

## DCE of the prostate: Contrast enhancement correlates to glandular lumen

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### Introduction

MR signal from prostate tissue show a biexponential T2-decay (1). Prostatic acini contain fluid that probably account for the slower decaying T2 component. Biexponential relaxation can only be observed if proton exchange between contributing compartments is slow (2). In commonly used tracer kinetic modeling it is assumed that all the tissue contribute to signal enhancement as predicted by a fast exchange model (3). The existence of a tissue component with slow proton exchange introduces an extra variable influencing signal enhancement. The existence of non-enhancing glandular lumen predicts an inverse correlation between tissue lumen and signal enhancement. This is not commonly acknowledged by the pharmacokinetic analysis performed in prostate imaging. The purpose of this work was to demonstrate the predicted inverse correlation between glandular lumen and contrast enhancement in prostate cancer.

### Methods

Seventeen patients who had undergone DCE MRI of the prostate prior to prostatectomy were included in this study. The MR examinations were performed on a Philips ACS-NT (1.5T) system with Power Track 6000 gradients. An endorectal coil was applied. Transverse T2W TSE images were obtained with the following parameters: repetition time = 2776 ms, echo time = 140 ms, field of view=180x126 mm, matrix=512x256, number of slices=10, slice thickness=5–7 mm, turbo factor=24, number of samplings=6, scan time=4:42 min. The Dynamic 3D Multi-shot EPI sequence was implemented with the following parameters: repetition time=55 ms, echo time=8 ms, flip angle=27°, field of view=180x126mm, matrix=256x108, number of slices=10, slice thickness=5–7 mm, number of samplings=1, EPI factor=19 and spectral fat suppression (SPIR). A total of 100 dynamic frames were scanned with a time interval of 2.83 s, resulting in a total imaging time of 4:43 min.

Radical perineal prostatectomy specimens were fixed in formalin before sampling. To facilitate orientation the apex, anterior and posterior parts of the glands were marked with different colors. The prostate was examined with serial sections cut at 5 mm starting perpendicular to the distal urethra. The slices were paraffin embedded, sectioned and stained with hematoxylin and eosin. All sections were evaluated microscopically for carcinoma. Tumor outlines were drawn with ink on the cover glass. Equidistant photomicrographs at 100X were obtained at 2.5 mm interval within the tumor outlines. A grid of 5 by 5 lines defining 25 points was superimposed on the photomicrographs. Tissue volume ratios of glandular lumen, epithelial tissue and stroma were assessed by point-counting. The histology slices with tumor outlines were macro-photographed to aid correlation with MRI images.

MR image analysis was performed using in house developed software programmed in IDL (ITT Visual Information Solutions, Boulder, Colorado, USA). ROIs defining the tumors were drawn in the T2W TSE images since these were easiest to compare with the macro-photos. Corresponding enhancement curves were extracted from the DCE images and maximum enhancement relative to the baseline signal was calculated.

### Results

One patient was excluded because the tumor was too small for reliable localization on the MRI images. Data on the remaining sixteen patients is shown in Figure 1. Correlation between lumen volume fraction and maximum enhancement was highly significant  $r=-0.86$ ,  $p<0.00001$ . Volume fractions of epithelia and stroma were not significantly correlated to the maximum enhancement,  $r=0.23$ ,  $p>0.2$  and  $r=0.14$ ,  $p>0.2$  respectively.

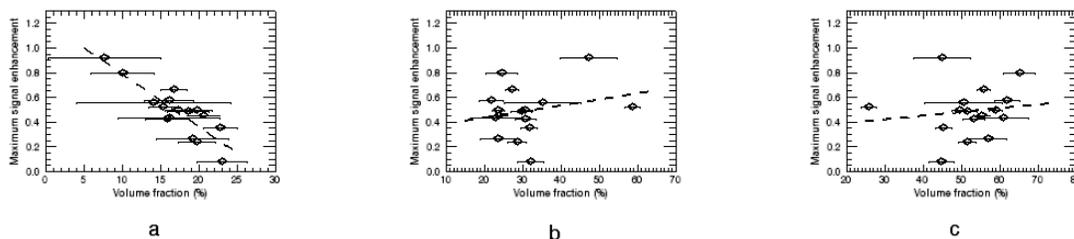


Fig. 1. Scatterplots with regression lines showing the relation between maximum signal enhancement and tissue volume fraction of lumen (a), epithel (b) and stroma (c).

### Discussion

The purpose of this work was to demonstrate the predicted inverse correlation between glandular lumen and contrast enhancement in prostate cancer. Several investigators (4-6) have found an inverse relation between signal enhancement and glandular content in prostate imaging. Although such a variation may be related to capillary density and integrity, a non-enhancing glandular lumen component offers an alternative explanation and introduces an ambiguity in data interpretation. Studies addressing the effect of glandular lumen on pharmacokinetic models are necessary. If the effects turn out significant, new models incorporating estimation of the lumen component may improve precision of pharmacokinetic modelling in prostate DCE MRI.

### References

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