

Assessment of colorectal hepatic metastases by quantitative T2 relaxation time: A method for evaluating tumour response to treatment?

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Introduction

Quantitative T2 relaxation time has been shown to be more accurate than visual assessment for the characterisation of focal liver lesions [1]. Malignant lesions such as metastases show shorter T2 relaxation times (<130 ms) compared to benign lesions [1, 2]. Dynamic contrast enhanced MR imaging and diffusion-weighted MR imaging are increasingly employed to provide surrogate markers of response for hepatic malignancies. However, the value of quantitative T2 measurements in evaluating the response of liver metastases to treatment has not been previously established. Such a measurement may also be potentially useful for assessing the effects of conventional and novel therapeutics.

Purpose

The aim of the study was to determine the T2 relaxation time of colorectal hepatic metastases and ascertain changes in their T2 relaxation time following chemotherapy in responders and non-responders.

Materials and Methods

42 patients (26 male, 16 female, mean age = 56 years, range 43 to 69 years) with 96 hepatic colorectal metastases underwent baseline MR imaging on a 1.5T system (Intera, Philips Medical System, Best, Netherlands) using a SENSE phased-array body coil. Following routine T1 and T2-weighted axial imaging of the liver, a combination spin-echo/ gradient-echo (GRASE) sequence was performed to yield T2-weighted images at five different echo-times. Quality assurance for the sequence was performed with a water phantom at room temperature prior to examination. Twelve sections were acquired during each 20 seconds breath-hold (TR = 1800ms, TE = 16ms, 32ms, 48ms, 64ms and 80ms, $\alpha = 90^\circ$, gradient strength = 30 mT/s, 7 mm section thickness, slice gap = 1 mm, single acquisition, 340 cm FOV, Matrix = 112 x 256, SENSE factor = 2) and examination of the entire liver was completed in two breath-holds. Quantitative T2 maps of the liver were generated using a IDL based software by fitting a mono-exponential function to the multi-echo T2 weighted images. In each patient, regions of interest (mean 223 mm²) encompassing a metastasis (n = 96) was drawn on the T2 maps and their median values recorded. Regions of interest (mean 314 mm²) were also randomly placed across normal appearing liver (n = 100), taking care to avoid large blood vessels, to record their median T2 values. The median T2 values of metastases and normal liver were compared using the Mann-Whitney test. In 11 patients with 28 metastases, imaging was repeated using the above protocol at six weeks following first-line chemotherapy (Capcitabine and Oxaloplatin) treatment. At repeat MR imaging, regions of interest (mean 152 mm²) were drawn to record the median T2 of metastases. The pre and post treatment median T2 values of metastases were compared using the Wilcoxon Rank test for responders (n=16) and non-responders (n=12). Responders were defined as showing at least a partial response as per RECIST criteria [3].

Results

The mean median T2 value of colorectal hepatic metastasis was 66.5 ± 11.2 ms and the mean median T2 value of normal liver was 47.7 ± 4.9 ms. These results are in agreement with those of published literature [5]. Metastases had a significantly higher median T2 relaxation time compared to normal liver (p < 0.0001, Mann Whitney test). The box and whisker plot (Figure 1) shows the distribution of values within the two groups. Following chemotherapy, although there appeared to be a decrease in the T2 relaxation time of metastases in responders, and a slight rise in T2 relaxation time in non-responders (Table 1 and Figure 2), this did not reach statistical significance (p > 0.05) due to the considerable overlap between the two groups. There was no difference in the pre-treatment median T2 of metastases between responders and non-responders. However, non-responders had a significantly higher T2 relaxation time (p = 0.03) compared to responders at the end of chemotherapy.

Discussion

The monitoring of therapeutic effects of drugs in-vivo poses a major challenge to imaging. Dynamic gadolinium enhanced MR imaging derived vascular indices are now widely evaluated as surrogate markers for anti-vascular and anti-angiogenic treatment. More recently, diffusion-weighted imaging [4] has been used to detect early treatment response. The measurement of T2-relaxation time, although relatively simple to perform, does not appear to be sensitive to treatment related changes.

Conclusions

Colorectal hepatic metastases have higher T2 relaxation times compared to liver. Although we found non-responding liver metastases to have a higher T2 value compared to responders at the end of chemotherapy treatment, quantitative T2 measurements do not appear sensitive to the effects of chemotherapy treatment.

Table 1. The median pre and post-treatment T2 relaxation times of metastases in responders and non-responders

	Responders (n = 16)	Non responders (n = 12)	P – value (Mann-Whitney)
Median Pre-treatment T2 (ms)	67.3 ± 8.6	71.4 ± 16.5	p = 0.83
Median Post-treatment T2 (ms)	61.6 ± 12.6	76.2 ± 18.4	p = 0.03
P- value (Wilcoxon-Rank)	p = 0.11	p = 0.8	

Figure 1. Box plots of the T2 relaxation time of liver metastases and normal liver.

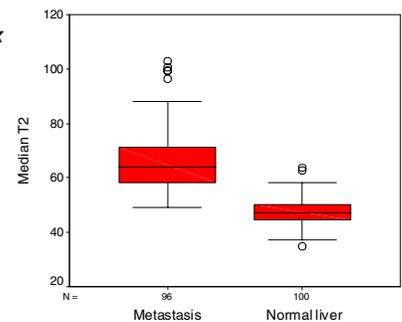
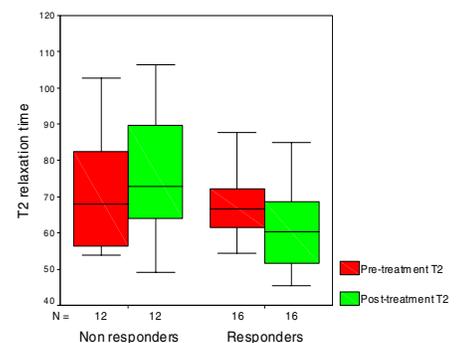


Figure 2. Box plots of the T2 relaxation times of liver metastases before and after chemotherapy in responders and non-responders



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References

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