# DYNAMIC CONTRAST-ENHANCED MRI IN RECTAL TUMOURS – INITIAL REPRODUCIBILITY MEASUREMENTS AT 3 T WITH AND WITHOUT BOWEL RELAXANT

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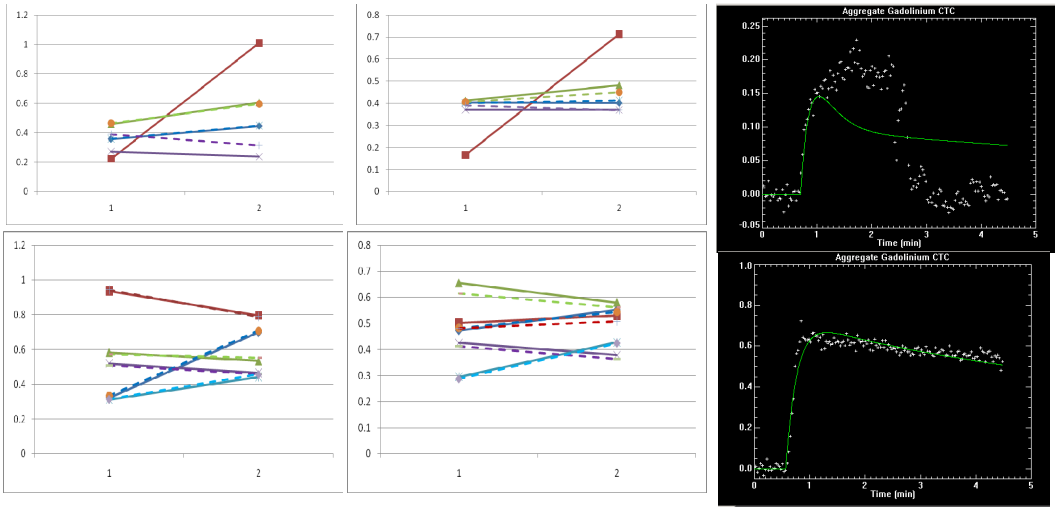
**Introduction.** Dynamic contrast-enhanced (DCE) MRI and the fitting of pharmacokinetic (PK) models to the resulting image data has been widely used in oncology to investigate tumour vascularity, particularly in conjunction with treatment response. Despite the improved SNR offered by 3T MRI systems, to date the majority of these studies have been performed at 1.5T. This may be due in part to concerns over reproducibility of DCE-MRI at 3T, where increased RF inhomogeneities are likely to impact on the quantification of T1 values required for accurate PK modelling. Although there have been a number of studies looking at reproducibility of DCE-MRI in tumours at 1.5 T [1,2], there has been relatively little corresponding work at higher field strengths and to our knowledge no reports in rectal cancer alone.

**Aims**. The goals of this study were to investigate the reproducibility of PK parameters fitted to DCE-MRI data at 3T in a group of patients with rectal cancer and to compare results from patients with and without the administration of an antispasmodic agent to reduce bowel motion.

**Methods.** 9 patients with histologically confirmed rectal cancer were imaged on a 3T Achieva MRI system (Philips, Best, Netherlands) using a 32 channel cardiac coil, on paired visits within a week apart, prior to the start of treatment. All patients were asked to refrain from caffeine on the day of the scan and were imaged at similar times of the day when possible. 5 patients received an intra-muscular injection of 20 mg of the bowel relaxant butyl-bromide immediately prior to scanning. A further 4 patients did not receive a bowel relaxant. After conventional anatomical T1-weighted and T2-weighted imaging, a 3D spoiled gradient echo T1-weighted sequence (TR/TE = 3.1/1.26 ms, 12° flip angle, FoV 220 mm, acquired voxel size of 8×1.2×1.2 mm reconstructed to 20 slices of 4×1×1 mm, SENSE factor 1.6 in AP and FH directions with SENSE oversampling of 1.2) was planned axial-oblique to the tumour. Care was taken to try and reproduce slice positions on the second visit using planning images from the first MRI scan. 160 dynamics were acquired at a rate of 1.7 s/volume with 0.1 mmol/kg Magnevist (Bayer-Schering, Burgess Hill, UK) administered intravenously after the 10$^{th}$ dynamic immediately followed by a 20 ml saline flush, both delivered via a power injector at 4 ml/s. The dynamic sequence was immediately preceded by a similar acquisition of 1 dynamic with 8 averages and a reduced flip angle of 2° to provide an equivalent proton density weighted volume to enable calculation of T1 values. Regions of interest were drawn by a consultant radiologist around the tumour as visualised on T2-weighted images (matched to dynamic sequence geometry with a higher in-plane resolution of 0.5×0.5 mm) acquired prior to the DCE sequence. These ROIs were imported into MRIW (Institute of Cancer Research, UK) and PK modelling was performed on a pixel-by pixel basis for each ROI and additionally on the average ROI signal for each slice using a modified Kety model [3] and a population-based arterial input function [4] from which quantitative parameters such as the transfer constant, $K^{trans}$, and the fractional volume extravascular-extracellular leakage space, $v_e$, were extracted and pooled together for each patient visit. Due to the small numbers to date, initial results are displayed graphically rather than a full statistical analysis [1,2].

**Results.** Graphical plots show measured $K^{trans}$ (left graphs) and $v_e$ (right graphs) for patients with (bottom row) and without (top row) administration of a bowel relaxant values. Results from pixel-based and ROI-based analyses are indicated by solid and dotted lines respectively. A high degree of agreement between these two analyses is observed. In a number of the patients who did not receive bowel relaxant, significant motion was observed. The effect of significant bowel motion is demonstrated in the first contrast agent time curve below, with the fitted PK model shown as a green line. The bottom example show results from a quiescent bowel.




**Discussion.** This work demonstates initial results for the reproducibility of PK parameters $K^{trans}$ and $v_e$. An understanding of reproducibility values is crucial to determine whether subsequent changes observed following treatment are real. Despite the higher SNR afforded by 3T reproducibility in these patients, to date the reproducibility appears to be less than previously reported at 1.5 T in other solid tumours [1,2]. This may be due in part to the tumour site. The potential importance of a bowel relaxant is demonstrated by the large change in PK values associated with bowel motion during the DCE-MRI acquisition. In a few cases, there was a noticeable offset between the ROI and the enhancing tumour. Since ROIs were defined on T2-weighted images acquired prior to the DCE-MRI sequence, there is increased scope for patient movement to reduce. Further analysis using ROIs defined on the DCE images themselves should help to assess the impact of this particular issue, although this introduces bias into measurement of enhancement.

Of note, the bottom concentration time curve shows a less than perfect fit to the data, particularly for the initial uptake curve, which suggests a different PK model and/or population-based arterial input function may be more appropriate in these patients, and result in better reproducibility, particularly in this instance for the parameter $K^{trans}$. In summary, although bowel relaxants are often not used for clinical MRI of the rectum, these results demonstrate that large effects on PK parameters may arise from bowel motion in certain patients.

**References.** [1] Galbraith SM, *et al.* NMR Biomed. (2002) 15:132–142, [2] Alonzi R, *et al.*JMRI 32:155–164 (2010 [3] Tofts P, *et al*. JMRI (1999) 10:223–232 [4] Walker-Samuel S, *et al.* Phys. Med. Biol. (2006) 51:3593–3602