Histogram analysis of apparent diffusion coefficient in differentiating pancreatic adenocarcinoma and neuroendocrine tumor

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PURPOSE

Diffusion-weighted (DW) MR imaging is used for various aspects of the evaluation of pancreas lesions such as detection, diagnosis, and predicting patient prognosis [(1-4)]. Apparent diffusion coefficient (ADC) histogram analysis is a reproducible technique, and several ADC histogram parameters are more complementarily or effectively reflect the microstructure of tumors. However, there are no reports regarding the utility of ADC histogram analysis in differentiating pancreatic adenocarcinoma from neuroendocrine tumors. Therefore, the purpose of this study was to investigate whether histogram analysis of DW imaging can differentiate pancreatic adenocarcinomas from neuroendocrine tumors.

MATERIALS and METHODS

Sixty-four patients with histologically confirmed 53 pancreatic adenocarcinomas or 19 neuroendocrine tumors underwent respiratory-triggered fat-suppressed single-shot echo-planar DW 3.0-T MR imaging with b-values of 0, 200, 400, and 800 s/mm^2. The pulse sequence parameters were as follows: repetition time, which was based on the respiratory interval; echo time, 60 ms; flip angle, 90°; field of view, 350 mm; matrix, 60 × 112; number of excitations, 2 (b-values of 0, 200, and 400 s/mm^2) or 4 (b-value of 800 s/mm^2); sensitivity encoding acceleration factor, 4; and acquisition time, approximately 3–4 min. Frequency-selective fat saturation was used to reduce chemical shift artifacts. A free-hand region of interest on each equatorial plane delineated the tumors. We evaluated the pixel distribution histogram parameters of the ADC values derived from b-values of 0 and 200 s/mm^2, 0 and 400 s/mm^2, or 0 and 800 s/mm^2. The histogram parameters (i.e., mean, variance, coefficient of variation [CV], kurtosis, skewness, and 25th, 50th, and 75th percentiles) of the ADC values were compared between adenocarcinomas and neuroendocrine tumors using Mann–Whitney *U* test. The ability of significantly different histogram parameters to differentiate pancreatic adenocarcinomas from neuroendocrine tumors was analyzed using receiver operating characteristic curves.

RESULTS

Adenocarcinomas and neuroendocrine tumors were not significantly different in mean, skewness, or 25th, 50th, or 75th percentiles of ADC values calculated at any b-value combination. Variance, CV, and kurtosis of the ADC values were significantly higher in adenocarcinomas than in neuroendocrine tumors at all b-value combinations (Table 1). For adenocarcinomas, the area under the curve for variance, CV, and kurtosis were 0.740, 0.798, and 0.748, respectively, at b-values 0 and 200 s/mm^2; 0.709, 0.757, and 0.809, respectively, at b-values 0 and 400 s/mm^2; and 0.787, 0.786, and 0.801, respectively, at b-values 0 and 800 s/mm^2.

CONCLUSION

This study focused on the potential of ADC histogram analysis on DW imaging to differentiate pancreatic adenocarcinoma from neuroendocrine tumor. The ADC variance, CV, and kurtosis were significantly higher in pancreatic adenocarcinomas than in neuroendocrine tumors (Fig. 1), likely reflecting more inhomogeneous microstructures such as the abundant fibrosis or mucin within adenocarcinomas. Histogram analysis of ADC could be helpful in differentiating pancreatic adenocarcinomas from neuroendocrine tumors.

Table 1. Histogram Analysis of Apparent Diffusion Coefficient Values Derived from b-values of 0 and 800 s/mm^2

	Adenocarcinoma (n = 53)	Neuroendocrine tumor (n = 19)	*P*
Mean (× 10^{-3} mm^2/s)	1.41 ± 0.26	1.43 ± 0.28	0.995
Variance	0.07 ± 0.05	0.03 ± 0.02	<0.001
Coefficient of variation	0.18 ± 0.05	0.12 ± 0.05	<0.001
Kurtosis	1.02 ± 1.50	-0.20 ± 0.54	<0.001
Skewness	0.33 ± 0.71	0.28 ± 0.45	0.388
25th percentile	1.24 ± 0.25	1.30 ± 0.29	0.570
50th percentile	1.39 ± 0.27	1.42 ± 0.28	0.779
75th percentile	1.56 ± 0.29	1.55 ± 0.29	0.706

The values are presented as the mean ± the standard deviation.

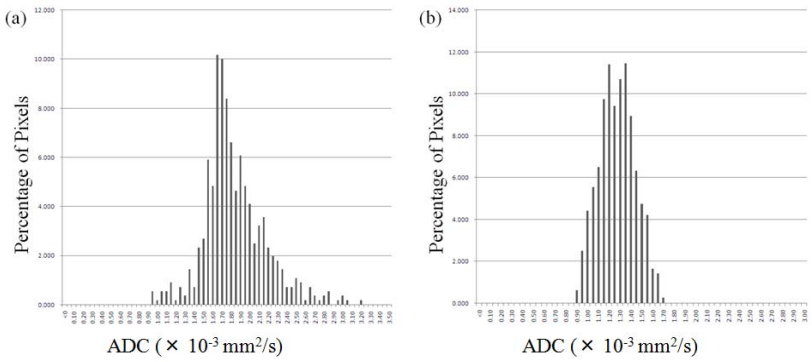

Figure 1. Histogram distribution of apparent diffusion coefficient (ADC) values obtained from b-values 0 and 800 s/mm^2 for (a) a representative pancreatic adenocarcinoma in an 83-year-old woman and (b) a representative neuroendocrine tumor in a 26-year-old woman. The ADC values of the pancreatic adenocarcinoma (variance, 0.12; coefficient of variation, 0.21; kurtosis, 2.05) are dispersed over a wider range than the ADC values of the neuroendocrine tumor (variance, 0.03; coefficient of variation, 0.13; kurtosis, -0.54), which indicate heterogeneous tissue components within the pancreatic adenocarcinoma.

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