

VALIDATION OF EFFECTIVENESS OF MULTI-PARAMETRIC ENDORECTAL MR IMAGE FEATURES FOR PROSTATE CANCER DETECTION AND CORRELATION WITH GLEASON SCORE

Yahui Peng¹, Yulei Jiang¹, Tatjana Antic², Maryellen L Giger¹, Scott Eggener³, and Aytakin Oto¹

¹Radiology, The University of Chicago, Chicago, IL, United States, ²Pathology, The University of Chicago, Chicago, IL, United States, ³Surgery, The University of Chicago, Chicago, IL, United States

PURPOSE: Prostate cancer (PCa) is the most common non-skin cancer and the second most common cause of cancer death in US men. Clinical detection of elevated prostate-specific antigen level followed by transrectal ultrasound-guided biopsy is currently the standard practice for PCa diagnosis, although it has well-known limitations. Multi-parametric prostate MR imaging, including T₂-weighted, diffusion-weighted (DW), and dynamic contrast enhanced (DCE)-MR images, has been shown promising for PCa diagnosis.¹ We report here a validation study, across multi-parametric endorectal MR images acquired from scanners of two different manufacturers, of three previously-identified quantitative image features that were shown to be beneficial in PCa detection and Gleason score (GS) correlation.²

METHODS: Previously, we analyzed multi-parametric endorectal MR (T₂-weighted, DW-MR, and DCE-MR) images (1.5T Phillips scanners) of 52 PCa patients who had undergone prostatectomy post MR imaging, and identified three image features that were effective in differentiating PCa from normal peripheral-zone (PZ) tissue regions of interest (ROIs): 10th percentile and average apparent diffusion coefficient (ADC) values, and skewness of T₂-weighted signal-intensity distribution. In our current study, we analyzed the multi-parametric endorectal MR images of 71 PCa patients imaged on 1.5T GE scanners who also had undergone prostatectomy post MR imaging. A radiologist and a pathologist identified 102 PCa and 59 normal PZ tissue ROIs via histology-MR correlation, and the pathologist provided tumor ROI-specific GS. We analyzed the same three image features, and their combination via linear discriminant analysis (LDA) and leave-one-ROI-out analysis, on the 71 GE cases. Effectiveness of the image features was characterized in terms of receiver operating characteristic (ROC) analysis and area under the ROC curve (AUC). Effectiveness was also compared by training the LDA classifier with the Phillips cases and testing it with the GE cases, and vice versa. Furthermore, Spearman correlation coefficients were calculated between the image features and GS.

RESULTS: AUC values (\pm standard error) in differentiating PCa from normal PZ tissue ROIs of the 10th percentile ADC, average ADC, and T₂-weighted skewness were 0.92 \pm 0.03, 0.89 \pm 0.03, and 0.86 \pm 0.04, respectively, for Philips cases; and 0.89 \pm 0.03, 0.87 \pm 0.03, and 0.72 \pm 0.04, respectively, for GE cases. AUC values of the three image features combined by LDA were 0.95 \pm 0.02 and 0.89 \pm 0.02, for the Phillips and GE cases, respectively. Training with the Phillips cases and testing with the GE cases yielded AUC value of 0.89 \pm 0.03, and 0.95 \pm 0.02 when the case sets were reversed. Spearman correlation between GS and the 10th percentile and average ADC values were -0.34 (p=0.008) and -0.30 (p=0.02), for the Phillips cases, and -0.27 (p=0.007) and -0.32 (p=0.001), for the GE cases, respectively.

DISCUSSION: Visually, Phillips and GE MR images show clearly different characteristics, particularly with respect to certain image artifacts. These differences stem from differences in proprietary image-acquisition protocols. However, the similarities in the performances of the computer-extracted image features in differentiating PCa from normal PZ tissue ROIs suggest that these image features, which effectively characterize PCa, may be independent of MR scanners. The robustness of these image features across MR scanners is highly relevant as it suggests that these image features can potentially be used clinically, and serve as good candidates for development of computer-aided diagnosis (CAD) methods.

CONCLUSION: Quantitative multi-parametric endorectal MR image features, the 10th percentile and average ADC values, and the T₂-weighted skewness, are effective across images obtained from Phillips and GE scanners in differentiating PCa from normal PZ tissue ROIs. The ADC features correlate moderately and negatively with GS.

REFERENCES

1. Hoeks CM, Barentsz JO, Hambrock T, et al. Prostate cancer: multiparametric MR imaging for detection, localization, and staging. *Radiology*. 2011;261(1):46-66.
2. Peng Y, Jiang Y, Yang C, et al. Quantitative analysis of multi-parametric prostate MR images: differentiation between prostate cancer and normal tissue and correlation with Gleason score—a CAD development study. *Radiology*. [Conditionally accepted]