Automation of spectroscopic scoring of prostate MRSI by a canonical correlation analysis based classification

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Introduction: A recent study showed high inter-observer agreement by using a standardized system for scoring spectroscopic imaging data of the prostate[1]. This study explores the feasibility of replacing the time expensive human interpretation of the MRSI exams by a statistical tissue segmentation technique based on Canonical Correlation Analysis (CCA) [2].
Methods: MRSI was performed on a 1.5T whole body MR scanner (Signa, GE) using an endorectal receiver coil. The MRSI data sets (n=2508 voxels) were analyzed by an experienced MRS reader on a standardized five category scale, and these scores were used as golden standard for statistics. All datasets were analyzed using CCA, which is a multivariate generalization of cross-correlation in order to include spatial information. In this study 3 versions of the spatial model of CCA were used: a single voxel (SV CCA), a 2-dimensional (Axial CCA), and a 3-dimensional model (3D CCA). The spectral models of CCA were based on scored in vivo spectra. A subgroup of 4 patients with a large number of malignant voxels was selected to verify the influence of spatial distribution of malignant tissue.

Descriptive statistics are shown in Table 1. Specificity ranged from 87% to 90% for all methods, indicating a good classification of healthy tissue. Sensitivity ranges from 65% to 71% due to a larger number of false negatives i.e. malignant spectra classified as healthy by the CCA classification. The 3D CCA method takes into account more spatial information leading to higher sensitivity (90%) and specificity (71%). Because in the subgroup a higher number of malignant voxels is present, the Axial CCA and 3D CCA benefit more from the spatial information. Also the accuracy of the 3D CCA (86%) is higher due to the increased incorporation of spatial information. The accuracy of the CCA methods is limited by two factors. Firstly, no anatomical MRI information was incorporated in the analysis; information that is used by the spectroscopist to achieve a higher scoring sensitivity. Secondly, the CCA methods incorporated spectra from central gland voxels, which are excluded when the data are scored with knowledge of morphologic information provided by T2 MRI.
Conclusion: CCA based methods provide a means of classifying prostate MRSI data with high accuracy and specificity. Sensitivity could be increased by increasing the spatial resolution of the spectral data and by adding morphologic information obtained from MRI.
References
[1] Jung,et al. Radiology 2004;233
[2] Laudadio,et al. MRM 2005 ;54(6)