The ADC value in esophageal caners on diffusion-weighted MR images for predicting effect of chemoradiotherapy

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Purpose

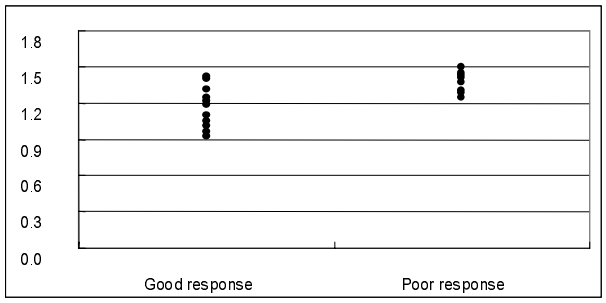
Recently prevailing diffusion-weighted imaging (DWI) has been applied to various kinds of solid tumors. This technique reflects tissue characteristics based on diffusion motion of water protons. In solid tumors, apparent diffusion coefficient (ADC) calculated from DWI are influenced by balances between intra- and extracellular water content, and cellularity of the tumor. In cases of rectal cancer, the ADC value of the tumor has also been reported to be useful in predicting the effect of chemoradiotherapy (CRT). In ISMRM 2005, we have already reported that the esophageal cancer can be successfully demonstrated on the tumors DWI respiratory triggering, and the apparent diffusion coefficient (ADC) value of the esophageal cancer is significantly lower than those in the normal esophagus. The purpose of this preliminary study is to investigate whether the ADC values of esophageal cancer can predict the response to CRT.

Materials and methods

Our study population included consecutive 19 patients (17 males and 2 females) with pathologically proven esophageal cancer, who underwent chemo-radio therapy and MRI for evaluation of the cancer. All the patients also underwent CT before and after CRT. The age of patients ranged 47-79 years old with mean age of 62 years. The histologic diagnosis of the tumor was squamous cell carcinoma in all patients. MR imaging was performed using a 1.5T unit (Symphony, Siemens) with a phased-array body coil. Initially, T2-weighted fast spin-echo images (T2WI) were obtained for defining anatomy and localizing the tumor. The location of the esophageal tumor was estimated by rough clinical information. Then, DWI in the section was obtained utilizing single shot echo-planar sequence (TR/TE=2300/75, b-value of 50, 300 and 600(s/mm^2), SENSE factor of 2) with respiratory-triggering. These oblique-sagittal images were uniformed with a section thickness of 3 mm without intersection gap, and a field of view of 350 mm. When abnormal signal intensity was detected on DWI, fusion images onto T2WI were also referenced for anatomic recognition. The MR images were independently evaluated for tumor location by two radiologists, who were blinded for the results of CRT. When the esophageal cancer was successfully demonstrated on DWI, the ADC values were measured by averaging measurement in three or more region of interest (ROI) at the tumor and esophagus on ADC map images. Then, CT images taken before and after CRT were evaluated regarding the presence and the wall thickness of the tumor. Esophageal cancers were classified as either good response or poor response according to whether the wall thickness of the tumor after CRT decreased in less than half of that before CRT or not. Finally, the ADC value of tumor was compared between good response and poor response group.

Results

In all 19 cases, the tumors were successfully demonstrated on both MR and CT. Eleven esophageal cancers were categorized in good response group. The averaged wall thickness of these cancers before and after CRT was 18mm and 7mm, respectively. Eight cancers were categorized in poor response group. The averaged wall thickness of these cancers before and after CRT was 13mm and 9mm, respectively. The averaged ADC value (10^{-3}mm^2/s) of cancers with good response were significantly lower than those in poor response were 1.17±0.20 and 1.37±0.09 ($p<0.05$).



Discussion

The current study shows that the esophageal cancer with good response to CRT tends to show decreased ADC value on DWI before treatment. In malignant tumors, the variety of ADC value in tumor may be related to the cellularity of tumor. Tumors with decreased ADC value are considered to have increased cellularity and increased nucleus to cytoplasm ratio. Our data also shows significant overlap in tumors with good response and poor response. This overlap in ADC values in these groups means that the response to CRT can not be predicted in the tumors with higher ADC values. In esophageal cancers with the higher ADC values, the response to CRT may be influenced by variety of factors including the volume of the tumors, the presence of desmoplastic changes in tumors, cellular edema, and keratinous matrix produced by squamous cell carcinomas. There may be some limitations in our study. Initially, our study population consists of only squamous cell carcinomas, which are common histologic subtype among Japanese. It is questionable that the results from our study can be applicable to adenocarcinomas. Secondary, since reproducibility of the ADC value in esophageal cancers is not investigated, the ADC value obtained by another sequence for DWI. Thirdly, the classification of the response to CRT was according only to the relative change of the wall thickness of the tumor, not to clinical course. Good response does not always been favorable prognosis.

Conclusion

The measurement of the ADC value in esophageal cancers may be useful in predicting the effect of CRT. Good response to CRT can be expected in the esophageal cancer with low ADC values, although the response can not be predicted in cancers with higher ADC values.