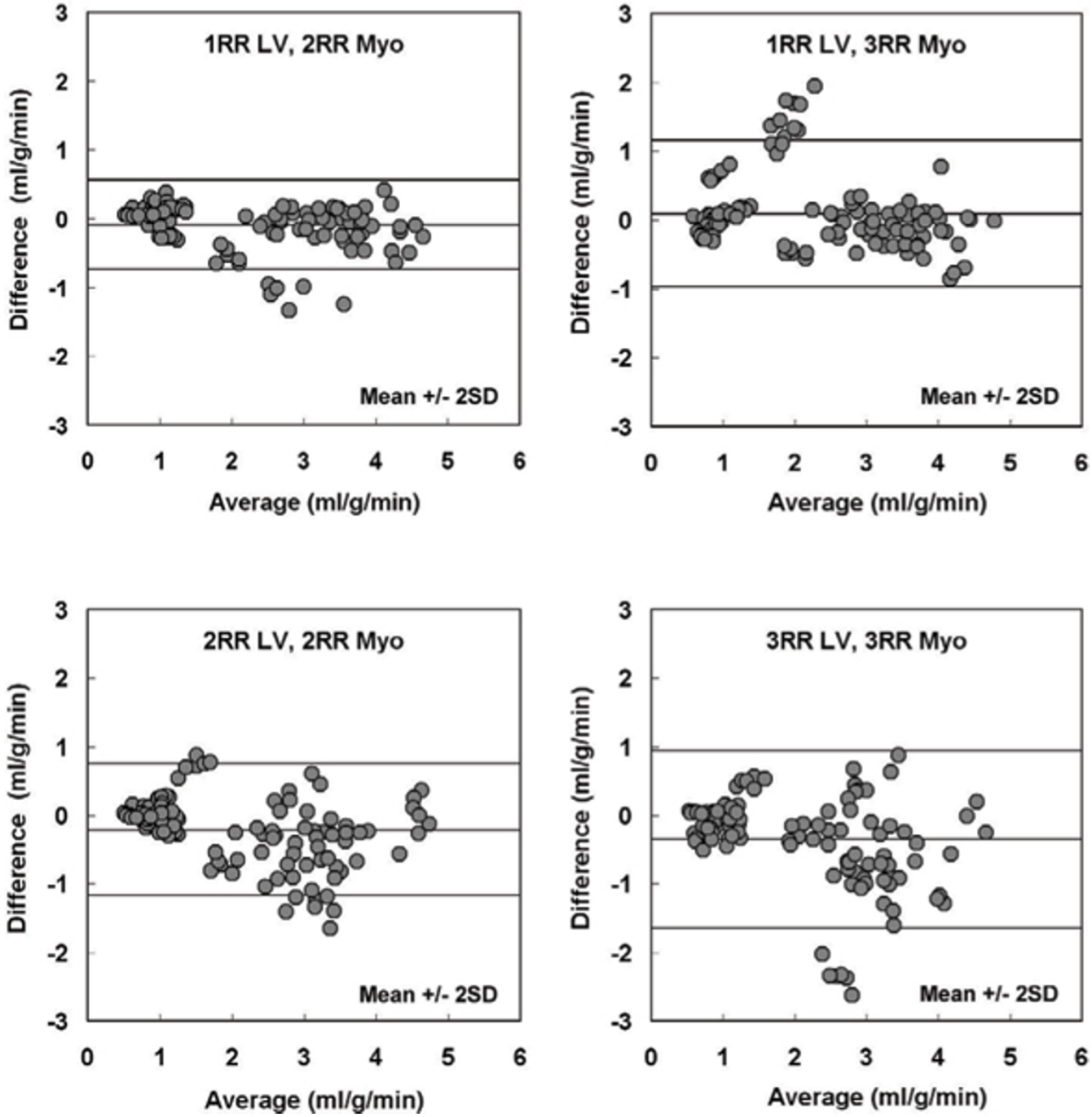
1RR LV, 2RR Myo
1RR LV, 3RR Myo
2RR LV, 2RR Myo
3RR LV, 3RR Myo
Difference (ml/g/min)
Average (ml/g/min)
Mean +/- 2SD
3
2
1
0
-1
-2
-3
0
1
2
3
4
5
6

Figure 3

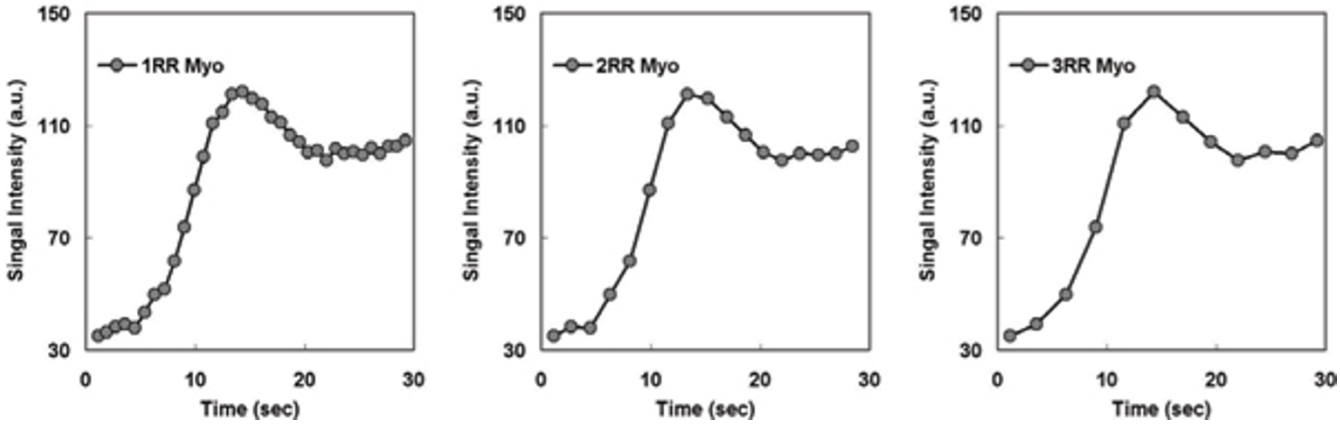

Figure 2