Nutritional Indicators are Correlated with the Radiological Severity Score in Patients with Mycobacterium avium Complex Pulmonary Disease: A Cross-sectional Study

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Abstract

Objective  Body weight loss in patients with Mycobacterium avium complex (MAC) pulmonary disease can be fatal. The administration of nutritional supplements should be an important component in the treatment of this disease. Objective data regarding the association between the nutritional status and disease severity have not been reported. This cross-sectional study aimed to compare the nutritional status and radiological severity scores in MAC pulmonary disease patients.

Methods  We retrospectively reviewed the records of 40 patients who were admitted to our institution for the treatment of MAC pulmonary disease between July 2008 and July 2010. Nutritional indices, including the ideal body weight ratio, triceps skinfold, mid-upper arm muscle circumference, and percentage of predicted resting energy expenditure, were compared with the radiological severity scores. Quantitative values of the extent of nodules, infiltration shadows, cavities, and bronchiectasis on the computed tomography scans were used to evaluate the radiological severity scores.

Results  The patients suffered from a significantly decreased percentage of ideal body weight, body fat and muscle mass. The average radiological score was 17.6±8.4 points. The percentage of ideal body weight (p<0.001), percentage of triceps skinfold (p<0.001) and percentage of mid-upper arm muscle circumference (p<0.002) were negatively correlated with the radiological scores, while the percentage of the predicted resting energy expenditure (p<0.001) was positively correlated with the scores.

Conclusion  A poor nutritional status is common in patients with progressive MAC pulmonary disease, which supports the hypothesis that aggressive nutritional interventions are indicated in the treatment of this disease.

Key words: chest computed tomography, Mycobacterium avium complex, nutrient assessment, pulmonary disease, radiologic score

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Introduction

Pulmonary disease caused by Mycobacterium avium complex (MAC) is becoming a significant health issue. MAC typically affects two types of patients: older men with underlying lung disease and middle-aged, lean women without lung disease (1). The pulmonary lesions can progress rapidly or slowly. In either case, the general condition of the patient significantly deteriorates as destructive pulmonary lesions
appear (2). Although multidrug chemotherapy including the newer macrolides is effective for MAC, the macrolide-containing regimen is not a panacea for the disease. A number of patients may not achieve sputum conversion, and some can experience recurrence even after sputum conversion (3). Patients with macrolide-resistant strains and those who develop recurrence are frequently treated with rifabutin and aminoglycosides (1). Treatment can also include pulmonary resection. These patients frequently present with a poor nutritional status as a result of disease progression, which hampers the efficacy of chemotherapy. It is necessary to strengthen the patient’s nutritional status during the course of treatment in order to achieve a favorable outcome (1, 4).

The administration of nutritional supplements is generally recommended in lean patients. Reports from surgeons have emphasized the importance of nutritional interventions as a part of multidisciplinary treatment (5, 6). Nutritional support should be individualized for each patient because the disease severity can affect the nutritional status. Objective fundamental data regarding the correlation between disease severity and the nutritional status are lacking.

This study aimed to identify the correlation between the nutritional status and radiological findings in patients with MAC pulmonary disease.

**Materials and Methods**

**Evaluation items**

We retrospectively reviewed the records of 40 patients who were admitted to our institution for the treatment of MAC pulmonary disease between July 2008 and July 2010. All of the patients met the American Thoracic Society (ATS)/Infectious Diseases Society of America (IDSA) diagnostic criteria, and their radiographic findings were typical for the disease (1). MAC isolates were identified using the AccuProbe test (Gen-Probe, San Diego, CA, USA).

The nutritional status of the patients was assessed using the following methods. The arm circumference and triceps skinfold (TSF) were measured with an Insertape and Adipometer (Abbott Japan Co., Ltd., Tokyo, Japan). The formula for calculating the arm muscle circumference (AMC) was as follows: (arm circumference -π×TSF). The percentage of TSF and percentage of AMC were obtained by comparing the values with age- and sex-stratified Japanese anthropometric reference data (7). The percent of ideal body weight (%IBW) was calculated by dividing the patient's body weight by the ideal body weight determined from the normal population (7). A percentage of IBW greater than 90% was considered to be within the normal range. Patients with a value below the normal range were considered to be malnourished. The values in the malnourished patients were subdivided into the following three categories: mild malnutrition (80-89%); moderate malnutrition (70-79%); and severe malnutrition (below 69%). The resting energy expenditure (REE) was measured using indirect calorimetry (the Deltatrac II™ metabolic cart: Datex-Engstrom Corp, Helsinki, Finland) as previously described (8). The predicted REE (REEpred) was calculated with the Harris-Benedict equation. The percentage of the predicted REE was defined as the REE, measured via indirect calorimetry, divided by the REEpred.

All of the patients underwent chest computed tomography (CT) scans in the supine position within two weeks after the nutritional assessments. The scans were performed using a SOMATOM Sensation 16 (Siemens, Erlangen, Germany). The parameters used for the evaluation were: 5.0-mm section thickness at 5.0-mm intervals with a 512×512 reconstruction matrix; 140 kV and 146 mA (135-195 mA); scan pitch, 1.25; rotation time, 0.5 s; and a high-spatial-frequency algorithm. All of the images were obtained at window settings appropriate for lung parenchyma (level, -450 Hounsfield units [HU]; width, 1,700 HU). The CT scans were assessed by two respiratory specialists with more than 10 years of experience.

The CT scores were determined as follows. The lungs were divided into six zones at the levels of the carina and inferior pulmonary vein (Fig. 1) (9, 10). In each zone, the lesions were recorded using the following notations: N, nodules (less than 10 mm); I, infiltration shadow (an area of...
Fig. 2. Four typical lesions that are scored: nodules (less than 10 mm), infiltration shadows (areas of opacity larger than 10 mm), cavities, and bronchiectasis.

Table. Patient Characteristics

<table>
<thead>
<tr>
<th>Patient characteristics</th>
<th>number (%)</th>
<th>median (SD)</th>
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<tbody>
<tr>
<td>Female (%)</td>
<td>34 (85)</td>
<td></td>
</tr>
<tr>
<td>Age at diagnosis, years</td>
<td>60.8 ± 13.3</td>
<td></td>
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<tr>
<td>Age at exam, years</td>
<td>65 ± 13.2</td>
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<tr>
<td>Body height, cm</td>
<td>158 ± 7.9</td>
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<tr>
<td>Body weight, kg</td>
<td>43.9 ± 8.8</td>
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<tr>
<td>Ideal body weight, %</td>
<td>78.7 ± 11.8</td>
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<tr>
<td>Triceps skinfold thickness, %</td>
<td>65.9 ± 35.6</td>
<td></td>
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<tr>
<td>Arm muscle circumference, %</td>
<td>83.5 ± 9.3</td>
<td></td>
</tr>
<tr>
<td>Type of pulmonary MAC disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fibrocavitary disease (%)</td>
<td>14 (35)</td>
<td></td>
</tr>
<tr>
<td>Nodular/bronchiectatic disease (%)</td>
<td>20 (50)</td>
<td></td>
</tr>
<tr>
<td>Mixed or unclassified disease (%)</td>
<td>6 (15)</td>
<td></td>
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<tr>
<td>Underlying lung disease</td>
<td></td>
<td></td>
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<tr>
<td>Previous tuberculosis</td>
<td>4 (10)</td>
<td></td>
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<tr>
<td>COPD</td>
<td>2 (5)</td>
<td></td>
</tr>
<tr>
<td>Bronchiectasis</td>
<td>3 (7.5)</td>
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</tbody>
</table>

Results

**Patient characteristics**

The patients’ characteristics are summarized in Table. Of the 40 patients, 34 (85%) were women. The mean age on admission was 65±13.2 years, and the mean age at the time of diagnosis was 60.8±13.3 years. Thirty-three patients (82.5%) were never smokers. Chronic obstructive pulmonary disease (COPD) and previous tuberculosis were noted in 5% and 10% of the patients, respectively. Fourteen patients (35%) had fibrocavitary disease, 20 (50%) had nodular/bronchiectatic disease, and six (15%) had mixed or unclassified disease. Neither steroids nor other immunosuppressive drugs were used in any patient. All of the patients were negative for HIV infection. As shown in Table, the patients with MAC pulmonary disease had significantly decreased %IBW values (78.7%, p<0.05), body fat (%TSF: 65.9%, p<0.05) and muscle mass (%AMC: 83.5%, p<0.05).

**Correlations between nutrient assessment and the radiological score**

The analyses were conducted using 40 CT scans. The average score of the lesions detected on the CT scans was 17.6±8.4 points. The correlations between the nutritional status parameters and the CT scores are shown in Fig. 3. Significant negative correlations were observed between the %TSF and CT scores (R=-0.54; p<0.001) (A) and between the %AMC and CT scores (R=-0.37; p<0.002) (B). There was a significant negative correlation between the %IBW and CT scores (R=-0.63; p<0.001) (C). The percentage of predicted REE (mean: 115.8±19.5%) was elevated and had a significant positive correlation with the CT scores (R=0.47; p<0.001) (D).

**Discussion**

Patients with MAC pulmonary disease are frequently malnourished. Nutritional support, therefore, plays an important role in the treatment of MAC pulmonary disease. Clinicians cannot provide patients with optimal nutritional support without knowing their nutritional status. Assessment and management by NSTs has become increasingly indispensable to the clinical treatment of MAC disease. This study evaluated the correlation between the patient’s nutritional status and clinical condition using a quantitative image evaluation method. Among the indices commonly used in nutritional analyses, we used TSF, AMC and IBW in this
The radiological score is the quantitative image score indicating the extent of NTM pulmonary disease. TSF: triceps skinfold, AMC: mid-upper arm muscle circumference, IBW: ideal body weight, REE: resting energy expenditure

study. The TSF measurement reflects the amount of body fat, and the AMC reflects the amount of muscle in the body. In addition, we performed an analysis of the resting energy expenditure, which has been introduced to NST management in recent years.

To our knowledge, data regarding TSF and AMC in patients with MAC pulmonary disease have rarely been reported. Our results showed that, in MAC patients, the amount of fat and muscle decreased with disease progression. Tasaka et al. demonstrated that the serum adiponectin levels, which are inversely correlated with the body mass index, are significantly elevated in MAC patients compared with those observed in control subjects. They hypothesized that adiponectin is involved in the pathogenesis of MAC disease (11). Kartalija and colleagues recently studied the serum adipokine levels in patients with pulmonary MAC disease using well-matched controls and found a slight elevation in the levels of adiponectin associated with the absence of an inverse relationship with body fat (12). Although we did not evaluate the adipokine levels in this study, we demonstrated a negative correlation between the amount of fat and disease progression. We also demonstrated a negative correlation between the amount of muscle and the progression of disease. The effects of disease progression on the amount of muscle in patients with MAC pulmonary disease are not well recognized. We did not evaluate whether the muscle function, such as the grip strength, was decreased in the MAC patients; however we hypothesized that a decrease in the amount of muscle and the attenuation of muscle strength influence the patient’s pulmonary function and the quality of life as the disease progresses (13, 14).

The %IBW of the study participants was 78.7%, indicating that the majority of the patients were moderately malnourished. In this study, the patients with a %IBW of less than 80% had higher radiological scores (22.1 points on average) compared with the patients with a %IBW greater than 80% (12.5 points on average). The radiological score may predict a patient’s nutritional status, as Ikegame et al. recently reported (15). A significant positive correlation was observed between the percentage of predicted REE and the CT scores. Increased resting energy expenditure in patients with chronic disease has been reported (16, 17). We theorize that a similar increase in the percentage of predicted REE can be noted in patients with MAC pulmonary disease. The acceleration of REE without adequate energy intake results in a decreased immune function resulting from the depletion of muscle mass and visceral proteins. We recommend that treatment be initiated without hesitation in patients with weight loss and an increased metabolic rate relative to the extent of the MAC lesions (1).

There is a question regarding whether MAC disease causes a poor nutritional status or whether a poor nutritional...
status causes MAC pulmonary disease. Kim and colleagues reported that patients with pulmonary NTM infection are taller and leaner than control subjects (18). Their results suggest that a more slender and taller phenotype may be a predisposition to the disease. Although our study was not longitudinal, but rather cross-sectional without control subjects, it included patients with a variety of degrees of radiological severity. The strong correlation between disease severity and the nutritional status observed in this study implies that disease progression may further deteriorate an already poor nutritional status. We are planning to conduct a prospective longitudinal study investigating whether nutritional supplementation can improve nutritional factors during the course of treatment.

This study is associated with several limitations. First, 5% of the patients had COPD, which may have influenced the results. Although the percentage of patients with COPD was notably small, studies comparing the nutritional status of COPD patients and MAC patients are required to clarify the influence of COPD on these results. Second, although our data showed mild to severe phases of disease progression, the number of patients in our study population was relatively small because we evaluated only patients who were hospitalized for intensive treatment. The accumulation of a larger amount of data from outpatient clinics is required because clinicians typically treat patients with MAC pulmonary disease as outpatients in the clinical setting.

Conclusion

This study revealed a strong correlation between the nutritional status and radiological scores in patients with MAC pulmonary disease. A prospective study is warranted to clarify the effects of the nutritional status on the disease prognosis.

The authors state that they have no Conflict of Interest (COI).

Acknowledgement

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References


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