Tracer kinetic parameters estimated with rapid DCE-MRI in patients with muscle-invasive cancer of the bladder are able to distinguish between the effects of neo-adjuvant chemotherapy and residual tumour

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1. Introduction

Treatment of muscle-invasive bladder cancer with chemotherapy and radiotherapy results in haemorrhagic inflammation, mimicking residual tumour on conventional MR images making interpretation difficult. Studies have shown that descriptive parameters obtained using DCE-MRI differ between bladder tumour and surrounding normal structures[1,2]. The aim of this study was to use DCE-MRI to determine both descriptive and tracer kinetic parameters post-chemotherapy and investigate whether parameters differed in areas of residual tumour and treatment effect (Tr-Eff).

2. Methods and materials

Eighteen patients with transitional cell carcinoma of the bladder underwent DCE-MRI scans following neo-adjuvant chemotherapy. Studies were performed on a 1.5 T Siemens Magnetom Avanto using the phased array pelvic coil. An axial T_1-w volumetric interpolated breath-hold examination (VIBE) sequence covering the whole bladder (TR / TE = 3.5 / 1.2 ms, $\alpha = 25^o$, FOV = 240 x 320 x 5.0 mm, GRAPPA factor = 2) was used for the dynamic acquisition. The acquired matrix of 144 x 158 x 10 (interpolated to 144 x 192 x 16) resulted in a temporal resolution of 2.5 s and data were acquired for 4.5 mins. Multiple flip angle VIBE sequences (α = 5, 10, 35^o) were used to obtain pre-contrast T_1 estimates. Individual arterial input functions (AIFs) were obtained from the external iliac arteries. Volumes-of-interest (VOIs) were defined in suspicious areas on high resolution T_2-w TSE scans (TR / TE = 4000 / 99 ms) and transferred to the lower resolution dynamic scans. Whole VOI signal-time curves were analysed using a two-compartment exchange mode (2CXM[3]) to obtain estimates of plasma perfusion, F_p, capillary permeability-surface area product, PS, and the volumes of extravascular extracellular and plasma space, v_e and v_p, respectively. Relative signal intensity at 80 s (rSI_{80s}, ratio of signal intensity at 80 s to baseline) was calculated for each VOI. The bladder was subsequently examined for evidence of residual tumour and / or Tr-Eff. Differences in parameters measured in areas of residual tumour and Tr-Eff were examined with a student's t-test. The sensitivity and specificity of parameters for differentiating between areas of residual tumour and Tr-Eff was calculated.

3. Results

23 abnormal sites were defined post-chemotherapy. On pathology, 9 and 14 areas were identified as residual tumour and Tr-Eff respectively. Figure 1 shows example signal-time curves from areas of residual tumour and Tr-Eff. Table 1 shows post-treatment median (and inter-quartile range) rSI_{80s} and 2CXM parameter values over all VOIs and separated into those VOIs which were subsequently found to be residual tumour or Tr-Eff. Median rSI_{80s} was significantly higher in areas of residual tumour than Tr-Eff (2.3 *vs* 1.7, p = 0.043), median F_p was higher in residual tumour than Tr-Eff (25.6 *vs* 11.5 ml/min/100 ml, p = 0.016). The sensitivity and specificity of rSI_{80s} for discriminating between residual tumour and Tr-Eff were 44% and 64% respectively, while those of F_p were 89% and 64% respectively.

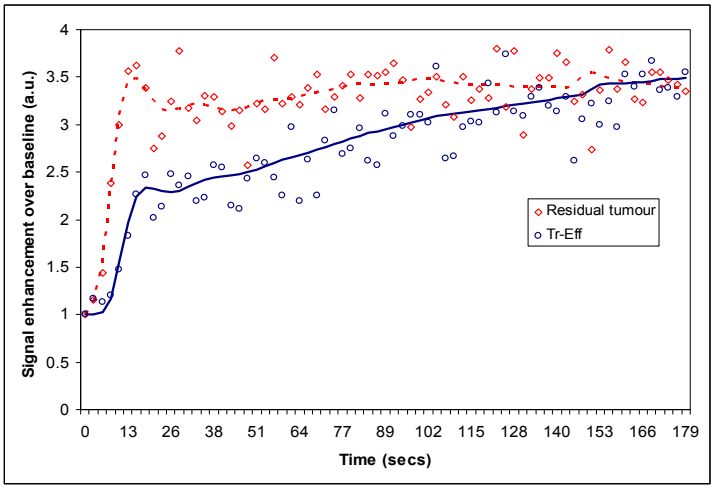

Fig 1: Signal enhancement curves from areas of residual tumour and Tr-Eff

	n	rSI_{80s}	F_p ml/min/100 ml	v_p ml/100 ml	PS ml/min/100 ml
All VOIs	23	2.0 (1.5 – 2.3)	15.4 (11.0 – 21.9)	11.4 (5.6 – 15.4)	4.0 (1.8 – 7.8)
Residual tumour	9	2.3 (2.2 – 2.6)	25.6 (15.8 – 38.4)	11.9 (8.7 – 25.3)	6.5 (3.0 – 8.0)
Tr-Eff	14	1.7 (1.4 – 2.2)	11.5 (9.7 – 17.2)	8.6 (3.6 – 14.2)	2.0 (0.4 – 6.6)
p-value	-	0.043*	0.016*	0.078	0.157

Table 1: DCE-MRI parameters averaged over all VOIs and VOIs classified as areas of residual tumour and Tr-Eff.

4. Conclusions

There are no existing DCE-MRI studies presenting post-neoadjuvant chemotherapy 2CXM parameters in patients with bladder cancer, however our post-chemotherapy estimate of F_p in areas of residual tumour agrees well with the pre-treatment F_p presented by Bains *et al.*[4] DCE-MRI parameters obtained post-chemotherapy are capable of distinguishing between residual tumour and the effects of treatment in patients treated for bladder cancer with neo-adjuvant chemotherapy.

References

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