Purpose

To assess the degree of correlation between high-resolution computed tomography (CT) and magnetic resonance imaging (MRI) findings in patients diagnosed with pulmonary fungal diseases, and to describe the diffusion-weighted (DWI) findings in this population.
Materials and Methods

This prospective study involved the review of data from all patients diagnosed with fungal lung disease in our hospital between January 2013 and October 2014.

The inclusion criteria were: respiratory symptoms (dyspnea, tachypnea or cough), pathological diagnosis of mycosis by bronchoalveolar lavage (BAL) or lung biopsy and performance of HRCT at the time of diagnosis. All patients underwent lung MRI for comparison with CT data.

HRCT examinations were performed using a 64-multidetector scanner (LightSpeed VCT; GE Healthcare, Waukesha, WI, USA) with the following parameters: 120 kVp; 250 mA; time, 0.8 s; and pitch, 1.375. On the same day, MRI was performed using a 1.5-T scanner (Magnetom AERA; Siemens, Erlangen, Germany). The sequences used were a half-fourier single-shot turbo spin-echo with respiratory gating, a volumetric interpolated breath-hold examination (VIBE), a T2-weighted fat-saturated BLADE and DWI.

Two chest radiologists with more than 10 years of experience who were blinded to the patients clinical information, except fungal infection, independently assessed MR and then CT images. After the two radiologists had conducted independent analyses, they reviewed the images together with a third chest radiologist (with >20 years of experience) to reach final consensus decisions.

In the evaluation of MRI data, reviewers identified one predominate pattern per patient (nodular, air-space disease or reticular).

Mean signal intensity of DWI-MRI was analyzed semiquantitatively by focusing a region of interest on each lesion as well as on the spinal cord at the same level. The lesion-to-spinal cord ratio (LSR) of signal intensity was measured on the same DW images with a diffusion gradient of b=800s/mm2.

HRCT images were assessed according to criteria defined in the Fleischner Society’s Glossary of Terms, and MRI data were described based on a previous CT/MRI correlation study. The following HRCT and MRI findings were evaluated: pulmonary nodules, air-space disease (consolidation and GGO), bronchiectasis, septal thickening, halo and reversed halo signs, lymph node enlargement, and pleural effusion. All findings were recorded as present or absent in six pulmonary lobes.

All results were statistically analyzed using commercial software (SPSS 11, SPSS Inc., Chicago, IL, USA; Excel 2003, Microsoft, Redmond, WA, USA). Chi-square was used to compare medians. Type I error was accepted as 0.05. P values < 0.05 were considered to indicate statistical significance.
Results

The study sample comprised 21 patients (17 men and 4 women) with a median age of 57 (range 32-80) years who were diagnosed with paracoccidioidomycosis \( (n = 11) \), histoplasmosis \( (n = 4) \), cryptococcosis \( (n = 4) \), and *Aspergillus* infection \( (n = 2) \) and met the inclusion criteria. Two patients were excluded from the study due to claustrophobia, which prohibited MRI examination.

Twelve of the 21 patients were smokers, six were non-smokers, and three were former smokers. Fungal infections were diagnosed by fibrobronchoscopy with BAL in 17 patients, open lung biopsy in two patients, and CT-guided biopsy in two patients. One patient died during the study period.

**HRCT and MRI Patterns and Findings**

Table 1 shows the presence or absence of main imaging findings in the six pulmonary lobes. The main CT pattern was nodular (Fig. 1), found in 80.9\% \( (n = 17) \) of patients. MRI demonstrated a nodular pattern in 94\% \( (n = 16) \) of these patients. CT and MRI consistently showed a reticular pattern in 14\% \( (n = 3) \) of patients (Fig. 2). In one patient, the reticular pattern was scored as predominant on MRI and the nodular pattern was predominant on CT. The airspace pattern was observed on CT and MRI in one (4\%) patient (Fig. 3). General pattern analysis indicated that MRI had 95\% accuracy in the prediction of CT pattern \( (p < 0.001) \).

**Distribution of Abnormalities**

Abnormalities were bilateral in 18 (85.7\%) patients. The three (14.3\%) patients with unilateral abnormalities had pseudotumoral lesions. The upper lobes were affected in 85\% of patients of all patients. The accuracy of MRI in pulmonary lesion detection was 98.3\% per lobe. Of six false-positive findings, five were localized in the lingulae \( (p < 0.01) \). Evaluation resulted in one false-negative MRI finding (in one patient whose CT images showed GGO), also localized in the lingula (Fig. 4).

**Diffusion-Weighted Sequences**

All DW MRI examinations were completed successfully, with no adverse effect observed. LSRs were obtained for all patients. The mean LSR was 0.772 ± 0.333. The LSRs of focal lesions were not significantly higher than those of diffuse lesions.
Table 1. Imaging findings per pulmonary lobes (n=126 lobes).

<table>
<thead>
<tr>
<th>Imaging findings</th>
<th>Computed tomography/Magnetic resonance findings (per lobe)</th>
<th>Magnetic resonance (%) detection</th>
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<tbody>
<tr>
<td>Small Nodules</td>
<td>54/54</td>
<td>100</td>
</tr>
<tr>
<td>Septal Thickening</td>
<td>12/10</td>
<td>83.3</td>
</tr>
<tr>
<td>Air space disease (consolidation and ground glass)</td>
<td>20/18</td>
<td>90</td>
</tr>
<tr>
<td>Bronchiectasis</td>
<td>10/8</td>
<td>80</td>
</tr>
<tr>
<td>Reversed halo sign</td>
<td>1/1</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 1

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Figure 1. Images from a 67-year-old man with histoplasmosis and chronic cough. A. CT demonstrated diffuse centrolobular subcentimetric nodules in both lungs. T2 BLADE fat-saturated (B) and T1 VIBE (C) coronal sequences demonstrated the same findings. D. Axial diffusion-weighted sequence showing no restriction in the pulmonary nodules.
**Figure 2.** Images from a 56-year-old man with paracoccidioidomycosis and dyspnea. A. CT demonstrated reticular patterns in both lungs, with septal thickening, ground-glass areas, and bronchiolectasis. B. A T2 BLADE fat saturated sequence demonstrated septal thickening, with some bronchiolectasis. C. A diffusion-weighted sequence showing no restriction in abnormal areas.

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**Figure 3.** Images from an 82-year-old man with COPD and aspergillosis presenting dyspnea, cough, and fever. A. CT demonstrated diffuse pulmonary consolidations and ground-glass opacities in both lungs. Axial T2 BLADE (B) and T1 VIBE (C) fat-saturated sequences demonstrated areas of airspace hyperintensity signal, suggesting the airspace pattern. D. A diffusion-weighted sequence showed no restriction in abnormal areas.

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**Figure 4.** Images from a 56-year-old man with paracoccidioidomycosis and dyspnea. A. CT demonstrated ground-glass opacity in the lingula. B. A T2 BLADE fat-saturated sequence did not show this finding.
Conclusions

In conclusion, MRI showed 95% accuracy in the prediction of CT patterns in patients with pulmonary fungal infection. Compared with CT findings, the detection accuracy of MRI was 98.3% per lobe. DW-MRI did not demonstrate restriction in any case evaluated, which could be useful in the differential diagnosis of fungal and malignant lesions.