# Prostate DCE-MRI with a 16-Channel Surface Array and Endorectal Coil Using Slice Oversampling and SENSE to Minimize Blood Inflow Effect

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**Introduction:** The reliability of pharmacokinetic (PK) parameters derived from DCE-MRI using approaches such as the Generalized Kinetic Model (GKM) depends on the accuracy of the measured arterial input function (AIF). For prostate studies, the best AIF locations are the femoral arteries which are susceptible to a large inflow effect which shortens the apparent blood $T_1$ and results in inconsistent contrast agent concentration. One way to solve this problem is using a prepolarization slab applied superior to the imaging volume, but the additional pulse increases SAR.[1] In this work, we achieve the same result by exciting a thicker volume and using slice oversampling with SENSE to maintain the same data size and temporal resolution.

**Methods:** A Diagnostic prostate MRI study including $T_2$-weighted, ADC map, 3DSI, $B_1$ map, and DCE-MRI was performed on two patients using the 16-channel anterior half of a 32-channel SENSE cardiac array (Invivo, Orlando, FL) in combination with an endorectal coil (BPX 30, Medrad, Warrendale, PA) on a 3.0 T whole-body scanner (Achieva 3.0T, Philips Medical Systems, Best, NL). Since the scanner is limited to 16-channels, the system was configured by software to replace the upper left corner element of the cardiac array with the endorectal coil. The endorectal coil was inserted after a digital rectal exam and inflated with a fluorocarbon (Fluorinert FC-77, 3M). The DCE-MRI protocol uses the dual-flip angle $T_1$-weighted SPGR approach comprising of a scan with FA=5 and a dynamic scan with FA =15 during contrast infusion. To evaluate slice oversampling and SENSE, the usual DCE protocol (TR/TE 5.5/1.96 ms, FOV 262 mm, 256x187 acquisition matrix, 10x 6 mm slices, 1.2 x slice oversampling, SENSE P4, temporal resolution 3.1 s) was run with 10 dynamic images without contrast infusion followed by one with an effective 4.8x slice oversampling and SENSE (TR/TE 4.0/1.95 ms, 12 x 6 mm slices, 4x slice oversampling, SENSE P3.1 and S2, temporal resolution 5.91 s) with contrast infusion of 0.1 mmole/kg dose of Magnevist (Berlex,) at a rate of 3.0cc/s after the third image of 52 total dynamic images. The standard DCE protocol was repeated again immediately after the DCE series. All analysis was performed using a house-written IDL (ITT, Boulder, CO) program along with MIPAV (http://mipav.cit.nih.gov/), ImageJ (http://rsbweb.nih.gov/ij/) and Excel.

**Results and Discussion:** The reduction of inflow effect is apparent in the high FA images acquired before contrast infusion (Figure 1). The arteries are darker with large slice oversampling (Figure 1d) than without it (Figure 1b), giving pre-contrast blood $R_1$ rates that are closer to expected values (Figure 1e). The over 100% error introduced in the [Gd] concentration shown in Figure 1f is significant and would lead to a proportionately large underestimation of the GKM rate constants. Figure 2 shows the GKM map with slice oversampling and SENSE.

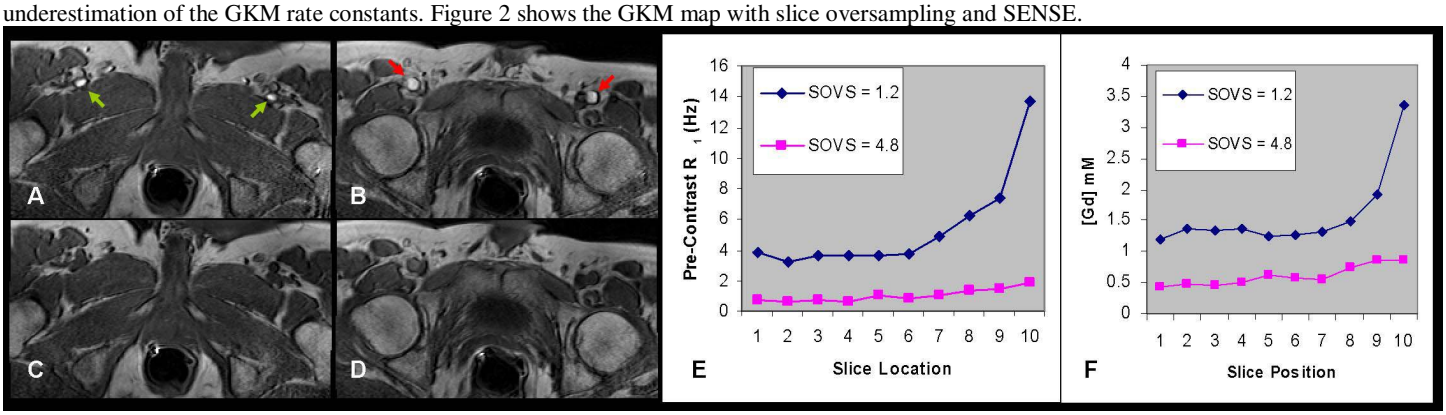


**Figure 1.** Blood inflow during DCE-MRI results in bright veins in inferior slices (A, green arrows) and bright arteries in superior slices (B, red arrows) with normal 1.2X slice oversampling but little effect with higher 4.8X slice oversampling. The reduced error with higher oversampling is shown in the precontrast $R_1$ rates (E) and calculated Gd concentration at the end of DCE-MRI study (F) as a function of slice position

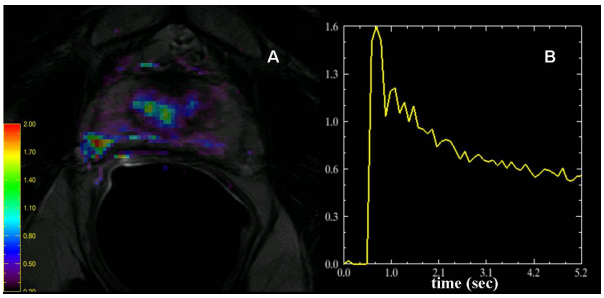


**Figure 2.** Rate constant, $K^{Trans}$, from fit of GKM to data acquired with 4.8x slice oversampling (A) using AIF (B) from right femoral artery in slice 6.

In both patients, there were non-uniform contrast, $R_1$ and [Gd] between the left and the right arteries and the prostate which was confirmed to be due to $B_1$ field inhomogeneity from the B1 map performed in the second patient. The right femoral artery was chosen for this analysis since the $B_1$ is within 10% of nominal value. The $B_1$ near the left femoral artery is about 30% larger which results in underestimation of [Gd] while the prostate region is about 20% larger. It is clear that a $B_1$ correction is needed in the analysis to improve the accuracy of the PK maps.

The achieved SENSE factor of two in the slice direction was not sufficient to compensate for the four-fold increase in excitation thickness resulting in lower temporal resolution. The inclusion of the 16-channel posterior half in a 32-channel system, and use of a two element endorectal coil would help. Even without these additions, the more accurate determination of the AIF is worth the 2-fold sacrifice in temporal resolution.

**References:**

1. Proc. Intl. Soc. Mag. Reson. Med. 16 (2008).
2. J Magn Reson Imaging. 27(6):1327-30 (2008).