Combined MR Volumetry and Diffusion Weighted imaging to better predict clinically significant prostate cancer on MRI/Ultrasound fused guided biopsy?

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Introduction: Prostate cancer (PCa) is the second leading cause of cancer death in American men. Diagnosis requires a transrectal ultrasound (TRUS)-guided biopsy. TRUS biopsies under-sample certain regions of the prostate, leading to false negative results in up to a third of biopsies. In addition, correlation with radical prostatectomy specimens has demonstrated Gleason Score (GS) upgrading from biopsy in around 40% of patients. Multi-parametric (mp) MRI and novel approaches such as MRI-ultrasound (US) fusion may overcome these limitations by providing information on tumor location allowing for targeting of abnormal areas on MRI.

Purpose: To evaluate the combined efficacy of MR Volumetry and Diffusion Weighted Imaging (DWI), in the detection of clinically significant prostate cancer using MRI-US fusion biopsy.

Materials and Methods: In this IRB-approved, retrospective study, 103 patients (mean age 63y±9) underwent mpMRI with T2WI, DWI and DCE imaging. Clinically significant disease was defined as Gleason ≥ 7. Qualitative assessment was performed using a 5-point Likert scale indicating the reader's degree of suspicion for the presence of clinically significant disease on mpMRI *(1: unlikely (~10%), 2: less likely (~25%),3: possibly (~50%), 4: probable (~50%), 5: definite (~90%))*. The tumor volume was segmented on the ADC map using commercial software (Osirix). Abnormal findings on mpMRI were then dichotomized as measurable (ie discrete lesion present) vs non-measurable (ill-defined MR abnormality without discrete margins)(Figure 1). Tumor volumes were calculated for measurable lesions. The relationship between qualitative analysis, measurable disease and biopsy results were established with X^2 univariate analysis. The threshold of ADC to predict clinically significant disease was assessed by using receiver operatic characteristics. P=0.05 was considered statistically significant.

Results: Clinically significant (GS≥7) Pca was identified on MRI targeted biopsy in 24/103 (23 %) of Patients. Abnormal MRI findings were considered non-measurable in 45/103 (44%) and measurable in 58/103 (56%) of patients. None of the patients with non-measurable abnormalities on mpMRI were found to have GS≥7 PCa on biopsy. There was a significant difference in mean ADC between patients with non-measurable and measurable MRI abnormalities (1.4 ± 0.2 x10^{-3} mm^2/s, and 1.1 ± 0. respectively) (p=0.0001). A threshold of 1 x10^{-3} mm^2/s was found to be the most predictive of clinically significant cancer, with a Se= 70% and Sp 94% (AUC=0.882, P=0.0001). When considering measurable lesions with a mean ADC ≤ 1x10^{-3} mm^2/s, the likelihood of clinically significant disease was 94%. A larger tumor volume showed a tendency towards higher Gleason score (mean volume =1cm^3 ± 0.8 vs mean volume 0.5 cm^3 ± 0.9, p=0.09). There was an inverse relationship between Gleason grade and ADC value (Figure 2).

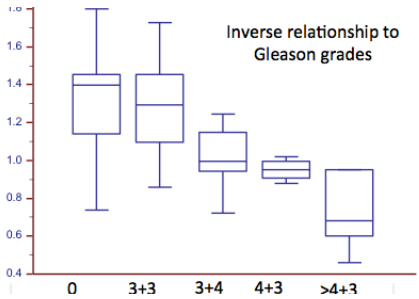

Figure 2: Box and Whisker blot demonstrating the association between Gleason grades and ADC

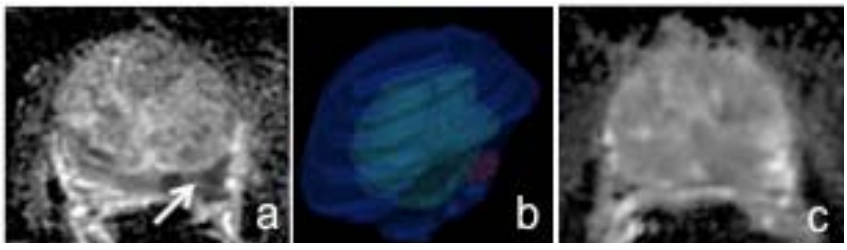

Figure 1:
a/ Discrete lesion/measurable volumetry
b/ Volume rendering image (red: tumor volume, green: transitional zone, Blue Whole prostate).
c/ non measurable disease

Discussion/Conclusion:
This preliminary study demonstrates the potential added predictive value of using tumor volumetry in combination with DWI, in the diagnosis of clinically significant prostate cancer using MRI-US fusion biopsy. Furthermore, it evaluates the feasibility of quantitative assessment in tumor burden.

Clinical Implication:
Prostate volumetry and ADC measurements may be used as new quantitative biomarkers, to accurately predict clinically significant disease using MRI targeted biopsy. Moreover, in the future, such tools could play a huge role in management of low-intermediate risk disease, serving as quantitative markers for active surveillance.