

Correlation of Endorectal 2D JPRESS findings with Pathological Gleason Scores in Prostate Cancer Patients

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Introduction: Prostate cancer is the most common lethal malignancy diagnosed in American men and the second leading cause of male cancer mortality (1). Magnetic Resonance Spectroscopy (MRS) is the most powerful non invasive technique capable of measuring chemicals within different human organs (2). During the last decade, proton (¹H) MRS in combination with anatomical MRI has been widely investigated in benign and malignant prostates. A major focus of this investigation is on assessing biochemical information based on citrate (Cit) and choline (Ch) levels recorded in the peripheral zone for early detection of prostate cancer (3). Two-dimensional (2D) J-resolved spectroscopy (JPRESS) offers better spectral dispersion than 1D MRS (4). A major advantage of endorectal 2D JPRESS is its ability in resolving the peaks of Cit, creatine (Cr), choline-containing compounds and spermine (Spm). A major goal of this work was to determine if the metabolite ratios of (Ch+Cr)/Cit and (Ch+Cr)/Spm in patients with two ranges of pathological Gleason scores (GS), namely (3+4) and (4+3) can be calculated using 2D JPRESS and correlated with prostate cancer aggressiveness.

Methods: A total of 24 patients who underwent endorectal 2D JPRESS were included in this study. The entire protocol was approved by the institutional review board (IRB), and informed consent was obtained from each human subject. The protocol combining MRI and MRS was performed at least 8 weeks after transrectal ultrasound-guided sextant biopsy. 14 men underwent radical retropubic prostatectomy and their pathologies were subsequently analyzed. The patients had two different GS: 3+4 (mean \pm SD, 57.7 \pm 8.7 years) and 4+3 (mean \pm SD, 63.5 \pm 9.9 years) of the patients ranged from 50 to 77 years. The patients were imaged on a 1.5 Tesla Avanto-Tim MRI Scanner equipped with high performance gradients (Siemens Medical Solutions, Erlangen, Germany). An inflatable endorectal coil (Medrad Corporation, Indianola, PA) was inserted in the rectum and 90cc of air instilled. The experimental parameters for 2D JPRESS were as follows: TR/TE=2s/30ms, 8averages/t1 increment (Δ t1), 64 Δ t1, 2000Hz along t₂ and raw data matrix of 1024x64. A 1.5x1.5x1.5 cm³ voxel was localized predominantly in the peripheral zone suspected for malignancy. Using the operator-defined 2D peak volumes in the frequency domain, metabolite ratios were calculated including total choline (Ch), creatine (Cr), spermine top (Spm_T), spermine bottom (Spm_B), citrate top (Cit_T) and citrate bottom (Cit_B). T test was done to compare the ratios in the two groups.

Results and Discussion: In the 2D JPRESS spectra (Fig.1) we could identify and quantify Ch, Cr, Spm and Cit peaks. There was a significant difference in the (Ch+Cr)/Cit ratio between the two groups with higher (Ch+Cr)/Cit ratio in patients with GS (4+3) than those with GS (3+4). (Ch+Cr)/Spm also showed a similar trend but did not reach statistical significance (Table.1). Determining which patients truly have low grade, low volume disease before surgery is currently difficult, especially with the inaccuracy of TRUS/PnBX. This study suggests that MR could potentially provide the clinician with presurgical non invasive grading criteria similar to GS.. This preliminary study demonstrates that the information obtained from the second spectral dimension provided by J-resolved spectroscopy can give clinically relevant information from human prostate pathologies. These pilot findings should be viewed as encouraging and demonstrate the huge potential that MR spectroscopy has to offer in prostate cancer diagnosis.

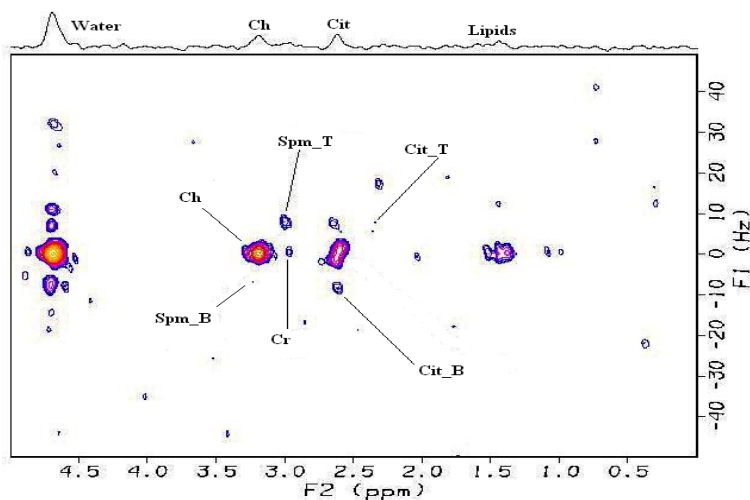


Fig.1.2D JPRESS spectrum of 63 yo prostate cancer patient.

Ratio	GS 3+4 (n=7)	GS 4+3 (n=7)	p value
	Mean \pm SD	Mean \pm SD	
(Ch+Cr)/Cit	1.48 \pm 0.83	2.90 \pm 0.94	0.01
(Ch+Cr)/Spm	1.59 \pm 0.73	2.71 \pm 1.47	0.09

Table.1. Statistical analysis of various Gleason scores.

Conclusion: The J-coupled metabolite resonances of Cit and Spm were clearly identified using 2D JPRESS and the ratios of Ch+Cr/Cit and Ch+Cr/Spm were calculated. This pilot study has confirmed using 2D JPRESS that the metabolite ratios increase with higher grade of cancer. These differences in ratios can potentially be used as non invasive markers of tumor aggressiveness.

References

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