Assessment of R2* in primary colorectal cancer: Reproducibility and sequential changes following chemoradiation in relation to DCE-MRI parameter changes.

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BACKGROUND: Intrinsic susceptibility weighted MRI (ISW-MRI) provides information on the oxygenation status of the blood volume. The aim of this study was to assess the reproducibility of R_2* and sequential changes following chemoradiation therapy (CRT), in relation to perfusion changes shown by dynamic contrast enhanced MRI (DCE-MRI).

METHODS: Following institutional review board approval and informed consent, 14 patients underwent ISW-MRI and 3D DCE-MRI at 1.5T using the following parameters: ISW - TR 100ms, TE 4.76 to 61.93 ms, NEX 2, FOV 260mm, 256^2 acquisition matrix, slice thickness 5mm, total 6 slices (R_2*: s^{-1}); DCE-MRI TR 6.6ms, TE 1.22ms, flip angles 3° (PDW) and 21° (T1w) NEX 1, FOV 260mm, 256×174 acquisition matrix, slice thickness 5mm, 12 slices (6 usable), TA: 6m 25s (extended Tofts model; $IAUGC_{60}$ (mmol.s) and K^{trans} (min^{-1})). Imaging was repeated at baseline (Day 1 and 2) to allow reproducibility assessment and at the following time points after chemoradiation (45 Gy in 25 fractions; capecitabine 850 mg/m^2): within 2 weeks of treatment completion, 6 weeks post and 11 weeks post (just prior to surgery). Parametric images were calculated using MRIW and DiffusionView software (Institute of Cancer Research, UK): Regions of Interest were drawn on the DCE-MR images by an experienced radiologist and transferred onto the R_2* images. Reproducibility was assessed by Bland-Altman statistics. Changes in R_2* were assessed by Wilcoxon rank test. Correlation between R_2* and K^{trans} was assessed by Spearman's rank correlation; two-tailed significance at 5%.

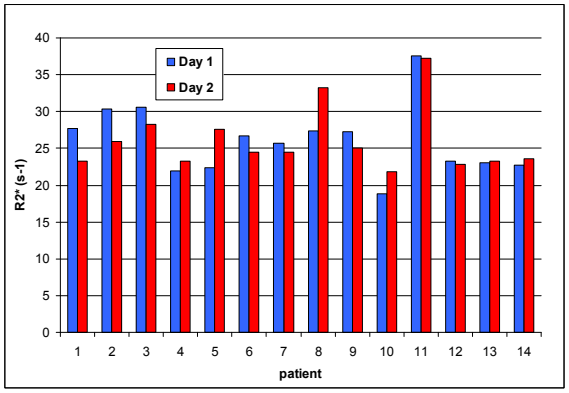
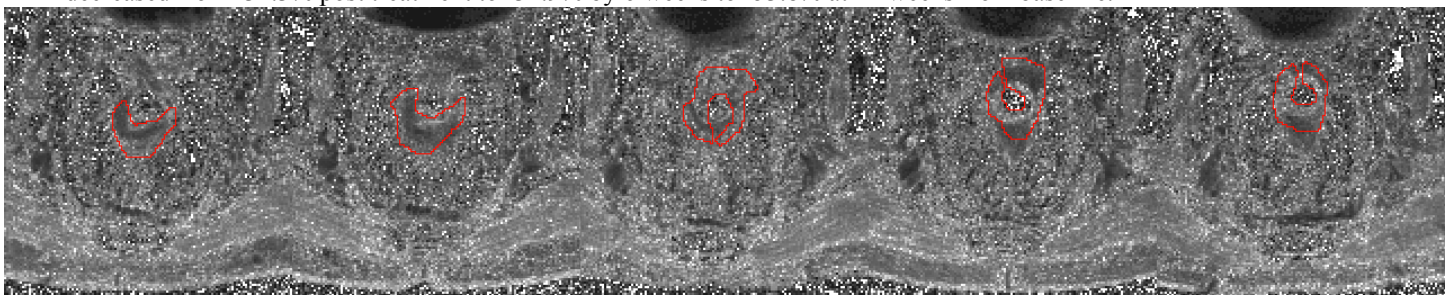


Figure 1: Reproducibility for R_2*

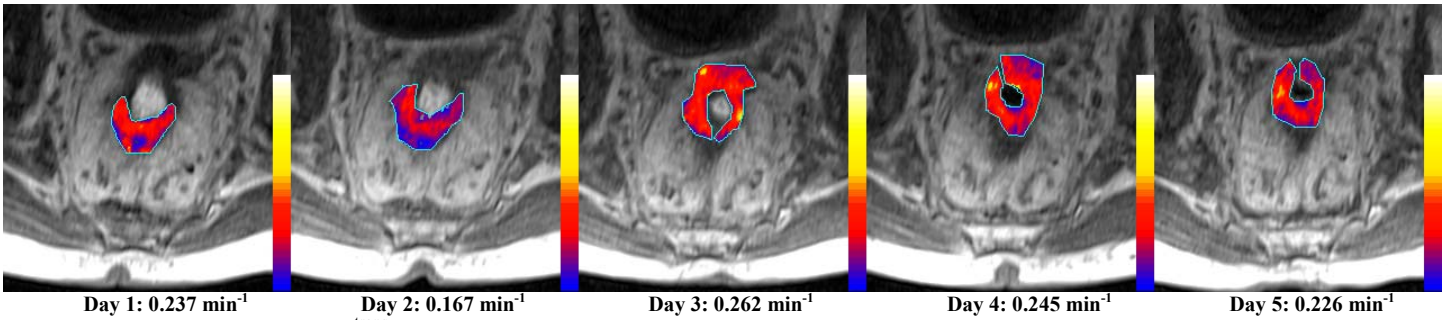
RESULTS: Imaging was successful at baseline (reproducibility) in 14/14 (100%), in 13/14 (92.9%) immediately post-treatment, in 11/14 (78.6%) at 6 weeks and in 9/14 (64.3%) patients at 11 weeks. Baseline R_2* values for the cohort are summarised in Fig. 1. The mean difference and 95% limits of agreement were -0.15s^{-1} and -6.15 to 6.22s^{-1} respectively, within-subject coefficient of variation 8.5%, and repeatability coefficient r = 23.5% (as a percentage of the mean).

Mean R_2* increased from +5.8% post treatment to +14.4% by 6 weeks post CRT reducing at 11 weeks to +5.0% from baseline. Correspondingly mean $IAUGC_{60}$ decreased from -11.1% post treatment to -26.6% at 6 weeks to -27.9% at 11 weeks from baseline. K^{trans} decreased from -32.3% post treatment to -34.9% by 6 weeks to -53.8% at 11 weeks from baseline.



Day 1: 28.9s^{-1} Day 2: 28.8 s^{-1} Day 3: 32.5 s^{-1} Day 4: 29.6 s^{-1} Day 5: 32.8 s^{-1}

Figure 2: Matched longitudinal series of R_2* images (top) and K^{trans} images (bottom). L>R: repro 1, repro 2, immediately after CRT, 6 weeks post CRT and 11 weeks post-CRT. ROI values are shown under the respective image.



Day 1: 0.237 min^{-1} Day 2: 0.167 min^{-1} Day 3: 0.262 min^{-1} Day 4: 0.245 min^{-1} Day 5: 0.226 min^{-1}

R_2* correlated negatively with K^{trans} and $IAUGC_{60}$ (r=-0.63, p=0.03, r=-0.54, p=0.07) at baseline but not after treatment.

CONCLUSION: R_2* increases with decreases in $IAUGC_{60}$ and K^{trans} accompanied by loss of correlation between R_2* and K^{trans} suggest that colorectal tumors are made hypoxic by chemoradiotherapy. These results have implications with regard to the optimal timing of surgery following the completion of therapy.