Diffusion-Weighted MR Imaging vs. Multi-Detector Row CT: Direct Comparison of Capability for Assessment of Management Needs for Anterior Mediastinal Solitary Tumors

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Introduction: Anterior mediastinal tumors comprise a diverse group of neoplasms and account for 50% of all mediastinal masses. These tumors can be mainly divided into cystic tumors, such as thymic cysts, and solid tumors. While teratomas, malignant germ cell tumors, and malignant lymphomas are typical solid tumors, thymic epithelial tumors are the most common. The WHO classification categorizes thymic epithelial tumors into several microscopic subtypes with distinctly different prognoses and treatments. According to a review of 200 patients with thymic epithelial tumors, 5-year survival rates by WHO classification subtype were 100% for type A thymoma, 100% for type AB, 94.1% for type B1, 75.0% for type B2, and 70.0% for type B3 (1). Anteriol mediastinum malignant tumors, on the other hand, are characterized by low survival rates with 5-year survival rates of 48.0% for thymic carcinomas (1), and 45.5 % for primary mediastinal germ cell tumors (2). In view of these findings, the clinical benefits of differentiation of these tumors is obvious, especially differentiation in clinical practice of tumors not needing further intervention or treatment and those needing them, as well as of malignant and other tumors. Many studies have reported that anterior mediastinal cystic and solitary tumors produce characteristic CT and MRI findings (3,4), but differentiation of these tumors is difficult in some cases (4,5). However, integrated PET/CT using 18F-FDG is reportedly useful (6), although the maximum standardized uptake values (SUVs) of thymic carcinomas overlapped those of high-risk thymomas (types B2 and B3), and SUVs of thymic carcinomas were higher than those of high-risk thymomas. On the other hand, no differences were observed between low-risk thymomas (type A, AB and B1) and high-risk thymomas (6). Recently, diffusion-weighted imaging (DWI) has been suggested, that apparent diffusion coefficient (ADC) values obtained with mediastinal DWI may also be useful for differentiation malignant from benign tumors (7,8). To the best of our knowledge, however, no studies have been reported which made a direct comparison of the diagnostic capabilities of morphological findings and ADCs for the diagnosis of anterior mediastinal solitary tumors. The aim of the study presented here was to evaluate and directly compare the capabilities of DWI and MDCT for the management of anterior mediastinal solitary tumors.

Materials and Methods: Twenty-two patients (11 men and 11 women; mean age: 49.0 years, age range: 22–75 years) were enrolled in this study. The pathological examination of the 22 anterior mediastinal tumors (mean diameter: 43.5 mm, range: 16.5 – 82.7 mm) resulted in a diagnosis of one type A thymoma, three type AB thymomas, six type B1 thymomas, five type B2 thymomas, one thymic carcinoma, and six malignant tumors (two malignant mixed germ cell tumors, two invasive lung cancers and two malignant lymphomas). MRI was performed with a 1.5T scanner and DWI with a sequentially reordered half-Fourier single-shot STIR spin-echo echo-planar imaging sequence (TR = 5,000 ms, TE = 70 ms, TI = 180 ms, echo train length = 41, slice thickness = 5 mm, slice gap = 1.5 mm, NEX = 5, b-values 0 and 1,000 s/mm2, field of view (FOV) = 300–350 × 300–350 mm, matrix size = 96 × 96, reconstruction matrix = 256 × 256). Motion-probing gradients were added to the three axes (axial, sagittal, and coronal) on DWI. On the other hand, the patients were scanned with two 64-detector row CT scanner, and non-contrast-enhanced and contrast-enhanced CT images were acquired.

The tumors were divided into two groups according to need for management: tumors not needing further intervention or treatment (group A; thymoma type A, AB and B1) and tumors needing further intervention and treatment (group B; other thymoma types and malignancies). The ADC of each tumor was measured, and probabilities of malignancy and need for further intervention and treatment were visually assessed on CT by using 5-point scoring system. The differences in ADCs between group A and B and between malignancies and others in group B were evaluated with the Mann-Whitney's U-test. Next, feasible threshold values for differentiation of group B from group A and distinguishing malignancies from others in group B were determined by means of the ROC-based positive test. Finally, McNemar's test was used for comparing diagnostic capabilities of DWI with those of CT.

Results: The results for ADC values are shown in Table 1. ADCs for the two groups were significantly different ($p<0.01$). The result for differentiation capabilities are shown in Table 2 and 3. Application of the threshold value for differentiation of group B from A showed no significant difference ($p>0.05$). However, application of the feasible threshold value for distinguishing malignant from other tumors in group B showed that specificity (66.7%) and accuracy (81.3%) of DWI were significantly better than those of visual score ($p<0.05$). Representative cases are shown in Figure 1.

Conclusion: DWI has better potential than CT for assessment of management needs for anterior mediastinum solitary tumors.

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Table 1. ADC values for anterior mediastinal solitary tumors

	n	Mean ADC ± SD	(Range) ($\times 10^{-3}$ mm^2/s)
Malignant	7	1.11* ± 0.24	(0.70 – 1.41)
Benign	15	1.82 ± 0.44	(1.15 – 2.85)
	n	**mean ADC ± SD**	**(Range) ($\times 10^{-3}$ mm^2/s)**
Group A	10	1.96** ± 0.47	(1.18 - 2.85)
Group B	12	1.29 ± 0.33	(0.70 - 1.80)

Table 2. Capability for differentiating group A from group B

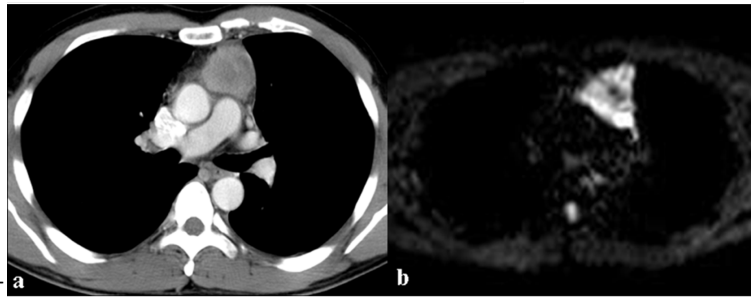
	Feasible threshold value	*Sensitivity (%)*	*Specificity (%)*	*Accuracy (%)*
ADC value	1.9×10^{-3} mm^2/s	100 (12/12)	60.0 (6/10)	81.8 (18/22)
Visual score	3	100 (12/12)	60.0 (6/10)	81.8 (18/22)

Table 3. Capability for differentiating malignant tumors from others in group

	Feasible threshold value	*Sensitivity (%)*	*Specificity (%)*	*Accuracy (%)*
ADC value	1.5×10^{-3} mm^2/s	100 (7/7)	66.7* (6/9)	81.3* (13/16)
Visual score	3	100 (7/7)	11.1 (1/9)	50.0 (8/16)

**: significant difference from visual score according to McNemar's test ($p<0.05$)*

Fig 1. 44-year-old male patient with thymic carcinoma



(a) Contrast-enhanced CT scan shows a slightly heterogeneous anterior mediastinal nodule The scores for probability of need for further intervention and treatment and for probability of malignancy are 4 and 3, respectively. This case is true-positive both for assessment of the need for further intervention and treatment and for differentiating malignant from benign tumor. (b) DWI shows very high signal intensity. The ADC value for the cancer is 1.18×10^{-3} mm^2/s. This case is true-positive both for assessment of the need for further intervention and treatment and for differentiating malignant from benign tumor.