QUANTITATIVE IMAGE TEXTURE ANALYSIS PREDICTS MALIGNANCY ON MULTIPARAMETRIC PROSTATE MRI

Geoffrey A. Sonn, M.D., Lewis D. Hahn, M.D.*, Richard Fan, Ph.D., J Barker*, A R Depeursinge*, Ph.D., Daniel L. Rubin, M.D., M.S.*
Stanford, CA
(Presentation to be made by Dr. Geoffrey Sonn)

Objectives: Multiparametric MRI (mpMRI) and targeted biopsy are transforming prostate cancer diagnosis. Results from multiple centers demonstrate improved detection of clinically significant prostate cancer using MRI-guided biopsy. During MRI interpretation, lesions are most commonly scored using the Prostate Imaging Reporting and Data System (PI-RADS) grading system. For MRI to gain widespread acceptance and utility, its results must be reproducible. However, despite a standardized reporting system, the clinical utility of mpMRI is limited by variation in image interpretation across radiologists. At our institution, the overall cancer yield for biopsied PI-RADS 4 lesions is 47% (34/72), but the cancer yield among different radiologists who diagnose PI-RADS 4 lesions varies tremendously (range 0-100%). To overcome difficulty with reproducibility of mpMRI and to reduce the variability of radiologists, we propose to incorporate a computerized image analysis algorithm into image interpretation. We hypothesized that computerized quantitative image analysis would improve MRI interpretation beyond that achieved by radiologists alone. Specifically, we sought to apply quantitative image texture analysis to lesions identified on MRI to improve prediction of malignancy.

Materials and Methods: To date, mpMRI and targeted biopsy has been performed on 141 subjects harboring 173 lesions on MRI at our institution. 3T MRI images of 33 lesions in 33 patients were obtained. Each lesion had been classified as PI-RADS 3, 4 or 5 by a radiologist and subsequently targeted at biopsy. Targeted biopsy pathology was used as the gold standard. Each lesion was circumscribed by a radiologist based on three MRI sequences (T2, Apparent Diffusion Coefficient (ADC), and peak contrast Differential Subsampling with Cartesian Ordering (DISCO)). The coefficients from a Riesz wavelet analysis of the images were computed as image features to characterize tissue texture within each lesion. Riesz wavelets are advantageous because they do not presuppose any particular biologically-relevant patterns that are often required by other types of image texture features. Riesz coefficients from each pulse sequence, separately or in combination, were analyzed using an elastic net linear regression model to predict whether the lesion was benign or malignant. Performance of the prediction methodology was evaluated using leave-one-out cross validation.

Results: Radiologist classification of the 33 lesions was PI-RADS 3 (n= 11), PI-RADS 4 (n=13), or PI-RADS 5 (n=9). On biopsy, cancer was detected in 2 (18%) PI-RADS 3 lesions, 6 (46%) PI-RADS 4 lesions, and 9 (100%) PI-RADS 5 lesions. Overall, the biopsy pathology was cancerous for 17 lesions and benign for 16 lesions. The highest performance of the texture analysis was obtained with a combination of ADC and peak contrast DISCO Riesz features. The area under the curve (AUC) of the receiver operator characteristic (ROC) curve was 0.83. This AUC was higher compared to classifiers based on Riesz features from each sequence considered individually or in any other combination. Overall, the classifier correctly predicted the biopsy result for 64% of PI-RADS 3 lesions, 85% of PI-RADS 4 lesions, and 78% of PI-RADS 5 lesions.

Conclusions: This study demonstrates the feasibility of using quantitative Riesz texture analysis to predict whether a suspicious lesion on mpMRI (PI-RADS ≥3) is cancerous. Particularly notable is the 85% correct prediction for PI-RADS 4 lesions, given the tremendous variability of biopsy results for PI-RADS 4 lesions among different radiologists. Validation of this approach in a larger dataset is ongoing. In the future, we expect that quantitative image analysis will be incorporated into grading systems to refine prostate mpMRI image interpretation, enable greater reproducibility across radiologists, and improve patient counseling and decision making about prostate biopsy.

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