# HYPR Myocardial Perfusion MR Imaging

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## INTRODUCTION

Recently, we have developed a non-iterative reconstruction technique called HYPR (HighlY constrained back PRojection) [**1**] to increase the permissible undersampling of temporally evolving acquisitions further. This technique, when used in combination with a hybrid radial/Cartesian acquisition technique [**2-3**], provides relatively artifact free images with high SNR and high temporal resolution for large undersampling factors in selected applications. Here we have investigated the use of HYPR for myocardial perfusion imaging, in which the goal is to differentiate contrast kinetics of normal and ischemic myocardium. Standard filtered backprojection (FBP) reconstruction in undersampled radial acquisition MRI leads to considerable streak artifacts in the resulting images due to using only a small subset of the total number of projections necessary to satisfy the Nyquist criterion. In the HYPR technique, the SNR of each individual time frame is mostly determined by the SNR of the composite image comprising several time frames. Moreover, constraining backprojection by the composite image produces individual time frames that are relatively artifact free.

## MATERIALS AND METHODS

Time–resolved images of myocardial perfusion were simulated using the HYPR technique applied to the data obtained with an ECG-gated 3D hybrid radial/Cartesian (interleaved stack of stars) acquisition technique. For each subset of interleaved radial acquisitions in the *kx-ky* plane, a series of *kz* partitions were acquired. For each *kz*, all or a subset of all the acquired projections were used to form a relatively streak-free composite image with high SNR. Individual time frames are formed by a constrained backprojection of the time-frame projections with backprojection weights determined by the composite image. The resulting images have high temporal resolution afforded by the low number of projections per frame, and high SNR and low artifact level as dictated by the characteristics of the composite image. Typical scan parameters for an ECG-gated, saturation recovery hybrid gradient echo imaging technique are TR/TE/Flip = 3.4 ms/1.6 ms/20°, FOV = 320 mm x 320 mm, 96 mm slab with 6-10 partitions, and RBW = ±62.5 kHz, 128-256 X 8-16 projections per partition acquired in a single breathhold during the first pass of 0.1 mmol/kg contrast agent injected at 2-3 ml/s.

## RESULTS AND DISCUSSION

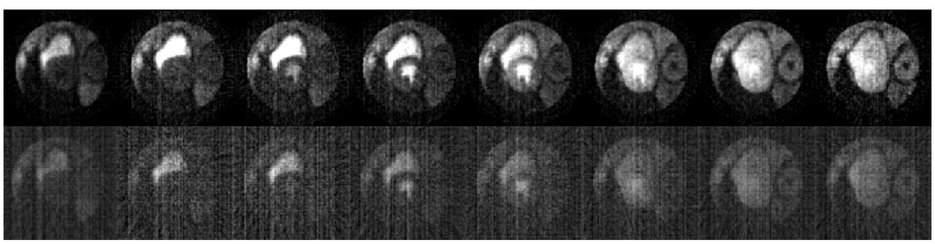

**Figure 1:** Comparison of simulated HYPR (top) and FBP reconstruction (bottom) using 20 projections per frame. The HYPR composite images were formed from three time frames that advance in time.

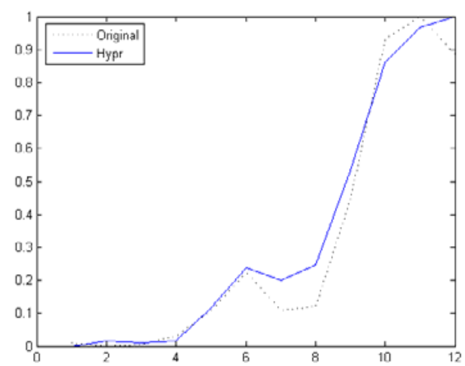


**Figure 2:** The corresponding myocardial signal vs. time for HYPR and from fully sampled images are shown.

Figure 1 compares perfusion simulation results reconstructed with the FBP and HYPR techniques using only 20 projections per time frame. Three time frames were combined to obtain the HYPR composite images with a sliding window reconstruction. Compared to the FBP technique that leads to images with low SNR and considerable streak artifacts, the HYPR images are relatively artifact-free with high SNR. The uptake curve in the myocardium obtained with the HYPR technique (solid) clearly demonstrates the temporal characteristics of the myocardium and is in good agreement with that of the fully sampled images (dotted).

## CONCLUSIONS

Our initial results suggest that the HYPR technique for myocardial perfusion imaging may offer advantages by providing combined angular and temporal undersampling factors of 10 or more. Further studies are underway to optimize and investigate potential benefits of the HYPR technique for MR myocardial perfusion imaging.

## REFERENCES

**1.** Mistretta, *et al.*, MRM, 55, 30, 2006. **2.** Peters, *et al.*, MRM, 43, 91, 2000. **3.** Vigen, *et al.*, MRM, 43, 170, 2000.

## ACKNOWLEGMENTS

This work was supported in part by NIH grant 1RO1HL/RR66488-01A1.