Quantitative analysis of myocardial perfusion reserve with correction for R-R interval variability

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Introduction:

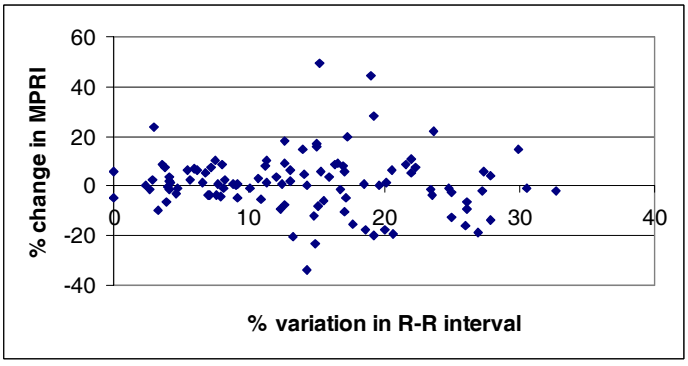
Bolus tracking of first pass images allows quantitation of myocardial perfusion reserve. However changes in heart rate, misgating of the ECG and arrhythmia make assumptions of uniform temporal sampling invalid. As was shown in (1), inaccuracy of temporal sampling may significantly affect the calculation of perfusion indices. This abstract reports the effect of correcting for real-time RR interval variation, compared to assuming uniform temporal sampling, in a larger patient group than (1).

Methods:

Dual sequence (2) first pass perfusion images were acquired at 1.5T (Siemens Avanto) in 105 patients undergoing clinically indicated myocardial perfusion CMR. A saturation recovery, segmented-EPI sequence (factor 4), incorporating TSENSE (rate 2) and fat saturation was used for myocardial imaging. Flip angle 30°, TR 5.8ms/TE 1.22ms, bandwidth 1860Hz/pixel. Read field of view (FOV) 34-40cm; phase FOV 75% of the read FOV; base matrix 128x96; pixel size range 2.4x2.4-3.1x3.1mm, slice thickness 8mm. An accurate arterial input function (AIF) was obtained using a fast GRE sequence (to minimise T2* concerns (3)) immediately after each R-wave (TR/TE 1.08/0.58ms, FA 10°, 5x5x10mm voxels, 3900Hz/pixel) at the middle of the three myocardial slices. Subjects abstained from caffeinated products for 24 hours prior to scanning. Gadolinium-BMA (Omniscan) 0.1mmol/kg body weight was injected at 7ml/s (Spectris, Medrad, Indianola, Pa) via an 18-gauge cannula. Three short axis slices were acquired over 50 nominally consecutive cycles during adenosine (140mcg/kg/min) and 20 minutes after at rest. Segmental myocardial perfusion reserve indices (MPRI) were computed using a two-compartment model and Fermi-function deconvolution. The timing of each input data point to the analysis was taken from DICOM image headers. For this abstract, global MPRIs were compared against those obtained using averaged RR interval timings, *i.e.* constant during each input series of images.

Results and Discussion:

For each patient, the % change in MPRI values between timestamped and RR-averaged analyses are shown plotted against % variation (100 x stdev/mean, n=50) in the ECG RR intervals (taking the mean of rest and stress). Increased scatter in MPRI occurs with more variation in RR interval. No significant effect of time-stamped analysis was found overall (paired t-test, MPRI RR-averaged vs time-stamped: (mean±stdev) 1.93±0.50 vs 1.94±0.48 p=0.72, n=105) , which is probably to be expected since this test also included a wide range of MPRIs and normal and defect segments. As proposed in (1), cycle timings differing greatly from the average may indicate incorrect gating giving images of different myocardium; work in progress will remove these input points from the perfusion assessment.



Conclusion:

Accurate time-stamping of each input data point can reduce one source of random error in quantitative analysis, compared to assuming input data sampled at the average R-R interval.

(1) Di Bella et al, Proc. 14th ISMRM (2006):3577. (2) Kim et al, JMRI 23:81-6. (3) Kellman et al, MRMed 56:1132-4