ADC and Perfusion Signal Fraction Measurements: Feasibility in Ovarian Cancer at 3 Tesla

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Introduction

Ovarian carcinoma is the second most common malignancy of the female reproductive tract, but the most frequent cause of death from gynaecological malignancy. The fundamental clinical problems remain the high frequency of primary and acquired drug-resistance, despite newer highly active agents, and the paucity of information regarding the mechanisms of resistance (1). Clinical studies to identify these mechanisms are of the utmost importance to improve treatment and survival. DWI is a functional imaging technique that displays information about water mobility, tissue cellularity and the integrity of the cellular membranes (2). The apparent diffusion coefficient (ADC) value is inversely related to the cellularity of tumours and thus can be used for evaluation of treatment response (2,3). Additionally, the signal changes at low b-values are associated with suppression of flowing spins (perfusion), which might in itself provide useful diagnostic information. Our long-term aim is to evaluate parameters measured using DWI as surrogate markers of tumour response/resistance to chemotherapy in both primary ovarian cancer and omental/peritoneal implants, which can be a challenging patient group to image; the aim of this preliminary study is to assess the feasibility of this method.

Materials/Methods

The study protocol was approved by the Ethics Committee. Patients with advanced ovarian cancer (FIGO stage 3 or above) and scheduled to undergo neoadjuvant treatment with chemotherapy prior to interval debulking surgery (IDS) were eligible for the study. All patients had a staging CT prior to the start of chemotherapy to assess the bulk and location two marker lesions: the primary ovarian lesion and a peritoneal or omental deposit. To date data have been acquired from 4 patients.

Imaging protocol: MRI examinations were performed on a 3 T whole body scanner (HDx, GE Healthcare, Waukesha, WI) with an 8-channel cardiac array coil. High resolution T2W axial FRFSE images were used to evaluate the extent of the disease and confirm the position of the primary ovarian cancer and omental/peritoneal implants. DWI images were obtained using a diffusion-weighted EPI sequence (TE/TR = 87/2000 ms; slice thickness 8mm; FOV 35cm×28 cm; matrix 128×96). Multislice imaging with multiple b-values (0, 100, 150, 200, 250, 350, 500, 750, 1000 s/mm^2) was performed in a single breath-hold. When more than seven slices were needed to cover the tumour region, a second breath-hold was performed.

DWI analysis: Pixelwise analysis was performed using customised software written in Matlab. ADC maps were calculated by performing a non-linear fit to data acquired with b-values 100–1000 s/mm^2. By comparing the extrapolation of this fit with the b=0 image, the approximate relative signal fraction at b=0 attributable to flowing spins (perfusion) was calculated. The pelvic tumour and omental/peritoneal implant were outlined by an experienced radiologist, using the FRFSE images for guidance. The relative position of the ROI was manually adjusted for motion if necessary.

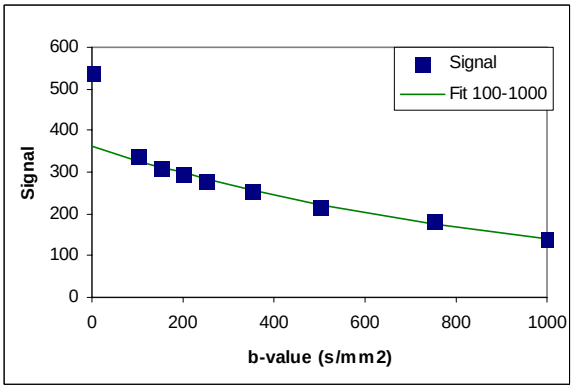

Figure 1: Typical tumour signal variation with b-value, and exponential fit to points b=100-1000 s/mm^2. The point at b=0 lies above the extrapolation—the perfusion effect.

Results

Figure 1 illustrates the fit to DWI data for a typical omental implant. The data for b=100–1000 s/mm^2 are well-described by a standard exponential fit, whereas the b=0 data-point does not lie on this line due to the extra signal contribution from perfusion. The perfusion fraction measures the proportion of signal at b=0 due to this effect. Figure 2 shows typical images and also maps of ADC and fractional perfusion signal. As expected, the tumour appears bright on DWI images, due to their low ADC compared to surrounding tissues. Table 1 shows the measured values of ADC and fractional perfusion signal for each patient and tumour.

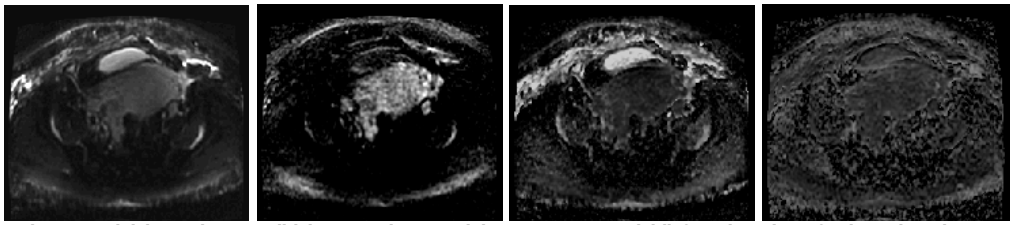

Figure 2: (a) b = 0 image; (b) b = 500 image; (c) ADC map; and (d) fractional perfusion signal map.

Conclusions

This work demonstrates that our DWI methods in ovarian cancer are feasible at 3T. Future work will aim to assess any correlations between the measured parameters and treatment outcome, and to compare the fractional perfusion signal with DCE-MRI.

References

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Acknowledgements

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Patient	ADC (× 10^{-3} mm^2/s)		Perf. signal fraction	
	primary	peritoneal	primary	peritoneal
1	1.47	1.18	38 %	47 %
2	1.12	1.20	34 %	35 %
3	1.33	-	41 %	-
4	0.90	1.28	37 %	35 %

Table 1: results for each patient and tumour.