Can baseline T1-DCE-MRI perfusion and permeability parameters predict concurrent chemoradiotherapy response in patients of NSCLC?

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Target Audience This work targets those, who are interested in predicting lung cancer treatment response by dynamic contrast-enhanced (DCE) MRI.

Purpose To investigate the capability of using DCE-MRI parameters to predict response to concurrent chemoradiotherapy (CCRT) in patients with non-small cell lung cancer (NSCLC).

Introduction DCE-MRI has been extensively used in monitoring treatment response on many anatomies. However, this technique was not fully explored in lung cancer due to breathing motion. By using a mutual information non-rigid registration method to eliminate body motion and using modified Tofts Model and de-convolution method (Omnikinetics, GE, Life Science), clinical relevant parameters could be extracted from a breath-hold DCE-MRI to monitor treatment response on NSCLC patients.

Methods This study was approved by the institutional review board, and written informed consent was obtained from all 37 subjects. All patients with stage IIIA or IIIB NSCLC, who underwent DCE-MRI before CCRT were enrolled. All MR examinations were performed on a 3.0 T scanner (Signa Excite HD, Medical System, USA) by using an eight-tunnel body phased-array coil. Multi-flip angles were first performed before dynamic scanning to determine pre-contrast T1 mapping. Dynamic sequence (3-Dimensional T1W fast spoiled gradient echo with repeat time/echo time = 2.9/1.3 ms, flip angle = 12°) was then performed with a 4s tempo resolution and continued for 168s. During dynamic acquisition, patient took a breath for every 12s. After three dynamic scanning performed, contrast agent was injected in order to maintain a stable base line for algorithm fitting. All multi-filp angle data and dynamic data were nonlinearly aligned by using registration algorithm before pharmacokinetic analysis by Omnikinetics software. Regions of interests (ROI) were outlined on the whole tumor, where the largest area of tumor was observed. The perfusion parameters (including BF, BV, MTT) and permeability parameters (including K^{trans}, K_{ep}, V_e, V_p) calculated by histogram analysis were recorded. The relationship between these obtained parameters and tumor regression was evaluated by Spearmen's correlation analysis. The patients were classified into two groups according to the tumor regression rate after treatment as respond group (group A) and non-respond group (group B). The Mann-Whitney U test was used to compare parameters between responders and non-responders. The value of parameters on predicting responders were calculated by receiver operating characteristic curve (ROC).

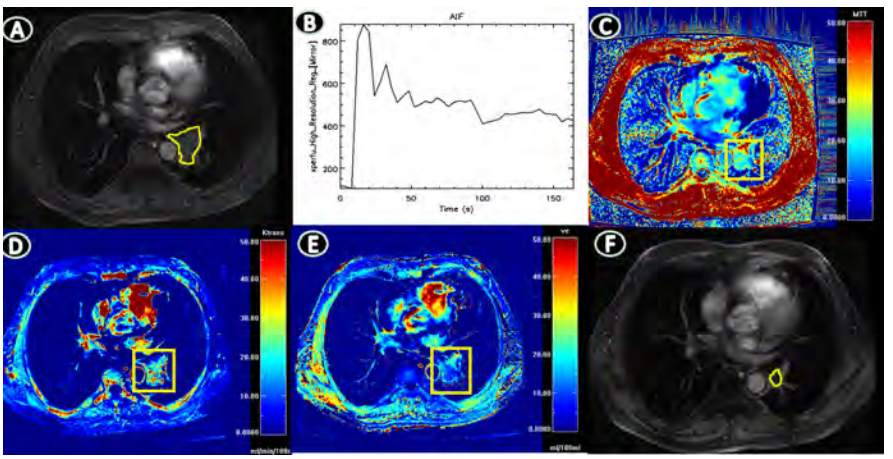

Fig. 1 A 65-year-old man with non-small cell lung cancer, who showed good response to concurrent chemoradiotherapy. A. pre-treatment enhanced T1W-imging, B. AIF, C. Axial color-coded MTT maps (mean value, 27.48s), D. Axial color-coded K^{trans} maps (mean value, 0.44 min^{-1}), E. Axial color-coded V_e maps (mean value, 0.14), F. post-treatment enhanced T1W-imging.

Result Good consistency of DCE-MRI parameters measured by the different radiologists (P<0.05) was observed. Tumor regression rate after treatment had negative correlated MTT and the V_e, and had positive correlation with K_{ep}. Statistical significant differences existed between group A and group B both in perfusion and permeability parameters (P＜0.05). Group A had lower MTT [(32.89 ±5.38) s vs. (47.32 ±7.77) s] and V_e [(0.22 ±0.05) vs. (0.31 ±0.07)] than group B, whereas group A had higher K_{ep} [(220.43 ±96.43) % vs. (130.01 ±33.57) %] and K^{trans} [(0.42 ±0.17) min^{-1} vs. (0.30 ±0.08) min^{-1}] than group B. ROC indicated that when setting threshold of V_e on small than 0.24 for predicting responders, the specificity, sensitivity and accuracy were 85%, 83% and 84%, with area under curve of 0.859 (P＜0.001).

Conclusion Baseline perfusion and permeability parameters calculated from T1-DCE-MRI were seen to be a viable tool for predicting the response after CCRT of NSCLC, and permeability parameters seemed to be more useful than perfusion parameters.