ASSESSMENT OF TREATMENT RESPONSE WITH FUNCTIONAL MAGNETIC RESONANCE IMAGING IN METASTATIC THYROID CARCINOMA

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Introduction

Differentiated thyroid carcinoma (DTC) is the most common malignant tumor of the endocrine system. Even though DTC is among the most curable cancers, patients with distant metastases have a 5-yr survival rate of about 50%. [1] Dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI) has been shown to be capable of evaluating microcirculation and angiogenic properties of various tumor entities [2], and has been considered to be a predictive marker to evaluate DTC treatment. [3] Particularly when the standard procedures are questionable, MRI is especially important to play a complementary role in monitoring long-term follow-ups of DTC patients. [4] In this study, we performed DCE-MRI to investigate the microcirculation changes of the metastatic thyroid carcinoma during a long-term antiangiogenic therapy.

Materials and Methods

This study was designed within an interdisciplinary team and was an IRB approved human study. 17 patients with metastatic papillary thyroid carcinomas, 8 males and 9 females with an average age of 65±12 years, were enrolled. Patients underwent DCE-MRI using a Gd-chelate (Omniscan, GE Healthcare, 0.2 mmol/kg Bw) with a flow rate of 0.6 ml/s injected after first five repetitions by a power injector. Patients received pharmacological treatment with an RAF/VEGF-R kinase inhibitor. One baseline scan was performed prior to treatment and a follow up scan was scheduled after 8 weeks of therapy. The dynamic scans were performed on a standard clinical 1.5T scanner (Twinspeed, GE, Milwaukee, WI) using a 3D Spoiled Gradient Echo Sequence (SPGR) (TR/TE: 6.46/2.12 ms; FA: 16º; FoV: 360mm; matrix: 256×256; in-plane resolution: 1.4 x 1.4mm^2; slice thickness: 7mm; 10 contiguous slices; acquisition time: 10s; 50 time points).

DCE-MRI data analysis was performed using in-house developed software based on the IDL environment. Contrast enhancement within the region of interest (ROI) was evaluated by quantitative pharmacokinetic parameters by applying a two-compartment model, which characterizes the angiogenic and microcirculatory properties of the lesion, and enables quantification of amplitude (Amp [a.u.]), volume transfer constant (K^{trans}[min^{-1}]) and exchange rate (k_{ep}[min^{-1}]). [5] The results were confirmed by histology. In addition, parametric color-coded enhancement maps were created as readily readable DCE enhancement images.

Results

DCE-MRI was successfully performed and quantified in all 34 exams. Characteristic contrast enhancement was observed for different tissues including malignant tumor, artery and benign non-vascular tissue as expected. One patient exhibited dramatic motion during the baseline and follow-up scans and therefore the determined quantitative result was unsatisfactory. One patient had a solid tumor with extremely low contrast enhancement. In 11 out of the other 15 patients, the follow-up scans after the first treatment revealed significant decreased Amp ($p<0.01$), K^{trans} ($p<0.01$) and k_{ep} ($p<0.05$), which with an average decrease of -24.4%, -51.7% and -28.7% separately. One patient had increased follow-up values in all pharmacokinetic parameters. Other 3 patients obtained decreased K^{trans} and k_{ep} values only with an average decreased of -69.7% and -63.4%.

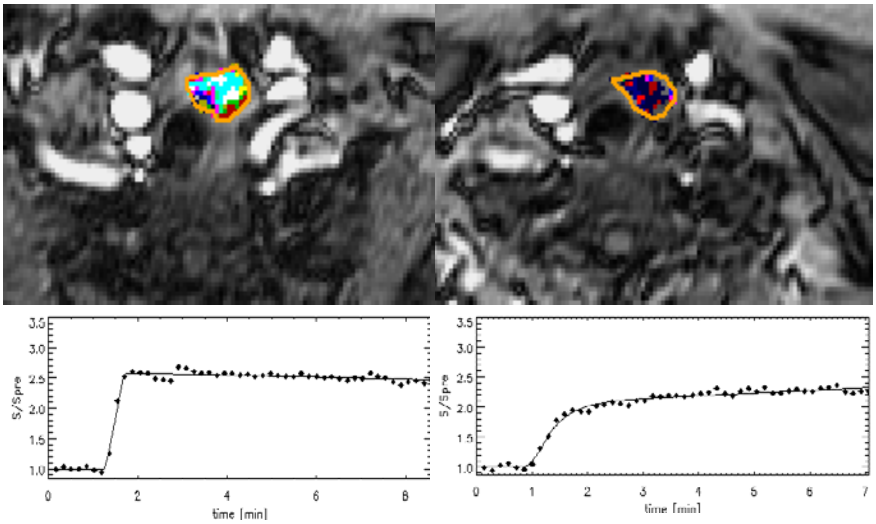

Fig 1, DCE-MRI parametric maps and signal intensity curves within the tumor ROI for the baseline (Left column) and the follow up after treatment (Right column).

Conclusion

This study demonstrated the feasibility of DCE-MRI to assess the microcirculation in metastatic thyroid carcinoma and its changes during therapy. The methodology was shown to be robust. The results are a surrogate biological readout of response to treatment that is independent of volumetric changes. The use of DCE-MRI may facilitate clinical drug development, and validating DCE-MRI as a biomarker appears feasible.

References

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