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Study on the therapeutic effects and prognosis evaluation of non-invasive ventilation in patients with chronic obstructive pulmonary disease with lung cancer

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Abstract.
BACKGROUND: Chronic obstructive pulmonary disease (COPD) is a prevalent respiratory complication among the elderly, and its severity can escalate to respiratory failure as the disease progresses.
OBJECTIVE: To evaluate the application value of non-invasive ventilation in the clinical treatment of patients with COPD and lung cancer. This study assesses its therapeutic effects and its impact on patients' quality of life (QoL) as measured by the Functional Assessment of Cancer Therapy-Lung (FACT-L) scale.
METHODS: A retrospective analysis was conducted on clinical data from 102 patients with COPD and lung cancer. Patients were divided into two groups: the control group ($n = 48$), who received conventional treatment, and the observation group ($n = 54$), who received non-invasive positive pressure ventilation (NIPPV) in addition to conventional treatment. Relevant indicators of curative effect, including blood gas indices, incidence of dyspnoea, improvements in mental health and appetite, and FACT-L QoL scores, were analysed at 2 weeks, 1 month, and 6 months post-treatment.
RESULTS: At 2 weeks post-treatment, the observation group who had used NIPPV showed significant improvements in blood gas indices, dyspnoea, mental state and self-care ability compared with the control group ($p < 0.05$). At 1 month, these benefits persisted and included improved maintenance of body weight ($p < 0.05$). By 6 months, the observation group had a lower incidence of pulmonary encephalopathy ($p < 0.05$), and QoL, as measured by the FACT-L scale, improved significantly in the observation group but declined in the control group ($p < 0.05$).
CONCLUSION: NIPPV demonstrates significant efficacy in treating COPD patients with lung cancer, particularly in enhancing curative effects and improving patients' QoL.

Keywords: Non-invasive ventilation, lung cancer, respiratory failure, quality of life

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1. Introduction

The incidence of malignant tumours, including lung cancer, is strongly correlated with age. Elderly individuals are particularly susceptible to cancer due to diminished immune function [1]. While the clinical and pathological features of lung cancer are similar across age groups, elderly patients experience markedly higher mortality rates. This disparity can be largely attributed to the presence of multiple complications, impaired organ function, and other age-related factors [2,3]. Chronic obstructive pulmonary disease (COPD) is a prevalent respiratory complication among the elderly, and its severity can escalate to respiratory failure as the disease progresses. Without timely and effective intervention, patients are at risk of developing severe pulmonary encephalopathy [4]. Environmental factors (such as air pollution), lifestyle choices (such as long-term smoking) and endogenous factors contribute to COPD's manifestations, often resulting in varying degrees of small airway constriction. This leads to heightened airway resistance and difficulty in sputum expulsion. Additionally, chronic inflammation of the airways thickens respiratory membranes, causing ventilatory obstruction and compromised lung function. This is especially problematic in patients who are battling both lung cancer and COPD [5]. Lung cancer and COPD represent two of the most pressing healthcare challenges, not only in China but also globally.

The current treatment options for patients with concomitant cancer and COPD include surgery, chemotherapy, radiotherapy, targeted therapy, immunotherapy, and palliative care [6]. However, these methods have some shortcomings, such as limited efficacy, high toxicity, low tolerance and poor quality of life (QoL). Some patients may be ineligible for surgical intervention due to advanced cancer stages or compromised physical health. Similarly, resistance to drugs or radiation can render chemotherapy or radiotherapy ineffective for some individuals. The absence of specific biomarkers or immune checkpoints may limit the applicability of targeted therapy or immunotherapy. For those in terminal stages or grappling with refractory symptoms, palliative care may be the only feasible treatment option [7].

Non-invasive positive-pressure ventilation (NIPPV) is performed with a face or nose mask. This is a method of mechanical ventilation without airway invasion that has been increasingly applied in intensive care units, avoiding endotracheal intubation and its associated comorbidities [8]. Several meta-analyses have demonstrated that NIPPV has greater benefits than conventional medical therapy for patients with acute exacerbations of COPD [9]. Further, NIPPV can improve oxygenation, reduce hypercapnia, relieve dyspnoea, decrease respiratory muscle fatigue and prevent atelectasis and pulmonary infection.

The purpose of this study was to evaluate the clinical value of non-invasive ventilation in the treatment of patients with COPD with lung cancer after lobectomy and to assess its effect on their symptoms, QoL and prognosis. This study aimed to provide a safe and effective alternative therapy for patients with COPD with lung cancer who had poor response or tolerance to conventional therapy.

2. Materials and methods

2.1. General information

The clinical data of 102 patients with COPD with lung cancer admitted to the authors' hospital from February 2010 to February 2015 were analysed retrospectively. The inclusion criteria for all patients were as follows: (1) Patients were diagnosed according to the Global Initiative for Chronic Obstructive Lung Disease 2016 and National Comprehensive Cancer Network 2016 guidelines. The diagnosis of COPD was based on the presence of chronic respiratory symptoms, a history of exposure to risk factors and a post-bronchodilator Forced Expiratory Volume in the first second (FEV1)/Forced Vital Capacity (FVC)

ratio < 0.7. The diagnosis of lung cancer was based on the histological or cytological confirmation of malignant cells in the lung tissue or sputum [10,11]. (2) Patients' ages ranged from 60 to 80. (3) Informed consent and cooperation from patients and their families were received.

The exclusion criteria were as follows: (1) Patients who had pulmonary tuberculosis, severe pneumothorax, or a history of other pulmonary diseases, such as interstitial lung disease, bronchiectasis, and cystic fibrosis. (2) Patients who had a history of severe cardiac cerebrovascular disease, malignancy, and other systemic diseases, such as diabetes mellitus, chronic kidney disease, and liver cirrhosis. (3) Patients who were unconscious or had mental diseases, could not complete the questionnaire, or were lost to follow-up after the treatment.

Patients were categorised into either the observation group or the control group based on whether they received mechanical ventilation. The control group consisted of 48 patients who underwent standard treatment protocols. This included expectorants, antitussives, anti-asthmatic medications, nutritional support and interventions for water, acid-base and electrolyte imbalances, as well as anti-infective agents and respiratory stimulants. Continuous monitoring of vital signs was conducted to promptly address any emergencies. The observation group, comprising 54 patients, received mechanical ventilation in addition to the standard treatment regimen. Demographically, the control group included 36 men and 12 women with an average age of 67.2 ± 6.8 years. The group consisted of 23 cases of adenocarcinoma, 18 cases of squamous cell carcinoma, two cases of adenosquamous carcinoma and five cases of small-cell carcinoma. The observation group included 39 men and 15 women with an average age of 65.8 ± 7.2 years and included 25 cases of adenocarcinoma, 20 cases of squamous cell carcinoma, three cases of adenosquamous carcinoma, and six cases of small-cell carcinoma. No patients in either group had cardiovascular complications or disturbances in consciousness. All patients were diagnosed with COPD according to established guidelines for the condition [12]. Statistical analysis confirmed that there were no significant differences between the two groups in terms of gender distribution, age or pathological subtypes of lung cancer ($p > 0.05$).

2.2. Methods

All patients with COPD and lung cancer received routine treatment after lobectomy [13]. The patients in the observation group were also treated with NIPPV using a BiPAP Vision respirator from Wanman, Germany. The ventilation mode was spontaneous/timed, and the inspiratory positive airway pressure was adjusted according to the patient's tolerance and comfort level within the range of 4 to 25 cmH20. The expiratory positive airway pressure ranged from 4 to 12 cmH2O according to the oxygen saturation level ($> 90\%$), the inspiratory-expiratory time ratio was set at 1:1.5 to 1:2 according to the patient's respiratory rate (< 24/min) and the backup respiratory rate was set at less than or equal to the patient's spontaneous respiratory rate. The NIPPV treatment commenced within 24 hours after surgery and lasted for at least 1 week or until the patient's condition improved significantly. It was performed at least three times a day for a minimum of 2 hours per session and the NIPPV mask was removed every 2 hours for oral and skin care.

2.3. Data collection

Data were collected regarding body weight, electrolyte disturbance (defined as serum sodium level < 135 mmol/L or > 145 mmol/L, serum potassium level < 3.5 mmol/L or > 5 mmol/L and serum calcium level < 2 mmol/L or > 2.75 mmol/L), gastrointestinal bleeding (defined as haematemesis or melaena), blood gas analysis (including pH, PaO2, and PaCO2), incidence of dyspnoea, improvement in mental state and appetite, partial self-care ability, death and pulmonary encephalopathy. The Functional

Assessment of Cancer Therapy-Lung (FACT-L) scale was used to assess QoL. These data points were collected at 2 weeks, 1 month, and 6 months after treatment concluded.

2.4. Statistical analysis

SPSS 13.0 software was used to analyse the data. The differences between the two groups were compared by t-test and Chi-square test. When $p < 0.05$, the difference between the two groups was statistically significant.

3. Results

3.1. Comparison of the curative effects between the two groups 2 weeks post-treatment

The therapeutic effects of the observation group were significantly superior to that of the control group in blood gas index, dyspnoea, mental and appetite, and self-care ability ($p < 0.05$). These results suggest that non-invasive ventilation can significantly improve the symptoms of patients with COPD and lung cancer in a short period of time. There was no significant difference in body weight, electrolyte disturbance, gastrointestinal bleeding, and pulmonary encephalopathy between the two groups ($p > 0.05$), indicating that these were not affected by NIPPV treatment in the early stage. See Table 1 for details.

3.2. Comparison of the curative effects between the two groups 1 month post-treatment

At 1 month post-treatment, the patients in each group demonstrated varying degrees of improvement. The observation group had significantly more patients with no significant change in weight, mental and appetite improvement and self-care ability blood gas index, dyspnoea than the control group ($p < 0.05$), indicating that NIPPV treatment can prevent weight loss and enhance the well-being and independence of patients. There was no significant difference in the gastrointestinal bleeding and pulmonary encephalopathy, electrolyte disturbance between the two groups ($p > 0.05$), indicating that these complications were not related to NIPPV treatment. See Table 2 for details.

3.3. Comparison of curative effects between two groups 6 months post-treatment

At 6 months post-treatment, the incidence of pulmonary encephalopathy in the observation group was significantly lower than that in the control group ($p < 0.05$), indicating that NIPPV treatment can reduce the risk of this serious complication in patients with COPD with lung cancer. However, there was no significant difference between the two groups in electrolyte disturbance, gastrointestinal bleeding, and Pulmonary encephalopathy ($p > 0.05$), indicating that these were not influenced by NIPPV treatment in the long term. See Table 4 for details.

3.4. Comparison of the functional assessment of cancer therapy-lung quality-of-life scores between the two groups before and after treatment

In the control group, post-treatment analysis indicated a significant decline in physical status, functional status, and overall FACT-L QoL scores ($p < 0.05$). However, no significant changes were observed in social and family status ($p > 0.05$). indicating that conventional treatment was ineffective for these aspects of QoL in patients with COPD with lung cancer, which may be related to the progression of

Table 1
Comparison of efficacy between the two groups at 2 weeks of treatment [n (%)]

Group	Case	Blood gas was normal	The dyspnea disappeared	Mental and appetite improvement	Self-care in part	Body weight (kg)	Electrolyte disturbance	Gastrointestinal bleeding	Pulmonary encephalopathy
Control group	48	22 (45.8%)	24 (50.0%)	26 (54.2%)	18 (37.5%)	62.3 ± 8.4	12 (25.0%)	2 (4.2%)	6 (12.5%)
Observation group	54	51 (94.4%)	51 (94.4%)	54 (100%)	46 (85.2%)	64.5 ± 7.6	8 (14.8%)	0 (0.0%)	1 (1.9%)
P value		$P < 0.05$	$P < 0.05$	$P < 0.05$	$P < 0.05$	$P > 0.05$	$P > 0.05$	$P > 0.05$	$P > 0.05$

Table 2
Comparison of efficacy between the two groups at 1 month of treatment [n (%)]

Group	Case	Blood gas was normal	The dyspnea disappeared	Mental and appetite improvement	Self-care in part	Body weight (kg)	Electrolyte disturbance	Gastrointestinal bleeding	Pulmonary encephalopathy
Control group	48	28 (58.3%)	28 (58.3%)	20 (41.7%)	18 (37.5%)	60.8 ± 9.2	16 (33.3%)	4 (8.3%)	10 (20.8%)
Observation group	54	53 (98.1%)	53 (98.1%)	45 (83.3%)	45 (83.3%)	66.2 ± 7.9	12 (22.2%)	0 (0.0%)	3 (5.6%)
P value		$P < 0.05$	$P < 0.05$	$P < 0.05$	$P < 0.05$	$P < 0.05$	$P > 0.05$	$P > 0.05$	$P > 0.05$

Table 3
Comparison of efficacy between the two groups at 6 months of treatment [n (%)]

Group	Case	Blood gas was normal	The dyspnea disappeared	Mental and appetite improvement	Self-care in part	Body weight (kg)	Electrolyte disorder	Gastrointestinal bleeding	Pulmonary encephalopathy
Control group	48	24 (50.0)	24 (50.0)	18 (37.5)	16 (33.3)	58.6 ± 10.1	24 (50.0)	6 (12.5)	30 (62.5)
Observation group	54	52 (96.3)	52 (96.3)	42 (77.8)	42 (77.8)	67.4 ± 8.4	20 (37.0)	3 (5.6)	17 (31.5)
P value		$P < 0.05$	$P < 0.05$	$P < 0.05$	$P < 0.05$	$P < 0.05$	$P > 0.05$	$P > 0.05$	$P < 0.05$

Table 4
Comparison of the FACT-L quality of life scores between the two groups (x ± s)

Group	Time point	Physical condition	Functional status	Social and family status	Total score
Control group	Before treatment	14.01 ± 3.68	8.06 ± 4.21	14.86 ± 2.55	68.90 ± 14.01
	After treatment	8.64 ± 3.08	2.69 ± 2.54	13.96 ± 3.51	49.56 ± 12.64
P value		$P < 0.05$	$P < 0.05$	$P > 0.05$	$P < 0.05$
Observation group	Before treatment	12.65 ± 3.55	5.84 ± 3.24	16.32 ± 2.88	63.56 ± 13.51
	After treatment	17.64 ± 5.32	9.98 ± 4.25	19.84 ± 3.79	82.19 ± 12.34
P value		$P < 0.05$	$P < 0.05$	$P < 0.05$	$P < 0.05$
Inter-group	Before treatment	$P > 0.05$	$P > 0.05$	$P > 0.05$	$P > 0.05$
	After treatment	$P < 0.05$	$P < 0.05$	$P < 0.05$	$P < 0.05$

disease and complications. Conversely, in the observation group, there was a notable increase in scores for physical status, functional status, social and family status, as well as the overall FACT-L QoL after the treatment was administered ($p < 0.05$). This suggests that the treatment had a differential impact on the QoL metrics in the two groups. Before treatment, an inter-group comparison revealed no significant differences in all aspects of QoL between the two groups ($p > 0.05$). However, after treatment was administered, significant differences emerged in all QoL aspects between the groups ($p < 0.05$).

4. Discussion

Lung cancer has a high mortality rate, with survival factors including cancer stage and patient health. It often presents with symptoms such as weight loss and dyspnoea. In elderly patients, these symptoms are frequently complicated by the presence of COPD [11].

Moreover, COPD exacerbates lung cancer symptoms by causing abnormal gas exchange due to airway inflammation and other changes. Lobectomy is an effective treatment but can worsen COPD symptoms and cause other complications, such as electrolyte disturbances [14]. To mitigate this, timely mechanical ventilation after surgery is crucial. For patients with COPD with lung cancer, a low tidal volume and some positive end-expiratory pressure are recommended to prevent further complications, such as stump rupture [15].

Compared with conventional treatment, NIPPV has some advantages and disadvantages for patients with COPD with lung cancer [16,17,18]. The advantages include avoiding the complications of invasive mechanical ventilation (such as infection, barotrauma and tracheal stenosis), improving the patient's comfort and compliance, allowing the patient to communicate and eat normally, and reducing the cost and length of the patient's hospital stay. The disadvantages include the potential side effects of NIPPV (such as nasal congestion, skin breakdown, gastric distension, and aspiration), the need for close monitoring and adjustment of NIPPV parameters, and the possibility of delaying intubation in some patients who do not respond to NIPPV.

The primary finding of this study was that NIPPV treatment can significantly improve the symptoms, QoL and prognosis of patients with COPD with lung cancer after lobectomy. This is consistent with previous studies that have demonstrated the benefits of NIPPV in acute respiratory failure [19,20, 21]. Further, NIPPV can reduce the work of breathing, improve gas exchange, decrease respiratory muscle fatigue and prevent atelectasis and pulmonary infection. Additionally, NIPPV can reduce the risk associated with intubation, ventilator-associated pneumonia and mortality in patients with hypoxemic respiratory failure [20,21].

This study also found that conventional treatment was ineffective for some aspects of QoL in patients

with COPD with lung cancer, such as physical status and functional status. This finding may be explained by the fact that COPD and lung cancer are both chronic and progressive diseases that can impair the patient's physical and functional abilities. Moreover, conventional treatment may not be able to address the psychological and emotional needs of patients who face a life-threatening condition. Therefore, it is important to provide comprehensive and holistic care for patients with COPD with lung cancer, including psychological and social support, palliative care and symptom management.

The results of this study are similar to those of other studies that have evaluated the efficacy and safety of NIPPV in patients with COPD with lung cancer or other respiratory diseases. For example, a randomised, controlled trial by Ferrer et al. [19] found that NIPPV improved oxygenation, reduced intubation rate, and decreased mortality in patients with severe hypoxemic respiratory failure due to pneumonia or acute lung injury. A meta-analysis by Agarwal et al. [20] found that NIPPV reduced mortality, intubation rate and length of intensive care unit stay in patients with acute lung injury or acute respiratory distress syndrome. A retrospective study by Nava et al. [21] found that NIPPV improved survival and QoL in patients with end-stage chronic respiratory failure who were not eligible for lung transplantation.

However, some studies have reported different or conflicting findings on the efficacy and safety of NIPPV in patients with COPD with lung cancer or other respiratory diseases. For example, a randomised controlled trial by Antonelli et al. [22] found that NIPPV did not reduce mortality or intubation rate in patients with acute hypoxemic respiratory failure due to various causes. A prospective observational study by Demoule et al. [23] found that NIPPV was associated with a high failure rate and a poor prognosis in patients with acute respiratory failure due to lung cancer. A systematic review by Hess [24] found that the evidence for NIPPV in acute respiratory failure was limited by the heterogeneity of study designs, patient populations, NIPPV modes and settings, outcome measures and follow-up durations.

The study by Minervini et al. found that COVID-19-related psychological stressors increase the risk of headaches and temporomandibular disorders, which are common comorbidities in patients with COPD and lung cancer [25]. This suggests that NIPPV treatment may alleviate these issues. However, Badnjević et al. warned about the risks of utilising hastily authorised medical products, such as NIPPV devices, during pandemics, emphasising the need for rigorous oversight [26]. Both studies highlight the complexities of treating patients with COPD and lung cancer, especially during a public health crisis.

The limitations of this study include the small sample size, the retrospective design, the lack of randomisation and blinding and the potential selection bias. Therefore, the results of this study should be interpreted with caution and confirmed by further studies with a larger sample size, prospective design, randomisation and blinding and more rigorous inclusion and exclusion criteria.

5. Conclusion

This study suggests that NIPPV treatment can significantly improve the symptoms, QoL and prognosis of patients with COPD with lung cancer after lobectomy. Further, NIPPV may be a useful adjunctive therapy for this population. However, more studies are needed to verify the efficacy and safety of NIPPV in patients with COPD with lung cancer.

Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki and approved by the ethics committee of Kongjiang Hospital.

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Conflict of interest

None of the authors have any personal, financial, commercial, or academic conflicts of interest to report.

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Author contributions

Conception and design of the work: WXY; Data collection: CYJ, AHJ, LPP, ZCJ, YJY; Supervision: WXY; Analysis and interpretation of the data: CYJ, AHJ, LPP, ZCJ, YJY; Statistical analysis: WXY; Drafting the manuscript: WXY. All authors critically revised the manuscript and approved the final version.

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