

INTRODUCTION

We introduce a novel approach to combine multiple MR parameters for detection and assessment of prostate cancer (PCa). Our technique, referred to as IMPACT (Imaging and Multi-Parametric Analysis of Cancerous Tissue), combines MR diffusion weighted imaging (DWI) and MR spectroscopic imaging (MRSI) by partitioning tissue populations into three clusters: (2 healthy tissues, 1 tumor). The K-means algorithm¹ and priori information of prostatic and tumor metabolic and ADC values are used to define the three classes. Voxels identified as tumor are further partitioned into high, medium, and low degrees of suspicion.

MATERIALS AND METHODS

38 patients with known cases of PCa underwent combined MRI/MRSI/DWI exam on a 1.5T MR GE scanner using a combined pelvic phased array and endorectal coils (Medrad, Indianola, PA). The patients subsequently underwent radical prostatectomy. Imaging parameters were: DWI MRI with Spin-Echo EPI: (TR/TE = 4000/99.2 ms, FOV = 14x14 cm, 128x128, slice thickness 3 mm, b-factors: 0, 600, 800, 1000, and 1200 s/mm²), MRSI sequence with the selective excitation chemical shift imaging sequence PROSE: (TR/TE = 1000/144 ms, 16x8x8, FOV = 11x11 cm, slice thickness 3 mm). IMPACT was designed for the multiparametric analysis of MR data from prostate. Fig. 1 shows a two level hierarchical clustering of all voxels within the prostate. Voxels were classified using K-means clustering algorithm into three partitions: healthy prostate tissue (type I and II), and tumor. The choice of three classes was based on visual inspection of the cluster plot (Fig. 2) coupled with the understanding that within healthy prostate there are variations of metabolites and ADC values. Prior knowledge or ‘seeds’ were obtained for ADC^{2,3} and metabolic ratios^{4,5} for each tissue type from the literature. In the second stage, voxels classified as tumor are further partitioned into three classes: high, medium, and low suspicion.

RESULTS AND DISCUSSION

IMPACT is an unsupervised tissue segmentation technique based on K-means clustering. Fig. 2 shows a cluster plot of all voxels classified into three partitions from a 65 year old patient with PSA of 4.82 ng/ml and Gleason score 4+5. The surgical pathology report identified dominant tumor mass located in the left posterior, apex, mid, and base. In Fig. 3a, level I classified voxels are overlaid on the T2w image. The tumor (red) has clearly been segregated from the surrounding tissue. Fig. 3b shows tumor voxels partitioned into three degrees of suspicion. Our measure of degree of suspicion is based on comparison with prior information. Multi-parametric analysis with IMPACT could potentially overcome the limitations associated with measurement of an individual parameter. Preliminary results suggest that feasibility of discriminating healthy tissue from tumor. Further assessment of usefulness of the method as a diagnostic tool in terms of accuracy in measuring tumor volume and grade is presently ongoing. Our ultimate goal is to identify a unique Gleason score for each tumor class in level 2, providing a complete identification and assessment of PCa.

References: [1] Seber, G.A.F., *Multivariate Observations*, Wiley, 1984. [2] Gibbs, P. *et al.* *Magn Reson Med* 2001; 46:1054-1058. [3] Sato, C. *et al.* *J Magn Reson Imaging* 2005; 21:258-262. [4] Males R, *et al.* *Magn Reson Med* 2000; 43:17-22. [5] Zakian K, *et al.*, *Radiology* 2005; 234:804-814.

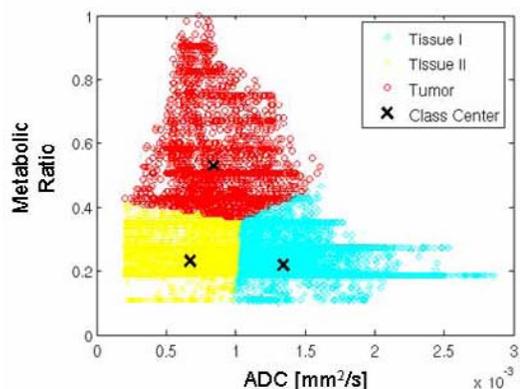
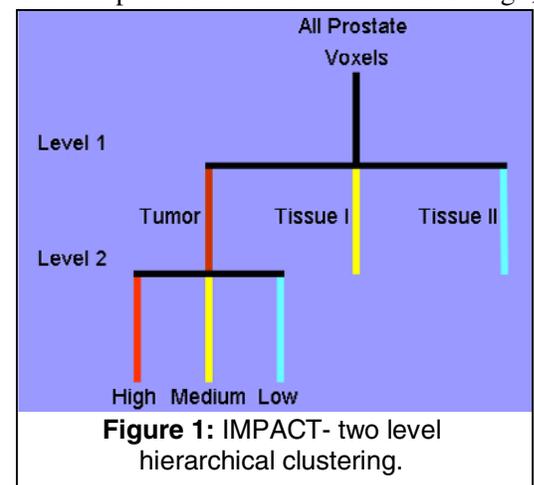


Figure 2: Cluster plot of all voxels

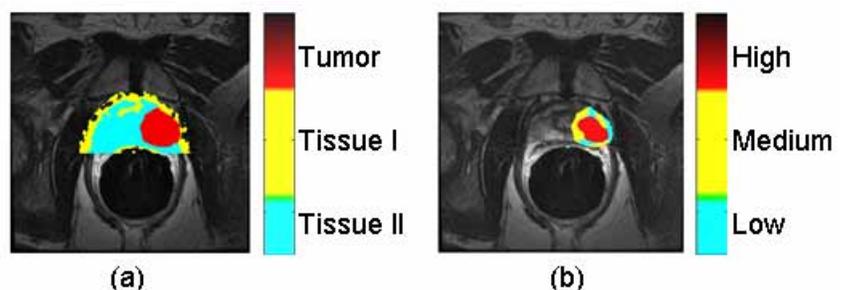


Figure 3: (a) Level 1 and (b) level 2 clustering of prostatic voxels.