Dynamic KWIC for High Temporal Resolution of Regional Myocardial Perfusion

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Introduction

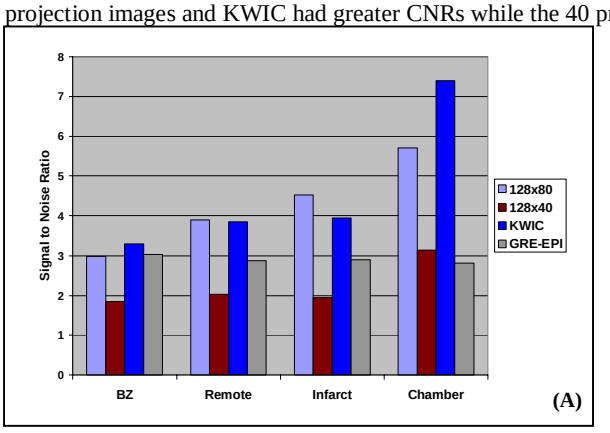
MRI first-pass contrast-enhanced perfusion for the detection of quantitative regional myocardial perfusion has been under development for the past decade (1). Gradient–echo with echo planar readout (GRE-EPI) pulse sequences have been used for first-pass perfusion but these sequences have limited coverage and poor SNR. In this study, an interleaved undersampled projection reconstruction (PR) imaging technique combined with K-space Weighted Image Contrast (KWIC) (2) processing was utilized to obtain first-pass kinetics in normal and hypo-perfused regions and the resulting signal-to-noise ratio (SNR), and contrast-to-noise ratio (CNR) for the two methods were compared.

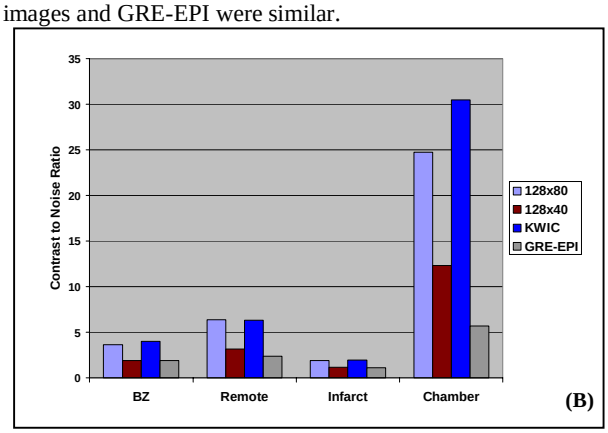
Method

First-pass perfusion kinetics was obtained in this study using both the commonly used GRE-EPI technique and dynamic KWIC. The interleaved PR technique described previously acquires a full dataset in multiple passes (3). During the first pass, radial data are acquired in equally spaced angles while, in the second pass views with angles that bisect those of the first pass are acquired. KWIC, a novel technique for manipulating contrast in projection reconstruction (PR) MRI makes use of the fact that the central region of k-space in PR imaging is over-sampled, allowing one to choose different weighting schemes to enhance or reduce the amount that each view, or line of data, contributes to the central k-space region. The hypothesis of this study is that the KWIC technique can also be useful in dynamic myocardial contrast enhancement studies; capable of yielding a series of images at a significantly higher effective temporal resolution than what is currently possible, without sacrificing spatial resolution or image quality. To compare the two methods we used an ovine model of acute infarction that results in normally perfused (remote), moderately perfused (border zone, BZ), and hypo-perfused (infarct) regions. Imaging was performed using a 1.5T whole body scanner (Signa, GE Medical Systems) with the following parameters for PR: 128 readout points, 40 views/ interleaf, 2 interleaves, 2 slices, TR/TE=6/2 ms, flip angle 15^0, FOV=32 cm, 6 mm slice thickness, ±64kHz receiver bandwidth. The parameters for GRE-EPI were: FOV 32cm x 24cm, 128x72 matrix, NEX=1, slice thickness=10mm, TR/TE=8/2 ms, 3 echoes/TR, receiver bandwidth ±62.5 kHz, flip angle 10^0. The PR images were reconstructed using 40 (one interleaf) and 80 (two interleaves) projections per image and post-processed using KWIC.

Results

The SNR results illustrate that images reconstructed from 80 projections had higher SNR in all regions compared to GRE-EPI, while the 40 projection images exhibited lower SNR (figure A). Using the KWIC filtering method (40 and 80 views used in the central and outer k-space regions, respectively) the SNR improved and was superior to the GRE-EPI images. Contrast-to-noise showed similar results with 80 projection and KWIC having greater CNR then GRE-EPI (figure B). Analysis was also performed investigating the CNR between regions of different perfusion levels. BZ-remote and remote-infarct CNR was higher for all PR reconstruction methods compared to GRE-EPI (figure C). For the BZ-infarct the 80 projection images and KWIC had greater CNRs while the 40 projection images and GRE-EPI were similar.





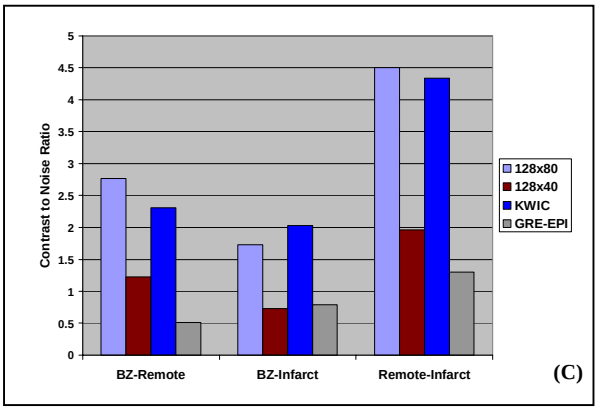


Figure. SNR and CNR for dynamic KWIC versus GRE-EPI during first-pass perfusion. **(A)** Images reconstructed from 40 projections with KWIC processing have higher SNR than GRE-EPI for all perfusion levels. **(B)** CNR showed similar results with the KWIC images having greater contrast. **(C)** A comparison between regional perfusion CNR indicates an improved ability to measure perfusion disparity using

Conclusion

This study demonstrated that PR combined with KWIC post processing can provide greater SNR and CNR compared to GRE-EPI in first-pass perfusion in the similar scan times. Regional differences in CNR showed that back projection had a higher signal between regions compared to GRE-EPI. This translates into improved ability to delineate between variations in levels of myocardial perfusion, which results in enhanced demarcation of normal, ischemic and infracted myocardium. In addition, this method has the potential to obtain whole-heart coverage by minimizing the number of projections and optimizing the KWIC post-processing method.

References

1. DJ Atkinson et al. *Radiology* 1990;174:757-762
2. Song HK et al. *Magn. Reson. Med*. 2004; 52:815–824
3. Song HK et al. *Magn. Reson. Med*. 2001;46:503-509