Multiparametric Approach to Diagnose Ovarian Lesions Preoperatively: Combination of ADC and MRS

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Introduction: Ovarian cancer is the most lethal of the gynaecologic malignancies, largely due to the advanced stage at diagnosis in most patients[1]. Surgery is necessary for the diagnosis, staging, and treatment of ovarian cancer with staging based on the International Federation of Obstetrics and Gynaecology (FIGO) system[2] which takes into account the primary mechanisms of spread of ovarian cancer (i.e. local extension, intraperitoneal seeding, lymphatic invasion and haematogenous dissemination[3]. There is evidence that adequacy of staging surgery for ovarian cancer is often not performed[4,5], especially when the preoperative diagnosis is that of a benign process[3] or performed by either a general surgeon or gynaecologist [4,5]. Accordingly there is increasing interest in the application of MRI to pre-operatively characterise ovarian neoplasms [6-8] and thus triage patients to gynaecological oncology surgeons when malignant or to general surgeons if benign. Here we undertook a pilot study to evaluate how the combination of apparent diffusion coefficient (ADC) measurements and single voxel spectroscopy (SVS) could pre-operatively characterise 10 patients with clinical suspicion of ovarian cancer (i.e. elevated serum CA-125, mass on radiologic imaging, and abnormal clinical findings).

Methods: The cohort comprised 10 patients (mean age 50 years; age range, 43-76 years) from which 13 SVS and ADC measurements were recorded from 13 separate locations (6 from solid tumours, 7 from cystic tumours). The diagnosis was substantiated by surgical excision and detailed histopathology. Data were collected on a whole-body 3T clinical scanner (Magnetom Trio, Siemens AG, Germany). Following orthogonal T2w imaging SVS was performed in the axial plane using an echo time (TE) = 135ms and repetition time (TR) = 2000ms with PRESS localisation[9]. Spectroscopy voxels were placed to sample the ovarian mass without contamination from surrounding tissues as assessed from orthogonal imaging. Water-suppressed spectra were acquired with 256 signal averages, 1024 complex data points, bandwidth of 1500Hz while non-water suppressed spectra were acquired with reduced signal averages (n=16). Axial diffusion-weighted (DW) images were acquired in the same slice locations as the T2w axial imaging using a spin-echo echo-planar imaging (SE-EPI) sequence (TE 84 ms, TR 2500 ms, section thickness 3.0 mm, FOV 190mm). DWI were collected with motion-probing gradient (MPG) pulses applied sequentially in three orthogonal axes to generate three sets of axial DW images (phase, read, slice) with b-values (0, 250, 500, 750 sec/mm^2). Spatially selected saturation slabs were used to suppress signal of inflowing spins at the edges of the imaging volume, while signal from fat tissue was suppressed by spectral inversion technique.

Spectra were reconstructed using jMRUI software[10] and presence and comparative magnitude of the total choline signal noted (water suppressed spectra) as well as the ratio of lipid signal (at 1.3ppm) to water (4.7ppm) (non-water suppressed spectra). ADC values were recorded from the same locations as the SVS measurements. This study was approved by the local institutional ethics committee, and written informed consent was obtained from all participants.

Table 1: Patient demographics

		ADC*	tCho	lip/H_2O^+	Diagnosis	Path
1	cystic	18.62	-	0.41	B	Endometriotic cyst
2	solid	12.90	++	18.58	M	High grade mucinous adenocarcinoma
3	cystic	18.01	++	7.61	M	High grade mucinous adenocarcinoma
4	solid	9.79	++	10.07	M	Serous adenocarcinoma
5	cystic	19.23	+	2.17	B	Benign serous cystadenofibroma
6	solid	12.47	+	24.90	M	Moderately differentiated clear cell carcinoma
7	solid	11.66	-	24.15	M	Serous adenocarcinoma
8	cystic	26.27	-	6.84	B	Mature cystic teratoma
9	solid	9.41	++	15.40	M	High grade serous Ca of fallopian tube
10	cystic	28.34	-	3.35	B	Benign cystadenoma
11	cystic	27.89	-	4.92	B	Benign cystadenoma
12	solid	25.64	-	6.11	B	Mature cystic teratoma
13	cystic	27.05	-	1.57	B	Mature cystic teratoma

*** (x 10^{-4} mm^2/sec); $^+$ x10^{-4} ; $^{++}$ M – malignant, B – benign.**

Results and Discussion: Thirteen combined SVS (Figure 1&2) and ADC (Figure 3) measurements were evaluated from ten patients (table 1). Five had malignant ovarian neoplasms and five benign ovarian neoplasms. Both ADC and MRS evaluations provided statistically significant differences between malignant vs. benign neoplasms (figure 1, 2&3). There is increasing evidence that suggests an improved diagnostic accuracy of MRI when a multi-parametric approach to cancer detection and characterisation is employed[11,12].

Conclusion: This pilot study demonstrates the combined use of MRS and ADC evaluation and suggests a role for pre-operative triaging of patients with ovarian neoplasms.

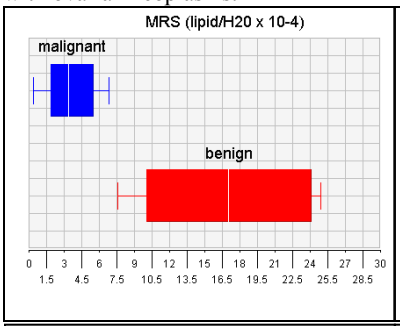

Fig.1: Box and whisker plot of MRS (lipid/H_20). Whisker – data range; box – 25th-75th percentile. p-value = 0.0008.

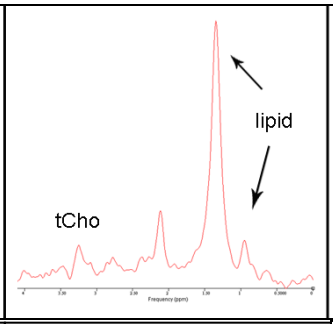

Fig.2: Water-suppressed spectrum from solid portion of high grade mucinous adenocarcinoma.

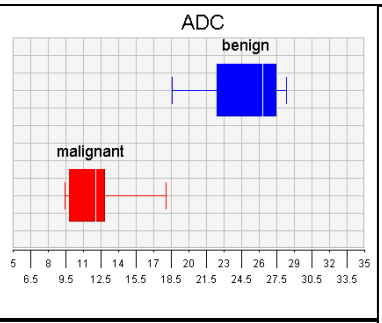

Fig.3: Box and whisker plot of ADC values. Whisker– data range; box– 25th-75th percentile. p-value= 0.0001.

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