EP009 Pilot study of empirical mathematical modeling of high temporal resolution prostate dynamic contrast-enhanced MRI

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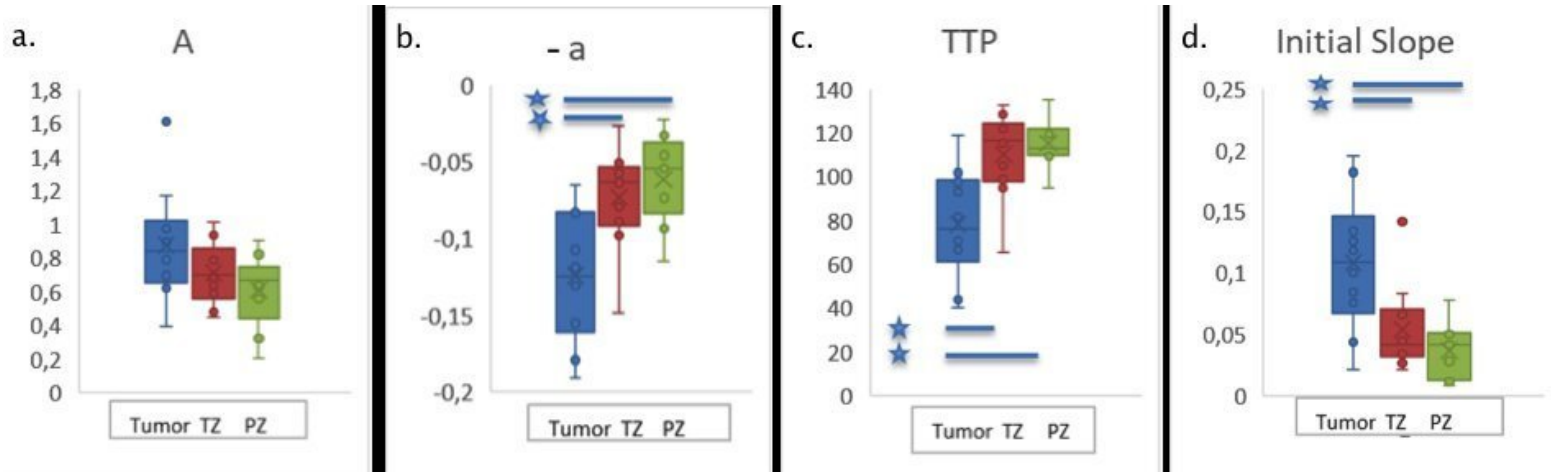
Introduction & Objectives: The use of dynamic contrast enhanced (DCE)-MRI in prostate cancer diagnosis is under scrutiny due to its centrality in a minority of diagnostic decisions. While pharmacokinetic models have been demonstrated in characterization of disease, they require a complex fitting and temporal resolution beyond that typically obtained in practice. Empirical mathematical models (EMM) of the signal, S(t), forego physical models for quality and simplicity of cruve-fitting. Our aim was to obtain preliminary characterizations of prostate tissues and tumors via an EMM) in high temporal resolution DCE-MRI.

Materials & Methods: In this pilot study, 10 males with suspected prostate cancer underwent DCE MRI of the prostate at relatively high temporal resolution (3D field echo, FOV: 25x25x6cm, Acq. Res: 3.5x3.5x4 mm, Acceleration: 3.5 x, TR/TE/FA 3.5/1.59 ms/10°, 1.3 s/frame, 150 frames) on a 1.5T MR scanner (Achieva, Philips Medical Systems, Best, The Netherlands) during injection of contrast agent (0.2 ml/kg at 3 ml/s; Dotarem, Guerbet). The EMM: $S(t)=A(1-e^{-at})$ was fitted for amplitude (A) and enhancement rate factor (a) to each voxel's signal time series, and initial enhancement slope (A*a) and time to peak (TTP) calculated [1,2]. The detected arrival of contrast agent marked time zero (t0) for calculation of TTP. Regions of interest were defined in areas of suspected tumor as well as in apparently healthy peripheral and transition zone and in muscle.



Results: Significant differences were seen (Figure 1) between tumor and both transition/central zone and peripheral zone for the enhancement rate factor ($p<0.0075$), TTP ($p<0.005$) and initial enhancement slope ($p<0.018$). Differences between transition/central zone and peripheral zone were not significant in this small pilot cohort.

Conclusions: Our preliminary results suggest that multiple EMM parameters derived from higher temporal resolution DCE MRI may differentiate between tumors and normal appearing prostate tissues. The simple EMM model used here, together with high temporal resolution DCE scanning, minimizes noise amplification that can cause variability in pharmacokinetic modeling. Further, EMMs do not necessitate additional scans baseline T1 mapping, nor the extraction of an arterial input function, thus rendering them easier to integrate into clinical practice if they prove useful.