

# Evaluation of b-value distributions for monoexponential model of prostate cancer diffusion-weighted imaging using b values up to 2000 s/mm<sup>2</sup>: a repeatability study on region of interest level

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## Purpose

To evaluate the effect of b-value distribution on the prostate cancer detection, Gleason score prediction, and repeatability of monoexponential model for diffusion weighted imaging (DWI) using b-values up to 2000 s/mm<sup>2</sup>.

## Methods

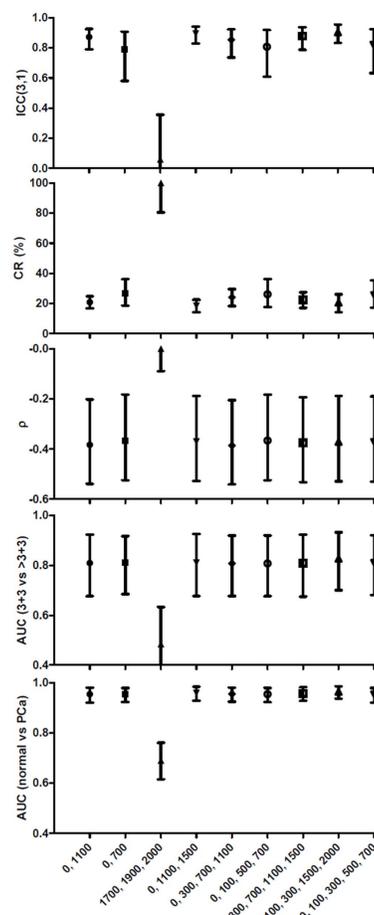
Fifty patients (mean±SD age 64±6 years, mean±SD PSA 11.2±7.1 ng/ml) with histologically confirmed PCa underwent two repeated 3T MRI (Philips, Ingenuity PET/MR) examinations using 32 channel surface array coil and 2 channel volume whole body RF coil for RF transmission before radical prostatectomy. Following the first MR examination, a patient was taken out of the MR bore and asked to rest for 10-15 minutes. After re-positioning of the patient on the MR table, the second MR examination was performed. DWI was performed using a single shot SE based sequence, with monopolar diffusion gradient scheme, epi read out, and the following parameters: TR/TE 3141/51 ms, FOV 250x250 mm<sup>2</sup>, acquisition matrix size 100x99, reconstruction matrix size 224x224, slice thickness 5.0 mm, 0.5 mm intersection gaps, SENSE factor of 2, partial-Fourier acquisition 0.69, SPAIR fat suppression, b values (number of signal averages) 0 (2), 100 (2), 300 (2), 500 (2) (2), 700 (2), 900 (2), 1100 (2), 1300 (2), 1500 (2), 1700 (3), 1900 (4), 2000 (4) s/mm<sup>2</sup>. One squared shaped region of interest (ROI), 5.6x5.6x5.0 mm<sup>3</sup>, was placed in the center of PCa using whole mount prostatectomy sections and anatomical T<sub>2</sub>-weighted images as the reference. The same sized ROI was placed in the contra-lateral side not containing PCa. Continuous reference to the previously positioned ROIs has been done to ensure similar ROI position between the repeated scans. Mean signal of ROIs was fitted using the two parameter monoexponential model (ADC<sub>m</sub> parameter). Multiple initialization values were used to limit possible effect of local minima in the fitting procedure. All possible b-value combinations consisting of 2 to 12 b values were evaluated. In total, 4082 b-value combinations were evaluated in terms of PCa detection, prediction of Gleason score, and repeatability. Of these, 4083 different b-value combinations, 66, 220, 495, 792, 924, 792, 495, 220, 66, 12, and 1 were combinations of 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, and 12 b values, respectively. Receiver operating characteristic curve analysis, AUC values, was used to evaluate ability of ADC<sub>m</sub> values calculated using different b-value combinations to discriminate PCa from normal tissue and PCa with Gleason score of 3+3 from those with Gleason score of >3+3. Spearman correlation coefficient (ρ) was calculated between ADC<sub>m</sub> values and Gleason score groups (3+3, 3+4, >3+4). In order to evaluate reliability and repeatability of ADC<sub>m</sub> values calculated using different b-value combinations, coefficient of repeatability (CR) and Intraclass Correlation Coefficient values, ICC (3,1) (1) were calculated.

## Results

Differences in AUC values between different b-value combinations were becoming smaller with increasing total number of b values in b-value combinations. For b-value combinations consisting of 2 b values, AUC values for PCa detection and Gleason score classification were in the range of 0.573-0.973, 0.479-0.840, respectively. The corresponding values for b-value combinations consisting of 6 b values were 0.949-0.978, 0.798-0.840 while for b-value combinations consisting of 10 b values were 0.956-0.962, 0.816-0.834, respectively. In a subset of b-value combinations containing b value of 0 s/mm<sup>2</sup> and additional 2 b values, AUC values for PCa detection and Gleason score classification were in the range of 0.947-0.973, 0.780-0.836, respectively. The corresponding values for b-value combinations consisting of b value of 0 s/mm<sup>2</sup> and additional 4 b values were 0.952-0.969, 0.804-0.836, respectively. Similarly to b-value distributions based on AUC and ρ values, differences between b-value combinations based on CR and ICC(3,1) values were becoming smaller with increasing total number of b values in b-value combinations.

## Conclusion

Our results indicate that the optimal b value distribution for ADC<sub>m</sub> estimation of PCa consists of 4-5 b values in total. Furthermore, there is no b-value distribution which is substantially outperforming the other b-value distributions (Figure 1). B-value distributions containing only b values at the end of the b-value range (~1500 to 2000 s/mm<sup>2</sup>) demonstrated the lowest diagnostic performance and repeatability. **References** 1. Shrout PE, Fleiss JL. Psychol Bull 1979; 86:420-428



**Figure 1:** AUC, ρ, CR, and ICC(3,1) values for selected b-value combinations.