Research Article

Computed Tomography Images under Iterative Reconstruction Algorithm in Analysis of the Efficacy of Honey-Fried Herba Ephedrae along with Western Medicine on Acute Exacerbation Chronic Obstructive Pulmonary Disease

Jun Xue ,1 Jun Zhang ,1 Li Li ,2 and Ping Zang 1

1Department of Pharmacy, Huangdao District Chinese Medicine Hospital, Qingdao 266500, China
2Pharmaceutical and Mechanical Enforcement Team, Qingdao O-shima District Market Supervision Authority, Qingdao, China

Correspondence should be addressed to Ping Zang; ghost@m.fafu.edu.cn

Received 15 June 2021; Revised 4 August 2021; Accepted 14 August 2021; Published 25 August 2021

Academic Editor: Gustavo Ramirez

Copyright © 2021 Jun Xue et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

To explore the application value of the reconstruction algorithm based on an iterative algorithm in the analysis of CT image and analyze the therapeutic effect of honey-fried Herba Ephedrae combined with Western medicine on acute exacerbation chronic obstructive pulmonary disease (AECOPD), a total of 96 AECOPD patients admitted to our hospital from January 2018 to December 2019 were selected as research subjects. According to a different treatment method, the subjects were divided into a control group (Ctrl group, conventional therapy) and an observation group (OG, conventional therapy + honey-fried Herba Ephedrae), with 48 in each group. The CT image algorithm was established based on the iterative algorithm, and the CT dose indexes of the reconstruction algorithm and the Filtered Back Projection (FBP) algorithm under the same conditions were compared ($P < 0.05$). After using CT to confirm the diagnosis of the subjects, the difference in indicators of forced expiratory volume in one second (FEV1), forced expiratory volume in one second to forced vital capacity ratio (FEV1%), and forced vital capacity (FVC), inflammatory factors of serum interleukin-8 (IL-8), serum interleukin-10 (IL-10), and tumor necrosis factor (TNF-α), the bronchial wall area, and the total treatment efficiency before and after different treatment was analyzed. The results suggested that the Computed Tomography Dose Index (CTDI) of iterative reconstruction (IR) algorithm when scanning different parts was higher than that of the FBP algorithm. The pulmonary function indexes and the expression of IL-8 and TNF-α in the OG were higher than those in the Ctrl group ($P < 0.05$); the bronchial wall area, bronchial wall area percentage, and IL-10 expression in the OG were all lower than those in the Ctrl group ($P < 0.05$). The effectiveness and improvement rates of the Ctrl group were 47.92% and 25%, respectively, significantly lower than those in the OG group, 56.25% and 31.25% ($P < 0.05$), and the total efficiency of the observation group was 87.5%, which was significantly higher than that in the Ctrl group (72.92%) ($P < 0.05$). In conclusion, based on the iterative algorithm, a CT reconstruction algorithm with better noise reduction performance was established, and the use of honey-fried Herba Ephedrae combined with Western medicine can improve the effective rate of treatment.

1. Introduction

Chronic obstructive pulmonary disease (COPD) is a chronic disease caused by toxic particles/gas with dyspnea as the main symptom, and the deaths in China account for 31.1% of the total worldwide [1]. AECOPD is an acute onset process in the course of COPD, and patients will experience severe respiratory airflow obstruction. The most common cause of AECOPD is respiratory infection [2]. Half of the patients have high concentrations of bacteria in the respiratory tract, and about 18% are caused by air pollution [3]. Currently, the AECOPD is treated mainly by drugs, and most of the commonly used drugs are Western medicine, including respiratory stimulants, bronchodilators, glucocorticoids,
and antibacterial and anti-inflammatory drugs [4]. However, there is abuse of antibacterial and antiviral drugs in the clinical treatment of AECOPD [5]. In recent years, the combined treatment of Chinese medicine and Western medicine has become a trend in the treatment of AECOPD. Pharmacological research results show that when honey-fried Herba Ephedrae acts on the bronchus, it stimulates the beta receptors of smooth muscle cells, results in downstream reactions, increases the content of cyclic adenosine monophosphate (cAMP), and finally achieves the purpose of curing lung diseases [6]. At the same time, some studies have combined ephedra mainly with other traditional Chinese medicines to treat COPD, with good effect [7], but few studies have combined ephedra mainly with Western medicine to treat AECOPD.

CT is widely used in the diagnosis of various clinical diseases because of its rapidity and safety. CT can directly present the degree of COPD lesions and the types of pathological changes in patients and clarify the anatomical changes in lungs with COPD [8]. However, when CT is used to diagnose patients, the radiation hazard to sensitive people such as infants, pregnant women, and other sensitive groups is even greater [9]. At present, the image reconstruction speed of the image reconstruction algorithm in the CT scanning process is faster, but there is much image noise, the image details are lacking, and a high dose of contrast agent is required. IR has the advantages of fewer projections and imaging under conditions of incomplete data and low signal-to-noise ratio, which is currently used in the reduction of image noise in medical equipment and the improvement of image quality, and at the same time decreases the dose of contrast agent [10]. The IR algorithm receives raw data that can characterize X-ray intensity based on the CT detector, finds the individual pixel values in the image matrix, and reduces the human anatomical structure, which can effectively reduce the patient radiation dose during the CT image reconstruction [12], but there is a problem with large image noise, waiting to be further optimized [13].

To sum up, at present, there are few studies on the joint effect of honey-fried Herba Ephedrae and Western medicine to treat AECOPD, and the iterative reconstruction algorithm can overcome the disadvantages of the current CT scanning algorithm. In this study, the iterative reconstruction algorithm was applied to CT scanning to diagnose AECOPD patients, and the therapeutic effect of ephedra along with Western medicine was discussed, so as to provide a reference for the clinical treatment of AECOPD.

2. Materials and Methods

2.1. Research Subjects and Grouping. A total of 96 AECOPD patients admitted to our hospital from January 2018 to December 2019 were selected; 48 of them were rolled into a Ctrl group, and the rest were rolled into an OG according to random sampling method. The Ctrl group was treated with conventional treatment methods such as anti-infection, anti-inflammatory, and bronchodilator according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) (2018) standard [14], and the OG accepted honey-fried Herba Ephedrae on the basis of conventional treatment. Inclusion criteria include (I) compliance with GOLD (2018) criteria; (II) COPD patients with acute exacerbations between the ages of 45 and 80 years; (III) consistent with the dialectical standards of TCM syndrome of lung, spleen, and kidney deficiency and mutual accumulation of phlegm and blood stasis. Exclusion criteria include (I) people with severe heart disease or other lung diseases; (II) people with severe nervous system, digestive system, and endocrine system diseases; (III) people who had taken Chinese herbal medicine one month before treatment. The process had gotten permission from the ethics committee of the hospital, and all subjects included had signed an informed consent form.

2.2. CT Image Processing Based on IR Algorithm. The original image obtained was reconstructed through Maximum Likelihood Expectation Maximization (MLEM), high- and low-frequency noise were removed, the correction amount was calculated and compared, the estimation value and the theoretical projection value of the tomographic image were further calculated, the difference between the theoretical projection value and the theory values was discussed, and finally, the IRCT image was obtained. The specific process of the CT image processing based on the iterative reconstruction algorithm is shown in Figure 1.

2.3. IR Algorithm. The maximum likelihood reconstruction algorithm can improve image noise and at the same time process the image details and edges [15]. To make the obtained CT image smoother, a fourth-order partial differential equation was adopted for noise reduction:

$$\frac{\partial f}{\partial t} = -\nabla^2 \left[ (\alpha(\|\nabla f\|)\eta + \alpha(\|\nabla f\|)f_c \right].$$  

where $\alpha(\|\nabla f\|)$ was the image diffusion coefficient, $\alpha(\|\nabla f\|) = (S^2/S^2 + (\|\nabla f\|)^2)$, $S$ was the noise signal, $\eta$ was the median filter value, and $f_c$ was the image tangent direction function, $f_c = (f_x f_y, 2 f_x f_y f_x, f_y f_x + f_y f_x f_y, f_y f_x f_y, f_y f_x f_y, f_y f_x f_y, f_y f_x f_y)$.

The wavelet shrinkage method and partial differentiation method were used to remove the high-frequency and low-frequency parts, respectively, to increase the smoothness of the image [16], and the MLEM image reconstruction algorithm was expressed as follows:

$$f_j^{k+1} = \frac{\sum_{i=1}^{n} a_{ij} q_i f_j^{k}}{\sum_{j=1}^{n} a_{ij}}.$$

where $\sigma^2$ was the variance of the received data and $\eta_q$ was the average value of the data received by the $i$-th detector unit.
2.4. CT Scanning Methods and Treatment Methods. A 64-slice spiral CT scanner was applied to scan all patients. The scanning tube current and tube voltage were 100 mA and 120 kV, respectively, and the reconstruction was performed with a thickness of 0.5 mm. The image was enlarged directly on the monitor to the best measurement size, the total area of subsegmental bronchus (WA0) and lumen area (WA1) was measured, and according to \( WA = (WA_0 - WA_1) \), the airway wall area \( WA \) and the percentage of the bronchial area \( WA\% = (WA_1/WA_0) \) were calculated.

Routine examinations were performed on all AECOPDs after admission. Patients in the Ctrl group accepted routine intravenous and antibiotic infections. At the same time, they were treated with symptomatic drugs for 15 consecutive days. In the OG, based on the Ctrl group, honey-fried Herba Ephedrae was added for treatment. 12 g of honey-fried Herba Ephedrae was boiled and decocted daily, once in the morning and evening, and the course of treatment was 15 days.

2.5. Comparison of Serum Levels of Inflammatory Factors. The ELISA method was adopted to detect the expression levels of IL-8, IL-10, and TNF-\( \alpha \). The specific operation method of ELISA was as follows. After the standard bottle was serially diluted according to the kit instructions, 100 \( \mu l \) of standard substance and the sample to be tested was added. With PBS buffer as a control, two multiple wells were set per well, and 50 \( \mu l \) of enzyme-labeled reagent was introduced to the sample well. The microtiter plate was placed in a 37°C incubator for 1 hour, and the remaining liquid was discarded. Then, a washing solution was included in each well, and after it was washed 5 times, it was dried. Subsequently, 50 \( \mu l \) of color reagent A and B was added to the wells, mixed well, and incubated at 37°C for 15 min. After that, a 50 \( \mu l \) stop solution was introduced to each well to stop the reaction. The absorbance of each well was detected at the wavelength of 450 nm, a standard curve was drawn based on the absorbance of the standard, and the concentration of the sample to be tested was further calculated.

2.6. Observation and Evaluation of Curative Effect. Basic data such as age, gender, and disease course of all research subjects were recorded; the levels of IL-8, IL-10, and TNF-\( \alpha \) before and after treatment was observed, and FEV1, FEV1\%, FVC, and other lung function indicators were tested.

According to whether the patient had cough and wheezing, it can be divided into three types: effective, improved, and ineffective [18]. The total effective rate of treatment = (number of effective cases + number of improved cases)/total number of cases \( \times 100\% \). Effective means no wheezing and no cough; improved means no wheezing or no cough; ineffective means wheezing and cough.

2.7. Statistical Methods. Experimental data processing was performed using SPSS19.0. Mean \( \pm \) standard deviation (\( x(\pm s) \) ) was applied to express measurement data, and percentage (%) was used to express the count data. The \( \chi^2 \) test was introduced. \( P<0.05 \) indicated that the difference was obvious.
3. Results

3.1. Analysis of Dose Reduction Level of IR Algorithm. Under the same dose reduction level, the dose reduction level of IR and the FBP algorithms was compared. Under the same dose reduction level and the same tube voltage (120 kV), when the head, sinuses, chest, abdomen, lumbar spine, and blood vessels were scanned by IR algorithm, the tube current had an obvious difference in contrast with the FBP algorithm ($P < 0.05$) (Figure 2). The Computed Tomography Dose Index (CTDI) was further compared under the same conditions, and the CTDI of the IR algorithm was higher than that of the FBP algorithm when scanning different parts (Figure 3).

3.2. CT Image Based on IR Algorithm. All patients were diagnosed by CT scan based on the IR algorithm. As shown in Figure 4, the lung CT scan showed patchy high-density shadows and striped atelectasis, compared with the iterative algorithm (Figure 4(a)); the CT image quality and sharpness after the iterative algorithm processed had improved (Figure 4(b)). The bronchial vascular bundles were blurred and thickened (Figure 4(c)); they were characterized by low lobe basal segments with patchy high-density shadows (Figures 4(d) and 4(e)); at the same time, the upper tip part of the lung and the coronary artery had lesions (Figures 4(f) and 4(g)).

3.3. Comparison of Basic Data. The basic data are compared in Table 1; there was no obvious difference between age, gender, Body Mass Index (BMI), and disease course ($P > 0.05$).

3.4. Comparison of Lung Function Indexes. The indexes of FEV1, FEV1%, and FVC were compared (Figure 5). There was no obvious difference in FEV1, FEV1%, and FVC before treatment ($P > 0.05$). After treatment, in contrast with that before treatment, two groups all indexes were increased ($P < 0.05$). After treatment, FEV1, FEV1%, and FVC in the OG were higher than those in the Ctrl group ($P < 0.05$).

3.5. Comparison of Serum Inflammatory Factors before and after Treatment. The IL-8, IL-10, and TNF-α before and after treatment were compared and analyzed (Figure 6). There was no obvious difference in them before treatment ($P > 0.05$), IL-8 and TNF-α were greatly lower after treatment than before treatment ($P < 0.05$); IL-10 after treatment was higher than before treatment ($P < 0.05$); and IL-8 and TNF-α in the OG were greatly lower than the Ctrl group after treatment ($P < 0.05$); the IL-10 of the OG was higher than that of the Ctrl group after treatment ($P < 0.05$).

3.6. Comparison of Bronchial Wall Area before and after Treatment. The CT quantitative method was applied to compare and analyze the tracheal wall area before and after the two treatment methods (Figures 7 and 8). After treatment, the bronchus wall area (WA) in the Ctrl group was greatly higher than that in the OG ($P < 0.05$). The bronchial area percentages were further compared, which were greatly lower in the OG than the Ctrl group after treatment ($P < 0.05$).

3.7. Comparison of Treatment Effects. A comparative analysis of the therapeutic effects of the two treatment methods (Figure 9) showed that the treatment effective rate and improvement rate of the Ctrl group were 47.92% and 25%, which were greatly lower than those of the Ctrl group, 56.25% and 31.25% ($P < 0.05$); the ineffective rate of the OG was 27.08%, which was higher than that of the Ctrl group (12.5%) ($P < 0.05$). The total effective rate was further compared. As shown in Figure 10, that of the OG was 87.5%, which was greatly higher than that of the Ctrl group (72.92%) ($P < 0.05$).

4. Discussion

At present, the diagnosis of COPD is mostly confirmed by histology and pulmonary function examination. The pulmonary function examination has limitations in examining AECOPD [19]. Histological examination is the gold standard, but its traumatic nature causes rejection in most patients. In recent years, CT scanning has been used in AECOPD examination, but it is affected by the noise processing and image resolution in the image processing process, which seriously hinders its wide application. In the study, the sharpness, noise control, and CT dose index of CT images based on the IR algorithm was optimized. It was found that the CTDI of CT reconstruction algorithm based on the iterative algorithm when scanning different parts was higher than that based on the FBP algorithm, indicating the use of evaluation function achieved noise control. Papadakis and Damilakis (2019) [20] pointed out that, at the same dose, the iterative algorithm can not only improve the signal-to-noise ratio and reduce image noise but also improve the resolution of the image, which was similar to the results of this study.

In recent years, there have been studies using the combination of Chinese and Western medicine to treat AECOPD. Although the accuracy of Western medicine and the long-term nature of traditional Chinese medicine have been used at the same time, there is no unified standard [21]. Honey-fried Herba Ephedrae has the effects of moisturizing the lungs, resolving phlegm, and relieving asthma and cough. Studies have pointed out that honey-fried Herba Ephedrae can stimulate the smooth muscle cells, accelerate the relaxation of bronchial smooth muscle, and have a certain effect on lung diseases [22]. The FEV1, FEV1%, FVC, and IL-10 values of the OG treated with honey-fried Herba Ephedrae were greatly higher than those of the Ctrl group ($P < 0.05$), and the WA, WA%, IL-8, and TNF-α in OG were greatly lower than those in the Ctrl group ($P < 0.05$). Many researches have shown that the occurrence and development of COPD patients are related to a variety of cytokines and inflammatory factors, but most of the research focuses on
Figure 2: Comparison of tube current (* statistical differences compared to FBP algorithm, $P < 0.05$; ** significant differences compared to FBP algorithm, $P < 0.01$).

Figure 3: Comparison of CT dose index.

Figure 4: Continued.
Figure 4: CT images. (a) CT scan image of lungs of AECOPD patients; (b) AECOPD patient pulmonary CT image based on iterative reconstruction algorithm; (c) CT scan image of the pulmonary artery in AECOPD patients; (d) CT scan image of the lobe basal segment; (e) CT scan image of the lobe basal segment; (f) CT scan image of the upper tip of the lung; (g) CT scan image of the coronary arteries.

Table 1: Comparison of basic data.

<table>
<thead>
<tr>
<th>Group</th>
<th>Ctrl group (N = 48)</th>
<th>OG (n = 48)</th>
<th>t value or χ² value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (year)</td>
<td>64.12 ± 3.12</td>
<td>63.86 ± 3.87</td>
<td>1.863</td>
<td>0.215</td>
</tr>
<tr>
<td>Male (example (%))</td>
<td>34 (70.83)</td>
<td>29 (64.58)</td>
<td>2.317</td>
<td>0.247</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>24.34 ± 2.12</td>
<td>22.45 ± 3.43</td>
<td>2.305</td>
<td>0.071</td>
</tr>
<tr>
<td>Course of disease</td>
<td>5.52 ± 1.32</td>
<td>5.19 ± 1.58</td>
<td>5.984</td>
<td>0.064</td>
</tr>
</tbody>
</table>

Figure 5: Continued.
Figure 5: Comparison of lung function indexes. (a) Comparison of FEV1; (b) comparison of FEV1%; (c) comparison of FVC (* an obvious difference in contrast with the Ctrl group).

Figure 6: Comparison of serum inflammatory factors before and after treatment. (a) Comparison of IL-8; (b) comparison of IL-10; (c) comparison of TNF-α (* an obvious difference in contrast with the Ctrl group).
IL-6, IL-17, C-reactive protein (CRP), and other indicators [23]. He et al. (2018) [24] showed that, after the treatment with Western medicine combined with Pingchuan soup, the expression levels of IL-8 and TNF-α in the OG were greatly lower than the Ctrl group (P < 0.05), and the lung function indexes of the OG were higher than the Ctrl group, which complied with the results of this study. Liang et al. (2018) [25] adopted sand salmeterol fluticasone propionate and Bufei Huoxue soup to explore the effect of Bufei Huoxue soup on the treatment of COPD patients, and the results suggested that while the pulmonary function indexes of the OG who were treated with salmeterol fluticasone propionate and Bufei Huoxue soup were increased, expression of IL-8 and TNF-α was greatly reduced, which conformed to the results of this study. At the same time, studies have shown that Bufei Naqi Decoction can greatly reduce the inflammatory factors TNF-α and IL-8, and IL-10 showed an upward trend [26], which was consistent with the results of this study. Therefore, the treatment effects of the two groups were further analyzed and it was found that the total effective rate of the OG was greatly higher than that of the Ctrl group (P < 0.05), indicating that the combination of honey-fried Herba Ephedrae and Western medicine was more effective in treating AECOPD.

5. Conclusion

In the study, a CT reconstruction algorithm was established based on an iterative algorithm, and noise reduction was discussed. Then, it was applied to the diagnosis of AECOPD, and the AECOPD patients were treated with honey-fried Herba Ephedrae combined with Western medicine to observe the therapeutic effect. However, only inflammatory factors of IL-8, IL-10, and TNF-α were discussed, and IL-6, IL-17, and CRP were not. In future studies, AECOPD-related cells factors and inflammatory factors will be further analyzed. In summary, a CT reconstruction algorithm with better noise reduction performance based on an iterative algorithm is constructed, and the use of honey-fried Herba Ephedrae combined with Western medicine treatment can greatly improve the treatment effective rate of patients.
Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

References


