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*Original Article*

# Effect of CT-guided microwave ablation for non-small cell lung cancer combined with severe chronic obstructive pulmonary disease

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**Abstract:** Objective: To investigate the perioperative complications and safety of microwave ablation (MA) therapy for patient's non-small cell lung cancer (NSCLC) combined with severe chronic obstructive pulmonary disease (COPD). Methods: A total of 28 patients with NSCLC combined with severe COPD in our center were analyzed for complications during MA therapy and post-treatment outcomes. Results: All patients were successfully ablated by puncture, with a tumor efficiency of 85.7% and no death within 30 days. The tumor tissues showed hypodense changes, cavitation, and decreased CT values when the CT was reexamined 24 hours after surgery. A total of 24 patients showed different surgery-related complications, and were cured after targeted treatments. During the follow-up, the lung tumor disappeared, while the fibrous scars and foci as well as pulmonary cavity still remained. CT imaging examination showed there was no enhancement in the tissue after resection. Conclusion: In this study, we confirmed that the complications of NSCLC combined with severe COPD after MA were manageable, safe and effective.

**Keywords:** Severe chronic obstructive pulmonary disease, non-small cell lung cancer, microwave ablation, clinical effect, perioperative adverse event

## Introduction

The latest epidemiological surveys show that lung cancer is the most prevalent tumor type worldwide. Approximately 2 million new lung cancer patients are diagnosed each year, accounting for about 20% of new cancer cases [1, 2]. In terms of age, the incidence of lung cancer in elderly patients is positively correlated with age, which means that the incidence is higher in elderly patients than in other age groups, reaching 46.3% [3, 4]. Chronic obstructive pulmonary disease (COPD) is one of the most common respiratory diseases in elderly patients. Combined with the increasingly serious environmental pollution, the incidence of lung cancer plus severe COPD is increasing annually. The latest incidence of lung cancer in the population is 16.7%, among which non-small cell lung cancer (NSCLC) is the most common [5, 6].

At present, surgical resection of lesions is still the preferred treatment for lung cancer. However, patients with lung cancer combined with severe COPD have insufficient lung reserve function, and surgical resection of partial lung tissue will affect patients' respiratory function. Moreover, most of the patients are elderly and prone to a variety of complications, resulting in only 15% of patients tolerating surgical treatment [7, 8]. Therefore, seeking other effective methods to eliminate lung cancer lesions is an important way to improve the overall treatment of NSCLC. Microwave ablation (MA) technology mainly uses microwave thermal effects to induce protein denaturation to coagulate blood and cause tissue necrosis, thereby achieving the clinical treatment purpose of killing tumors [9]. With the rapid development of ablation technology, it has been gradually extended to tumor reduction therapy from its initial application mainly for simple excision of epidermal tis-

**Table 1.** The evaluation criteria for the efficacy of solid tumors

| Clinical effect | Size of CT measurement |
|---|---|
| Complete remission | The tumor disappears or the diameter of the tumor was less than 25% of the original one. |
| Partial remission | The maximum diameter of the tumor was reduced by >30%. |
| Stability | The diameter of the largest tumor was reduced by <30%. |
| Progression | The diameter of the largest tumor was increased by ≥20%. |

sues. Its good therapeutic effects have been reported in treating liver cancer [10]. Recently, percutaneous CT-guided ablation techniques have also been gradually invoked in the resection of lung cancer lesions, and it has been confirmed that MA can achieve good therapeutic results in the treatment of lung tumors, but its safety is still questionable [11]. Based on this, the aim of this study is to share clinical outcomes and perioperative adverse events in previous patients with NSCLC combined with severe COPD treated by CT-guided thermal wave ablation.

## Materials and methods

### *General information*

Patients with grade 3 or above in the criterion of Global Initiative for Chronic Obstructive Lung Disease or modified British medical research council were diagnosed with severe COPD complicated with lung cancer. In this study, we summarized the clinical data of 28 patients with NSCLC combined with severe COPD who were hospitalized in our hospital. All patients voluntarily chose to forgo surgery in favor of MA for lung tumors after preoperative assessment of surgical risks. This study was discussed and approved by the Ethics Committee of our hospital. All patients were informed and they signed a informed consent form.

### *Methods*

*Instruments:* We used a 64-row thin layer CT machine (Siemens, Germany) and a MA machine (XR-A2018w; Nanjing Great Wall Medical Equipment Co., Ltd., China). The output power was set at 2450±20 MHz, and that was continuously adjustable from 0-150 W/50 Ω.

*Surgical methods:* Routine preoperative CT examination was performed to assess the site, size, and morphology of the tumor and the surrounding tissue relationships, as well as to identify any contraindications to surgery (e.g., coagulation system problems, cardiovascular abnormalities). The patients were asked to abstain from eating and drinking for 8 h and 4 h, respectively. All patients received local anesthesia. Morphine was used during the operation if necessary (according to the pain level of patients). The patients were kept in a flat or prone position. The CT locator was pasted to the body surface relative to the tumor to determine the puncture point and approach path, while the time and power of MA were set. After local anesthesia with lidocaine, the tumor was accurately entered with the aid of CT, and then the ablation machine and cooling water circulation were connected, with the power set at 40-60 W and at 2450 MHz for 3-15 minutes. After the ablation operation and needle ablation, the operation was finished, and the patients were was admitted to the recovery room for observation and were returned to the general ward after having a stable condition.

### *Outcome measures*

*Primary outcome measure:* To evaluate the efficacy of patients with solid tumors after treatment, including complete response, partial response, stability, and progression. Effective rate = Number of cases with (complete response + partial response)/total number of cases * 100%. The evaluation criteria for the efficacy of solid tumors were based on the modified efficacy evaluation indexes of solid tumors issued by the American Society of Radiology in 2000 [12]. See **Table 1**.

*Secondary outcome measures:* We observed the occurrence of complications during the peri-hospital period (the standard was developed by the Tumor Ablation Working Group) and the changes in lesions at one, three and six months of follow-up.

### *Data statistics*

All data were analyzed by SPSS 20.0. The measurement data were expressed as mean ±

**Table 2.** Baseline data of patients

| | Statistics |
|---|---|
| Gender (Male/Female, n) | 15/13 |
| Age (Years) | 68.5±4.7 |
| Pathological classification (n) | |
| Squamous carcinoma | 11 |
| Glandular carcinoma | 15 |
| Large cell lung cancer | 1 |
| Other | 1 |
| Lesion location (n) | |
| Left lung | 12 |
| Right lung | 13 |
| Both lungs | 3 |
| Clinical stage (n) | |
| Stage I-II | 16 |
| Stage III-IV | 12 |

standard deviation ($\bar{x}$±sd), and the rates were expressed as number of cases/total cases (n, %).

## Results

*General information*

The general information of patients was shown in **Table 2**.

*Evaluation of clinical efficacy*

The results of this study showed that the effective rate of MA for lung cancer patients reached 85.7%, indicating that microwave radiofrequency had a good clinical effect in the removal of lung cancer tissues to a certain extent, as shown in **Table 3**.

*Typical imaging manifestations of CT after lung cancer tissue treatment*

CT re-examination was performed 24 hours after operation. It showed that the tumor tissue presented hypodense changes, cavitation, and decreased CT values after MA in lung cancer tissues, which confirmed that that the cancer was damaged to different degrees. See **Figure 1**.

*Complications*

Among the 28 patients, 24 patients had different surgical-related complications. However, after relevant targeted treatments, all the patients recovered without dying. See **Table 4**.

*Follow-up results at one month, three months and six months after surgery*

The results of this study showed that during the follow-up, the tumor size of the patients was further reduced, and the lesion disappeared. See **Figure 2**.

## Discussion

In recent years, ablation techniques have been gradually applied in the resection of tumors in various tissues with good surgical results. The classical surgical resection is preferred for the treatment of NSCLC, and ablation techniques are a novel treatment for patients who have lost the opportunity to undergo surgery to remove the tumor and prolong the survival period [13-16].

The results of this study showed that the efficiency of MA to remove the overall tumor body of lung cancer reached 85.7%. Although the effect of R0 resection of the tumor body was not obtained, the expectation of slowing down the tumor growth could be achieved. The MA technique mainly caused coagulative necrosis of tumor tissues through local heating, with the highest temperature exceeding 100 degrees. At the same time, it can also destroy the blood vessels around the tumor, thus blocking tumor regeneration and finally achieving the clinical effect of directly killing tumor tissues. The follow-up also indicated that after MA treatment, the reexamination of chest CT showed hypodense changes in the tumor tissue, ground-glass changes in the surrounding tissues, and decreased CT values. Subsequent follow-up also confirmed a good outcome that the tumor was gradually decreased and finally disappeared, preliminarily verifying that MA can achieve the same effect of tumor tissue removal as surgical operations to a certain extent, which corroborates the conclusions of previous studies [17-19]. The effective rate of this study was slightly higher than 75% which was shown in previous studies, this may be related to the sample size and the characteristics of the participants. A similar study has been reported in the past [20].

Currently, endoscopic resection of diseased lung tissue was a commonly used surgical procedure. Postoperative complications mainly included infection, bleeding and dyspnea, with

**Table 3.** Evaluation of clinical efficacy (n)

| Clinical efficacy | | | | Overall effective rate |
|---|---|---|---|---|
| Complete remission (CR) | Partial remission (PR) | Stability | Progression | (CR+PR)/Total number of cases |
| 22 | 2 | 2 | 2 | 85.7% |

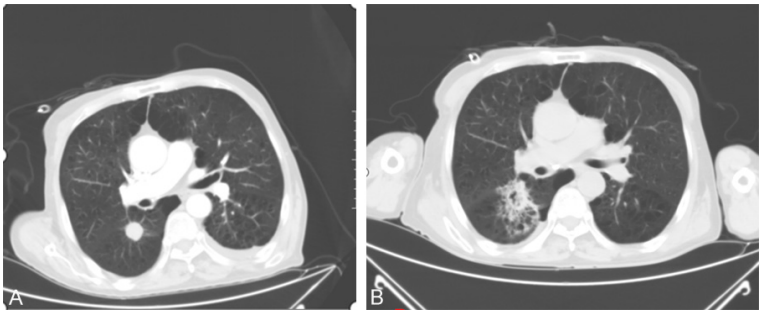

**Figure 1.** A 64-year-old male patient with a tumor in the lower lobe of the right lung was confirmed by puncture as lung adenocarcinoma. A: Preoperative CT image; B: CT image 24 h after surgery.

**Table 4.** Complications

| Complications | n |
|---|---|
| Pneumothorax | 14 (Closed thoracic drainage was required in 5 cases) |
| Subcutaneous emphysema | 2 |
| Pleural hemorrhage | 6 |
| Intrapulmonary infection | 1 |
| Delayed massive bleeding | 1 |

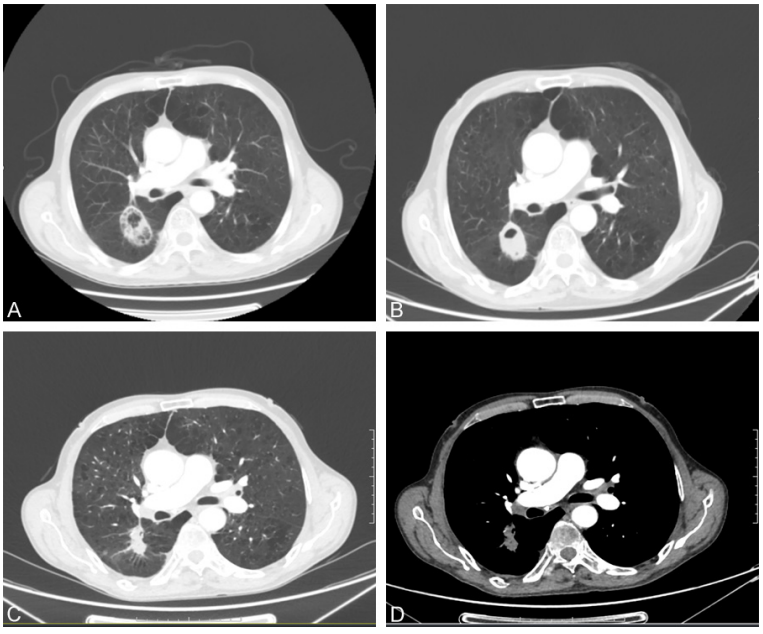

**Figure 2.** Tumor imaging changes during the follow-up period. A: One month after surgery; B: Three months after surgery; C: Six months after surgery (lung window); D: Six months after surgery (mediastinal window).

the incidence of about 10%. Previous literature showed that the incidence of complication of MA technique for resection of lung tissue was around 80%, while the results of this study were higher at 85.7%, among which pneumothorax was the most common (14 cases). The possible cause was that the lung elasticity of patients with COPD was weakened and the lung tissue could not heal effectively after the puncture needle was pulled out. Patients with severe COPD have poor lung function, and a small amount of pneumothorax can cause serious symptoms of chest tightness and shortness of breath, while thoracic closed drainage can effectively exclude the gas in the lung, improve lung function and relieve chest tightness symptoms. For patients with severe COPD, it is particularly important to select the diameter of the thoracic drainage tube if pneumothorax appears after ablation. The selection of the drainage tube with larger diameter can ensure effective and sufficient drainage of gas and indirectly promote the recovery of pneumothorax. However, some patients may have pneumothorax again after extubation, and the reason may be related to the pseudo healing of the puncture needle. Therefore, the indications for extubation after ablation of severe chronic obstructive pulmonary disease should be given attention, and the extubation time can be appropriately prolonged to

avoid the occurrence of pneumothorax pseudo healing [21]. There were no major disabling or fatal complications in any of the patients in this study, and no deaths due to ablative lung cancer resection have been reported in previous studies, demonstrating the relative safety of MA technology in the removal of lung cancer tissue. This was similar to the results of a previous clinical randomized trial with postoperative complication rate of 86.2% in 50 patients after MA technique [22].

There were several shortcomings in this study. First, this study was a single-center study and the sample size was small. A multicenter study with a larger sample is needed to further confirm the clinical effectiveness of MA in the treatment of NSCLC combined with COPD. Second, the clinical data collected in this study were simultaneous, and a prospective or nested case study is needed to clarify the effectiveness of microwave therapy in the treatment of lung cancer. Third, predictive assessment of clinical survival and lymph node dissection in microwave-treated lung cancer patients are also important studies to refine MA in the treatment of lung cancer.

In summary, MA therapy has a good remission rate in the treatment of NSCLC combined with severe COPD, with relative safety.

## Disclosure of conflict of interest

None.

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