

Utility of diffusion-weighted MR imaging in evaluation of esophageal cancers

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Introduction

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. However, in cases of esophageal tumors, respiratory motion in the lung significantly degrades image qualities and hinders calculating precise ADC values. In our study, respiratory triggering is utilized to overcome this problem. The purpose of this preliminary study is to investigate ADC values of esophageal carcinoma in comparison with normal esophagus.

Materials and methods

Our study population included consecutive 30 patients (28 males and 2 females) with pathologically proven esophageal cancer, who underwent MRI for evaluation of the cancer. The age of patients ranged 47-74 years old with mean age of 62.3 years. The histologic diagnosis of the tumor was squamous cell carcinoma in all patients. 13 patients underwent surgery, whereas 17 patients were treated with chemotherapy with or without radiation. MR imaging was performed using a 1.5-MR imaging unit (Symphony, Siemens Medical Systems, Erlangen, Germany) with a phased-array body coil. Initially, T2-weighted fast spin-echo images were obtained for defining anatomy and localizing the tumor. The location of the esophageal tumor was estimated by rough clinical information. Following T2WI with sagittal or oblique sagittal plane along the running course of the esophagus, DWI with same plane was obtained utilizing single shot echo-planar sequence (TR/TE=4000-4400/74-94, b factors of 0, 500 and 1000(s/mm²), 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 by two radiologists blinded for tumor location and surgical results, regarding the presence of tumor. 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. The ADC values of the cancers and esophagus were statistically analyzed by student paired t-test.

Results

The pathologic stage of esophageal cancer in 13 patients who were surgically treated were T3 (n=7), T2 (n=2) and T1b (n=4). In 26 patients, T2WI demonstrated esophageal cancers as focal thickening of the esophagus. The four missed cancers on T2WI corresponded to all T1b cancers that were confirmed on histologic specimen. In 29 patients, DWI at b-factor of 500 demonstrated focally increased signal intensity in the tumor. The length and width of these tumors (mm) were 22-100 (mean; 53), and 12-36 (mean; 24), respectively. The only one missed cancer on DWI was T1b cancer of 40mm in length at surgery. In measurement of ADC values, the ADC value of the normal esophagus could not be measured in 9 patients because the signal of the esophagus could not be defined. In 20 patients in whom ADC values of both tumor and normal esophagus were obtained, the mean ADC values of the tumor and normal esophagus were 1.28 ± 0.19 , and 1.87 ± 0.17 ($p < 0.001$). The mean ADC value of the 29 esophageal cancers was 1.31 ± 0.18 . In surgically treated patients; mean ADC values of the tumor of each stage did not significantly differed.

Discussion

MRI has achieved limited clinical use in the evaluation of esophageal cancer. Reasons for this include the substantial artifacts from breathing and cardiac motion, long examination times, and as a result, poor imaging quality and reliability. Our study shows that DWI with respiratory-triggering can successfully demonstrate esophageal cancer as high intensity lesions in majority of the patients. One of large merits of DWI over ordinary MR images is that this technique can demonstrate esophageal cancers with excellent tissue contrast, whereas T2WI demonstrate mere wall thickening of the esophagus. Even the esophageal cancers with T1b stage, which are confined within submucosal layer of the esophagus, can be demonstrated on DWI, whereas these tumors are generally hardly recognized on ordinary T2WI. The excellent tissue contrast on DWI is related to the difference of ADC values between the cancer and normal esophagus. The relatively lower ADC values in the esophageal cancers may represent restricted movement of water molecules in the tumor, relating to increased cellularity and nuclear to cytoplasmic ratio.

Conclusion

DWI is a useful technique in localizing esophageal cancer. The mean ADC values of the esophageal cancers are significantly lower than those in normal esophagus.