# Parallel Imaging with a Combined Endorectal-Surface Coil at 3T in Dynamic Contrast Enhanced MRI Studies of the Prostate

G. Metzger[1], M. Bernardo[2], D. Thomasson[3], A. Gharib[3], P. Choyke[2]

[1]Philips Medical Systems, Bethesda, MD, United States, [2]National Cancer Institute, National Institutes of Health, Bethesda, MD, United States, [3]Clinical Center, National Institutes of Health, Bethesda, MD, United States

INTRODUCTION: The use of anatomic and functional imaging in the localization, staging and management of prostate cancer is an important area of ongoing research. Current imaging of the prostate combines the use of an endorectal coil (ERC) with surface coils to extend the available FOV. Visualization beyond the prostate is needed to look for spread of disease and provide information from the region of the external iliac artery for characterization of the arterial input function (AIF) used in Generalized Kinetic Modeling (GKM) [1]. Given this coil configuration, parallel imaging methods can be used to increase the options available in prescribing scan parameters. Two applications studied here include the use of SENSitivity Encoding (SENSE) to 1) increase the temporal resolution of DCEMRI and 2) maintain temporal resolution, spatial resolution and SNR given the need for larger coverage in DCEMRI. This work demonstrates the first use of parallel imaging in the prostate with a combined ERC-surface coil setup and demonstrates its utility in improving the flexibility of performing dynamic imaging studies of the prostate.

METHODS: Imaging was performed on a clinical 3T scanner (Philips Medical Systems, Best, NL) using a multi-element coil composed of 2 anterior surface coils and an endorectal coil (ERC) (MRinnervu; Medrad, Pittsburgh, PA) retuned for 3T. Standard DCE-MRI images are acquired during bolus administration of 0.1mmol/Kg of gadolinium chelate at 3cc/sec using a 10 slice 3D Fast Field Echo with a temporal resolution of 6.1 sec and spatial resolution of 0.86 x 1.18 x 6.0 mm (FOV 220 mm, TR/TE 5.5/2.1 msec, flip angle 15 degrees, left-right (RL) phase encoding, 60 dynamics). SENSE acquisitions of DCEMRI data were acquired with similar imaging parameters but were modified in 2 different ways both of which shifted phase encoding to the anterior-posterior (AP) direction. First, with a SENSE factor of 2 (SF2), dynamic times were reduced to 3.1 seconds with all other parameters the same as the standard sequence requiring 120 dynamics to maintain visualization of contrast washout. Second, given the need for increased coverage the number of slices were increased from 10 to 12 and the data were acquired with SF 1.3 resulting in a temporal resolution of 5.7 seconds. Data viewing and processing were performed on the Philips Research and Image Development Environment (PRIDE) (Philips Medical Systems, Cleveland, OH). SNR figures were calculated by the mean signal of a region within the prostate over the standard deviation of the same region from the subtraction of 2 dynamics. Geometry factors were calculated with research software on the console based on the acquired reference scans.

RESULTS: Geometry factors for the ERC-surface coil combination were close to 1.0 in the region of the prostate and the external iliac artery for SF2 and 3 (Figure 1) while in regions outside the prostate local areas of poor performance are present with SF3. SNR figures for the SF 1, 2 and 3 for the standard acquisition strategy were 7.8, 5.9 and 3.6 respectively pre-contrast, where a SENSE factor of 1 results in sensitivity correction only. The SNR reductions with increased SENSE factors are close to the 29% and 41% as expected by theory given a geometry factor close to 1.0. Figure 2 shows the AIF and tissue Gadolinium concentration curves over time as well as the Ktrans map from GKM processing for SF2 and a temporal resolution of 3.1 seconds. Figure 3 shows similar results for another prostate case with an SF of 1.3 and a 20% increase in slice coverage with a final temporal resolution of 5.7 seconds. If an SF 1.2 were used, this acquisition would have maintained its SNR and temporal resolution at 6.1 sec.

DISCUSSION: It is necessary in this single average acquisition to switch the phase-encoding direction to AP from RL when using SENSE to avoid native foldover within the imaging FOV. Less coverage is needed in the AP direction because of the sensitivity of the coils and body geometry. In addition, the sensitivity profiles of the different elements are also more unique in the AP direction improving SENSE reconstruction. Unfortunately, motion artifacts from the rectum and subcutaneous lipids have the potential of ghosting into the prostate. With the use of a balloon type ERC, motion artifacts from the rectum have been reduced to an acceptable level.

Improving temporal resolution (Figure 2) will lead to more acccurate arterial input functions which in turn will improve the accuracy of the two compartment GKM. The result should be improved estimates of pharmacokinetic parameters derived from this model. In general, the temporal resolution of the acquisition should match the rate of injection. It needs to be determined if GKM benefits from more rapid injections where theoretically the use of an AIF should remove this as a factor. However, for visually assessing the data, more rapid injections and imaging strategies might improve the conspicuity of early enhancement.

Finally, this coil configuration allows us to use parallel imaging to increase our coverage without a tradeoff in temporal resolution, spatial resolution or SNR by using an SF proportional to the increased coverage (Figure 3). Future studies will benefit from this consistency in data acquisition when evaluating the role of kinetic parameters in the diagnosis and localization of prostate cancer.

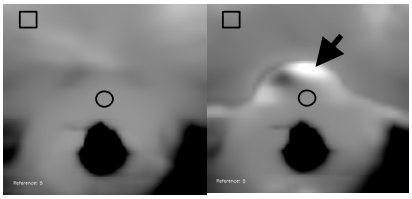

Figure 1

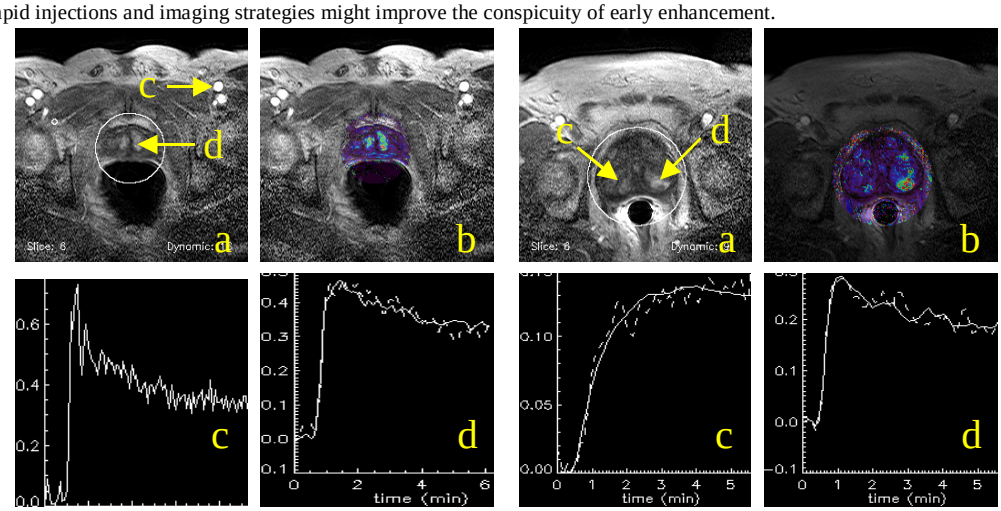


Figure 2




Figure 3

Figure 1: Geometry factor maps for SF2 (left) and SF3 (right) where the circle and square are the location of the prostate and artery with GFs of 1.0. The arrow indicates a GF of 1.4 in the SF 3 geometry factor map.

Figure 2: Dynamic data with 3.1 sec temporal resolution , SF = 2. (a) slice 6 of 10 at onset of contrast arrival. (b) calculated Ktrans parametric map. (c) arterial input function determined from location indicated in (a). (d) Contrast-time curve (broken curve) and GKM fit (solid curve) for location indicated in (a).

Figure 3: Dynamic data set with SF = 1.3. (a) Slice 8 of 12 slice data set. (b) calculated Ktrans parametric map. (c) and (d) individual voxel time intensity plots (broken curve) with a 2 compartment GKM model fit (solid curve) from the locations shown.

REFERENCES: [1] Tofts P et al. JMRI 1999; 223-232