

Respiratory Exercise Solutions in Precision Radiation Therapy for Lung Cancer

Fei Chu

Elekta Instrument (Shanghai) Ltd., Beijing Branch, Beijing 100101, China

Abstract: Objective: To study the intervention effect of incorporating respiratory motion solutions in precision radiotherapy for lung cancer. Methods: In the survey sample collected by the enterprise from 2022 to 2023, we selected 60 patients for sample study. They were randomly divided into two groups. Both groups received precision radiotherapy. The control group (n=30) received health education to help patients understand the importance of cervical radiotherapy for lung cancer. The observation group (n=30) received resistance respiratory training and lung function training. The lung function indicators, Piper fatigue scale, cancer-related quality of life score, and symptom score were compared before and after intervention in both groups. Results: Before intervention, there were no significant differences in lung function indicators, Piper fatigue scale, cancer-related quality of life score between the two groups ($P>0.05$). After intervention, the lung function indicators, Piper fatigue scale, and cancer-related quality of life score were significantly better in the observation group than in the control group ($P<0.05$). The observation group also had a lower symptom score than the control group ($P<0.05$). Conclusion: Incorporating resistance respiratory training and lung function training during precision radiotherapy for lung cancer can improve respiratory motion, enhance treatment effectiveness, and improve lung function. These findings are worth promoting.

Keywords: Lung Cancer; Precision Radiotherapy; Respiratory Exercises; Resistance Ventilator Training; Pulmonary Function Training.

1. Introduction

Lung cancer is a common malignant tumor in modern clinical practice, with an increasing incidence that poses a significant threat to human health and life. Precise radiotherapy is the most commonly used treatment method for lung cancer patients, especially for intermediate and advanced stage patients or those who are unable to undergo surgical treatment due to advanced age or poor physical condition [1]. With the gradual improvement in image-guided radiotherapy technology, positioning errors have less impact on the three-dimensional adaptive radiotherapy for lung cancer. However, respiratory motion remains a major factor affecting the accurate radiation dose of lung cancer [2]. Currently, there are various methods to address the impact of respiratory motion on precise radiotherapy for lung cancer, such as resistance breathing training and lung function training, which can reduce the internal gross target volume of patients, thus achieving a smaller planned target volume, improving lung function and controlling tumor progression. While some studies have applied resistance breathing training and lung function training in the treatment of precise radiotherapy for lung cancer, studies on their combined application remain limited. In this paper, the authors aim to analyze the impact of resistance breathing training and lung function training on the lung function, quality of life. In the survey sample collected by the enterprise from 2022 to 2023, we selected 60 patients for sample study [3].

2. Information and Methodology

2.1. General Information

From January 2022 to June 2023, a total of 60 lung cancer patients were selected from our institute. They were divided into two groups using random allocation. Both groups underwent precision radiotherapy. The control group (n=30)

received health education to help patients understand the importance of cervical radiotherapy for lung cancer. Among the patients, there were 20 males and 10 females, with an age range of 40-74 years and an average age of (58.65±5.19) years [4]. The duration of the disease ranged from 3 to 20 months, with an average duration of (12.65±3.49) months. There were 21 cases of adenocarcinoma, 4 cases of squamous cell carcinoma, and 5 cases of adenosquamous carcinoma. The number of lesions ranged from 1 to 6, with an average of (4.06±0.53) lesions. The observation group (n=30) underwent resistance breathing training and lung function training. Among the patients, there were 18 males and 12 females, with an age range of 41-76 years and an average age of (58.98±5.25) years. The duration of the disease ranged from 5 to 21 months, with an average duration of (12.79±3.58) months. There were 20 cases of adenocarcinoma, 6 cases of squamous cell carcinoma, and 4 cases of adenosquamous carcinoma [5]. The number of lesions ranged from 1 to 7, with an average of (4.10±0.59) lesions. The general information of patients in both groups was compared, and there were no significant differences ($P>0.05$).

Inclusion criteria: 1) Diagnosed with lung cancer after comprehensive examinations including clinical pathology; 2) First-time treatment at our institute; 3) Eligible for precision radiotherapy; 4) Consciousness clear, compliant with medical staff's treatment and care; 5) No missing clinical data; 6) Informed and signed the informed consent form [6].

Exclusion criteria: 1) Severe abnormal reactions in the heart, liver, or kidneys; 2) Other malignant tumors in different systems; 3) Respiratory-related diseases; 4) Mental disorders; 5) Intellectual or cognitive impairments; 6) Failure to cooperate during the intervention period [7].

2.2. Methodologies

Control Group: Implementation of Health Education: (1)

Patients need to be introduced to relevant knowledge and precautions regarding lung cancer and precision radiotherapy after admission. Based on the patient's psychological state, psychological interventions should be provided to build treatment confidence. At the same time, the patient's ward should be managed to create a comfortable and quiet environment, and guidance should be given to the patient for respiratory function training. 1) Develop an intervention plan: After the patient's admission, the overall condition should be assessed, and a physical fitness rating should be assigned. Understanding the patient's lifestyle, level of education, and knowledge of the disease will help to develop a targeted health education program [8]. 2) Learning disease-related knowledge: Based on the patient's actual situation, hierarchical learning of disease knowledge should be implemented to help the patient understand the importance of the causes of lung cancer, precision radiotherapy, and respiratory exercise solutions. 3) Psychological intervention: During the treatment process, patients need to receive psychological health education. Nurses need to keep up-to-date with the patient's psychological state and provide targeted intervention. The patient's confidence in recovery can be enhanced by playing rehabilitation videos, thereby maintaining an optimistic attitude [9].

Experimental Group: Implementation of Resistance Breathing Training and Pulmonary Function Training: (1) Resistance breathing training: Introduce relevant knowledge about resistance breathing trainers. During the intervention, guide patients to train with the resistance trainer. Connect a disposable inhalation hose to the breathing trainer, guide the patient to hold the hose in their mouth for inhalation, and inhale slowly and gently. Then, instruct the patient to exhale through the hose, keeping a whistling-like action and exhaling slowly until all air is completely expelled. Repeat the training. Each inhalation should be controlled between 1-3 seconds, and exhalation should be controlled between 2-6 seconds. Each training session should last for fifteen minutes, with two to three training sessions per day. (2) Pulmonary function training: 1) Breathing training: Instruct the patient to practice pursed lip breathing, diaphragmatic breathing, and breathing exercises, each for 10 minutes, twice a day. Pursed lip breathing: Inhale through the nose and purse the lips as if whistling, then exhale slowly. Diaphragmatic breathing: Place both hands on the chest and upper abdomen, inhale slowly through the nose, keeping the diaphragm lowered and the

abdominal muscles relaxed. Lift the patient's abdomen with the hands placed on it while keeping the hands on the chest stationary, inhibiting movement of the thorax. During exhalation, contract the abdominal muscles, allowing the hands on the abdomen to descend while keeping the diaphragm relaxed [10]. Breathing exercises: Perform lateral bending, chest pressing, rotary movements, leg lifting, and stretching exercises. 2) Exercise training: Based on the patient's actual situation, personalized exercises should be implemented, such as guiding the patient to walk in the ward, climb stairs, and practice tai chi to improve upper limb function. The exercise intensity should be controlled within the target heart rate range. Prior to exercise, engage in 3-5 minutes of waist rotation activity, gradually increase the exercise intensity until reaching the target heart rate. Once the target heart rate is reached, start timing the exercise. After exercise, perform 3-5 minutes of stretching exercises. Train for 20-40 minutes per day within the target heart rate state, gradually increase intensity based on the patient's physical condition and exercise intensity, and ensure consistent training three to five days per week [11].

2.3. Observation Indicators

- 1) Lung function indexes before and after the intervention;
- 2) Piper fatigue scale before and after the intervention;
- 3) Cancer quality of life scores before and after intervention;
- 4) Symptom scores.

2.4. Statistical Processing

SPSS20.0 statistical software was used to analyze the data, mean + standard deviation ($\bar{X} \pm s$) indicated the measurement data, t-value was examined, rate (%) indicated the count data, X² was examined, and the difference between the data of the two groups was statistically significant when $P < 0.05$ [3].

3. Results

3.1. Comparison of Lung Function Indices before and after Intervention

Before the intervention, the lung function indexes of the two groups of patients were compared ($P > 0.05$), and after the intervention, the lung function indexes of the patients in the observation group were better than those of the control group ($P < 0.05$), see Table 1;

Table 1. Comparison of lung function indices before and after intervention ($\bar{X} \pm s$)

Group	Number of cases	Spirometry (L)		FVC(L)		FEV1(L)		FEV1/FVC (%)	
		Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
Observation Group	30	1.67±0.13	2.90±0.30	1.35±0.21	2.96±0.42	1.09±0.13	2.78±0.17	40.35±5.46	67.36±6.89
Control group	30	1.65±0.10	2.33±0.24	1.39±0.23	2.24±0.33	1.07±0.10	2.09±0.18	40.19±5.82	52.24±6.39
t	-	0.668	8.12	0.703	7.383	0.668	15.264	0.110	8.813
P	-	0.507	0.000	0.485	0.000	0.507	0.000	0.913	0.000

3.2. Comparison of the Piper Fatigue Scale before and after the Intervention

Before the intervention, the Piper fatigue scale was

compared between the two groups ($P > 0.05$), and after the intervention, the Piper fatigue scale of all patients in the observation group was better than that of the control group ($P < 0.05$), as shown in Table 2;

Table 2. Comparison of Piper's fatigue scale before and after intervention ($\bar{X} \pm s$) (score)

Group	Number of cases	Behavioral fatigue		Emotional fatigue		Physical fatigue		Cognitive fatigue	
		Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
Observation Group	30	8.46±1.77	5.60±1.80	8.83±1.74	6.24±1.52	7.96±1.77	5.40±1.26	7.70±1.73	5.59±1.40
Control group	30	8.52±1.71	6.76±1.89	8.88±1.68	7.20±1.23	7.99±1.86	6.56±1.19	7.77±1.84	6.44±1.48
t	-	0.134	2.434	0.113	2.689	0.064	3.666	0.152	2.285
P	-	0.894	0.018	0.910	0.009	0.949	0.001	0.880	0.026

3.3. Comparison of Cancer Quality of Life Scores Before and After Intervention

Before the intervention, the cancer quality of life scores of

the two groups were compared ($P > 0.05$), and after the intervention, the cancer quality of life scores of the patients in the observation group were better than those of the control group ($P < 0.05$), as shown in Table 3;

Table 3. Comparison of cancer quality of life scores before and after intervention ($\bar{X} \pm s$) (score)

Group	Number of cases	Mental Health		Social Functions		General Health		Physiological functions	
		Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
Observation Group	30	58.46±3.46	89.46±5.23	60.35±3.52	93.46±5.17	62.58±4.25	94.52±3.45	58.32±3.68	90.65±5.26
Control group	30	58.91±3.52	78.46±5.03	60.79±3.55	81.45±4.25	62.98±4.33	83.57±2.61	58.49±3.71	79.46±5.03
t	-	0.499	8.303	0.482	9.829	0.361	13.864	0.178	8.421
P	-	0.619	0.000	0.632	0.000	0.719	0.000	0.859	0.000

Table 3 (continued)

Group	Number of cases	Energetic		Somatic Functioning		Emotional function		Physiological function	
		Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
Observation Group	30	64.35±6.46	88.56±7.85	61.32±5.49	88.34±6.56	69.82±4.53	89.82±5.03	71.56±3.98	92.65±4.18
Control group	30	64.71±6.52	78.92±9.33	61.79±5.52	76.46±6.15	69.13±4.58	79.68±4.98	71.03±4.16	83.35±4.12
t	-	0.215	4.330	0.331	7.236	0.587	7.846	0.504	8.679
P	-	0.831	0.000	0.742	0.000	0.560	0.000	0.616	0.000

3.4. Comparison of Symptom Scores

The symptom scores of the observation group were better

than those of the control group ($P < 0.05$), see Table 4.

Table 4. Comparison of symptom scores ($\bar{X} \pm s$) (score)

Group	Number of cases	Fatigue	Nausea and vomiting	Pain	Respiratory depression	Insomnia	Loss of appetite	Constipation	Diarrhea
Observation Group	30	26.95±4.56	8.22±1.53	22.79±4.86	26.11±4.25	21.25±3.13	22.06±4.13	18.63±3.65	13.36±3.22
Control group	30	33.47±5.19	12.87±4.46	30.77±5.84	35.12±6.93	30.99±7.57	32.29±6.34	27.44±6.61	8.19±1.35
t	-	5.169	5.402	5.753	6.071	6.513	7.405	6.391	8.110
P	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

4. Discussion

Currently, lung cancer is classified as a malignant tumor with relatively high incidence and mortality rates. In clinical practice, treatment measures such as surgery, radiotherapy, and chemotherapy are commonly employed in order to eliminate tumor tissues, control tumor recurrence rates, and improve lung function and quality of life for patients. However, precise radiotherapy treatment for patients with advanced-stage lung cancer can be affected by respiratory movements. In order to further enhance clinical efficacy for patients, effective measures have been taken to address respiratory movements. The commonly used methods in clinical practice are pulmonary function training and resistance breathing apparatus training, but there is limited research on the combined application of these two training methods [12].

This study discovered that the intervention effects in the observation group were superior to those in the control group, and the reasons lie in the following: through health education, patients' treatment compliance can be improved; resistance breathing apparatus training can assist patients in forming correct breathing techniques; and with the assistance of certain psychological interventions, patients can develop confidence in their treatment, thus enhancing lung function [13]. The implementation of pulmonary function training and guidance in maintaining breathing exercises can correct respiratory failure caused by lung tissue damage and improve alveolar ventilation in patients. The application of exercise training, through aerobic exercises, can regulate patients' breathing, increase lung tidal volume and oxygen diffusion capacity, significantly enhance various functions of the lung, stimulate the secretion of β -endorphins by the pituitary gland, improve muscle tension, increase lung ventilation, improve

appetite, and restore patients' physical functions to a more normal state, thereby effectively alleviating clinical symptoms [14].

In conclusion, during the precise radiotherapy for lung cancer, the combined use of resistance breathing apparatus training and pulmonary function training can correct respiratory movements and improve treatment efficacy. This approach is worth promoting.

References

- [1] Yingying W, Lu M ,Shuyan M , et al.Flottillin-1 enhances radioresistance through reducing radiation-induced DNA damage and promoting immune escape via STING signaling pathway in non-small cell lung cancer.[J].Cancer biology therapy,2023,24(1):2203332-2203332.
- [2] Lye-Yeng W, Ntemena K ,Hao H , et al.Risk of developing subsequent primary lung cancer after receiving radiation for breast cancer[J].JTCVS Open,2023(2):28.
- [3] Bruno C S D, Fernanda D ,Danielski G V , et al.Challenges to the effectiveness of next-generation sequencing in formalin-fixed paraffin-embedded tumor samples for non-small cell lung cancer[J].Annals of Diagnostic Pathology,2023(2):44.
- [4] Snigdha S, Tanya G ,Aarushi S , et al.Synthesis and characterization of Fesub3/ subOsub4/sub @SiOsub2/ sub@ PDA@Ag core-shell nanoparticles and biological application on human lung cancer cell line and antibacterial strains.[J].Artificial cells, nanomedicine, and biotechnology, 2024, 52(1):46-58.
- [5] Zhuo Q, Jiahui T ,Jiachen S , et al.Diallyl trisulfide inhibits 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone-induced lung cancer via modulating gut microbiota and the PPAR γ /NF- κ B pathway.[J].Food function,2024,15(1):158-171.
- [6] J. A G, Saad S ,Michael K , et al. The Impact of Prophylactic Cranial Irradiation and Consolidative Thoracic Radiation Therapy for Extensive Stage Small-Cell Lung Cancer in the Transition to the Chemo-Immunotherapy Era: A Single Institution Series[J].Clinical Lung Cancer,2023,24(8):696-705.
- [7] Jingxuan W, Nikos S ,Marjolein H , et al.Explainable machine learning model based on clinical factors for predicting the disappearance of indeterminate pulmonary nodules[J]. Computers in Biology and Medicine,2023(1):33.
- [8] Nikhil Y, Sang L H ,Cole F , et al. Cardiac radiation dose is associated with inferior survival but not cardiac events in patients with locally advanced non-small cell lung cancer in the era of immune checkpoint inhibitor consolidation. [J]. Radiotherapy and oncology : journal of the European Society for Therapeutic Radiology and Oncology,2023(1):190.
- [9] Saba N, Arunabh C ,Ali R , et al.Probing Baicalin as potential inhibitor of Aurora kinase B: A step towards lung cancer therapy [J].International Journal of Biological Macromolecules, 2023, 258(P1):128813.
- [10] Sorachai S, Lukana N, Kriengsak L , et al.Anthraquinones from the roots of *Morinda scabrida* Craib exhibit antiproliferative activity against A549 lung cancer cells and antitubulin polymerization [J].Fitoterapia,2023(1):33.
- [11] Xinan W, Mingxing F ,Tingting C , et al.Corrigendum to “The mechanism of low-dose radiation-induced upregulation of immune checkpoint molecule expression in lung cancer cells” [Biochem. Biophys. Res. Commun. 608 (2022 Jun 11) 102–107, doi: 10.1016/j.bbrc.2022.03.158. Epub 2022 Apr 2.PMID: 35397421] [J]. Biochemical and Biophysical Research Communications, 2023(1):683.
- [12] Shantanu G, A. D S ,P.S. G P , et al. A dynamic Boolean network reveals that the BMI1 and MALAT1 axis is associated with drug resistance by limiting miR-145-5p in non-small cell lung cancer[J].Non-coding RNA Research,2023(1):11.
- [13] Yufan Y, Jianyang W ,Jingbo W , et al.Unrevealing the therapeutic benefits of radiotherapy and consolidation immunotherapy using ctDNA-defined tumor clonality in unresectable locally advanced non-small cell lung cancer [J]. Cancer Letters,2023(1):66.
- [14] Julieta C M. J B ,Yolande L .Utilisation of radiotherapy in lung cancer: A scoping narrative literature review with a focus on the introduction of evidence-based therapeutic approaches in Europe[J].Clinical and Translational Radiation Oncology, 2023 (8); 14-17.