

Effect of respiratory muscle assessment-based muscle relaxation training on postoperative pulmonary function rehabilitation, sputum excretion and quality of life of patients receiving thoracic surgeries

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Muscle relaxation training relieves the nervousness and anxiety of patients, and attenuates the progression of respiratory tract infection, lung injury and other postoperative complications. In this study, we evaluated the effects of nursing intervention combined with respiratory muscle assessment-based muscle relaxation training on postoperative pulmonary function rehabilitation, sputum excretion and quality of life in patients receiving thoracic surgeries. A total of 140 eligible patients were randomly assigned into an observation group and a control group. The control group underwent routine nursing, and the observation group received nursing intervention combined with respiratory muscle assessment-based muscle relaxation training. Pulmonary function rehabilitation, sputum excretion and quality of life before and after nursing intervention were compared. After nursing intervention, pulmonary function indices [forced vital capacity (FVC), forced expiratory volume in one second (FEV1), maximal voluntary ventilation (MVV) and FEV1/FVC ratio] were significantly improved in both groups compared with those before nursing intervention, with significantly better outcomes in the observation group ($P < 0.05$). Sputum excretion was significantly superior in the observation group to that in the control group 48 h and 72 h after surgery ($P < 0.05$). The scores of all dimensions of quality of life (daily life, social activities, anxiety symptoms and depressive symptoms) were significantly lowered in both groups after nursing intervention compared with those before nursing intervention, and the decreases were significantly larger in the observation group ($P < 0.05$). Nursing intervention combined with respiratory muscle assessment-based muscle relaxation training can enhance the pulmonary function and effectively improve the sputum expectoration capacity and quality of life of patients undergoing thoracic surgeries.

Keywords: Nursing, Physical exercise

Thoracic surgery specializes in organs in the thoracic cavity, including momentous organs and tissues such

as the oesophagus, lungs and heart. Thoracic surgeries have complicated procedures, long durations and large postoperative wounds and easily result in a series of postoperative complications¹. The incidence rate of lung injury is 2-7%², which is manifested as postoperative complications including atelectasis, pneumonia and pulmonary infection, as well as acute respiratory failure in severe cases, affecting the prognosis³. Lung injury is classified into primary lung injury and secondary lung injury. Primary lung injury refers to lung injury induced during surgery and occurs within 2 days after surgery. Secondary lung injury means lung injury that is caused by postoperative regurgitation and aspiration, surgical complications and bronchopneumonia and generally occurs within 3-10 days after surgery⁴. Patients suffer from symptoms such as fever, cough, expectoration and sticky sputum that is difficult to expectorate, and even asphyxia in severe cases^{5,6}. Progressive muscle relaxation training not only relieves the nervousness and anxiety of patients, but also effectively attenuates the progression of respiratory tract infection, lung injury and other postoperative complications. However, it is difficult to determine the time and intensity of muscle relaxation training due to the differences among the conditions of patients⁷.

Here, we evaluated the respiratory muscles of patients by personalized muscle relaxation training for its influences on the postoperative pulmonary function rehabilitation, sputum excretion and quality of life of patients using simple tools.

Patients and Methods

Baseline clinical data

This study has been approved by the ethics committee of our hospital, and written informed consent was obtained from all patients. A total of 140 patients with acute myocardial infarction receiving thoracic surgeries in our hospital were selected as the subjects, including 75 males and 65 females. Then they were divided into a control group (n=70) and an observation group (n=70) using a random number table. Routine nursing was applied for the control group, whereas respiratory muscle assessment-based personalized muscle relaxation training was used for the observation group.

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The observation group had 37 males and 33 females, with a mean age of (47.57±5.65) years old and a mean BMI of (24.28±2.13) kg/m². The control group had 38 males and 32 females, with a mean age of (48.02±5.81) years old and a mean BMI of (24.51±2.25) kg/m². The general data exhibited no statistically significant differences between the two groups of patients ($P > 0.05$). These patients had no comorbidities.

Nursing methods

For the control group, routine nursing was conducted, which included the introduction of disease, preoperative preparation, precautions, anesthesia, surgical approach and related points for attention to patients admitted to the hospital before surgery, the strengthened observation of the condition of patients and the implementation of various basic care after surgery.

For observation group, respiratory muscle assessment-based personalized muscle relaxation training and routine nursing were carried out. Specifically, the respiratory muscles of all patients were assessed firstly as follows: the ruler was used to measure the abdominal breathing amplitude of the patient, i.e., the difference between end-breathing circumference and forced end-breathing circumference, and the tape was employed to measure the thoracic undulation amplitude, i.e., the difference between chest circumference at exhalation and chest circumference at inhalation. Based on the assessment of respiratory muscles, muscle relaxation training was divided into four levels (Table 1).

Observation indices

Pulmonary function indices: The pulmonary function of the two groups of patients was examined using a pulmonary function detector after surgery and 3 months after corresponding nursing. Four indices,

including forced vital capacity (FVC), forced expiratory volume in one second (FEV1), maximal voluntary ventilation (MVV) and FEV1/FVC ratio, were investigated, and a higher pulmonary function score meant better recovery. Sputum excretion: At 24, 48 and 72 h after surgery, the number of patients with spontaneous expectoration, assisted expectoration and sputum suction was recorded, and the effect of sputum excretion was compared between the two groups.

Quality of life indices: The quality of life of patients was evaluated by the St. George's Respiratory Questionnaire that is composed of 4 major dimensions (daily life, social activities, anxiety symptoms and depressive symptoms) and 16 items. Each dimension is scored 1-4 points, and a higher score indicates poorer quality of life. Both the reliability and validity of the scale are above 0.8⁸.

Statistical analysis

All data were statistically analyzed by SPSS 20.0 software. The quantitative data were expressed as (mean ± standard deviation), and the means of two groups were compared by the t test. The nursing intervention results of the same group were compared with the paired t test. $P < 0.05$ was considered statistically significant.

Results and Discussion

Pulmonary functions before and after intervention

Before nursing intervention, the pulmonary function indices (FVC, FEV1, MVV and FEV1/FVC) of patients had no statistically significant differences between the two groups ($P > 0.05$). After nursing intervention, these indices were significantly improved in both groups compared with those before nursing intervention, with significantly better improvements in the observation group than those in the control group ($P < 0.05$) (Table 2).

Table 1 — Level assessment for respiratory muscle

Level	Intervention or training modalities
I	0 cm < abdominal breathing amplitude ≤2 cm and 0 cm < thoracic undulation amplitude ≤4 cm, which requires nurses to guide the training of respiratory muscles (exhalation with the mouth slightly open and inhalation through the nose, three times a day, 10-15 min/time) and then instruct the expectoration (breathing deeply for several times, coughing with the mouth open, and expectorating quickly when the sputum enters the throat). If spontaneous expectoration is failed, nurses are required to assist the patients in expectorating.
II	2 cm < abdominal breathing amplitude ≤4 cm and 4 cm < thoracic undulation amplitude ≤6 cm, requiring balloon-blowing training for twice a day, 5-10 min/time, on the basis of trainings in level I.
III	4 cm < abdominal breathing amplitude ≤6 cm and 6 cm < thoracic undulation amplitude ≤8 cm, requiring abdominal breathing (breathing through the nostrils, with abdomen contraction at exhalation and abdomen expansion at inhalation, 3 times a day, 10-15 min/time) and breath holding trainings in addition to trainings in level II.
IV	Abdominal breathing amplitude >6 cm and thoracic undulation amplitude >8 cm, which requires breathing exercises and aerobic endurance training through walking, with the intensity mainly determined based on the comfort of patients.

Table 2 — Pulmonary functions before and after intervention (x±s)

Group	FVC (L)	FEV1 (L)	FEV1/FVC (%)	MVV (L)
Observation (70)				
Before intervention	1.75±0.26	1.12±0.16	56.23±11.04	52.65±13.64
After intervention	2.78±0.31	1.96±0.21	69.86±10.31	63.37±11.81
Control (70)				
Before intervention	1.71±0.23	1.09±0.13	55.64±11.83	52.71±16.21
After intervention	2.14±0.29	1.47±0.19	59.05±7.92	57.38±15.31
t*	0.9641	1.2175	0.3051	0.0237
P*	>0.05	>0.05	>0.05	>0.05
t**	12.6140	14.4763	6.9567	2.5919
P**	<0.05	<0.05	<0.05	<0.05
tΔ	21.2991	26.6202	7.5493	4.9711
PΔ	<0.05	<0.05	<0.05	<0.05
tΔΔ	9.7198	13.8100	2.0040	1.7523
PΔΔ	<0.05	<0.05	<0.05	<0.05

[Values compared between the two groups *before and **after intervention; Δ, values compared before and after intervention in observation group; and ΔΔ, values compared before and after intervention in control group]

Table 3 — Postoperative sputum excretion [n (%)]

Group	Spontaneous	Assisted	Suction
Control (70)			
Postoperative 24 h	24 (34.29)	38 (54.29)	8 (11.43)
Postoperative 48 h	31 (44.29)	32 (45.71)	7 (10.00)
Postoperative 72 h	48 (68.57)	21 (30.00)	1 (1.4)
Observation (70)			
Postoperative 24 h	27 (38.57)	36 (51.43)	7 (10.00)
Postoperative 48 h	41 (58.57)*	24 (34.29)*	5 (7.14)
Postoperative 72 h	57 (81.43)*	13 (18.57)*	0

[Compared with control group, *P <0.05]

Postoperative sputum excretion

No statistically significant difference was detected in sputum excretion between the two groups 24 h after surgery (*P* >0.05), which was significantly superior in the observation group to that in the control group 48 h and 72 h after surgery (*P* <0.05) (Table 3).

Quality of life scores before and after intervention

There were no statistically significant differences in the scores of all dimensions of quality of life (daily life, social activities, anxiety symptoms and depressive symptoms) between observation and control groups before nursing intervention (*P* >0.05). Such scores were significantly lowered in both groups after nursing intervention compared with those before nursing intervention, and the decreases were significantly larger in the observation group than those in the control group (*P* <0.05) (Table 4).

Thoracic surgeries involve the blood vessels and paratracheal tissues, and a large extent of resection usually leads to the extrusion or traction of pulmonary tissues with a part of function, and even partial lung resection. The complex operation can induce physiological disorders and often impair the

Table 4 — Quality of life scores before and after intervention (x±s)

Group	Daily life	Social activities	Anxiety symptoms	Depressive symptoms
Observation (70)				
Before intervention	3.84±0.32	3.51±0.18	3.72±0.34	3.69±0.19
After intervention	1.72±0.21	1.32±0.37	1.82±0.22	1.88±0.31
Control (70)				
Before intervention	3.85±0.33	3.49±0.12	3.73±0.26	3.71±0.23
After intervention	2.76±0.27	2.11±0.31	2.41±0.29	2.92±0.45
t*	0.1820	0.7735	0.1955	0.5609
P*	>0.05	>0.05	>0.05	>0.05
t**	25.4384	13.6930	13.5610	15.9235
P**	<0.05	<0.05	<0.05	<0.05
tΔ	46.3410	44.5312	39.2537	41.6497
PΔ	<0.05	<0.05	<0.05	<0.05
tΔΔ	21.3884	34.7334	28.3550	13.0787
PΔΔ	<0.05	<0.05	<0.05	<0.05

[Values compared between the two groups *before and **after intervention; Δ, values compared before and after intervention in observation group; and ΔΔ, values compared before and after intervention in control group]

pulmonary function. Besides, the respiratory volume of pulmonary lobe and the relevant vital capacity and one-time ventilation volume are decreased after surgery, which causes the retention of secretion in the respiratory tract and reduces the effective diffusion area of respiration, resulting in atelectasis, damage to normal gas exchange function of the lungs and apparent attenuation of pulmonary function^{9,10}. Meanwhile, postoperative pain can trigger reflex tonus of skeletal muscles and decrease the alveolar ventilation, tidal volume and vital capacity, even inducing complications such as chronic obstructive pulmonary disease, severe respiratory failure and microbial pulmonary infection^{11,12}.

Conventional respiratory muscle training is unsuitable for all patients due to great differences in the respiratory conditions of patients after surgery. In recent years, a respiratory muscle assessment scheme and corresponding respiratory muscle training methods have been formulated and applied in clinical practice. In this study, the respiratory function of patients was ameliorated, the progressive decline in pulmonary function was relieved, and symptoms including dyspnea, chest tightness and cough were alleviated, suggesting that nursing intervention combined with muscle relaxation training based on respiratory muscle assessment exerted a better effect on improving the pulmonary function than routine nursing intervention.

Instructing patients to cough and assisting them to expectorate can discharge the gas and liquid accumulated in the thoracic cavity, improve the vital

capacity and maintain pulmonary ventilation, thus efficiently preventing pulmonary infection. In the meantime, the training can decrease bacteria in the lungs, further lowering the probability of pulmonary infection^{13,14}. We herein found that nursing intervention combined with muscle relaxation training based on respiratory muscle assessment played a positive role in improving the quality of life of patients. Additionally, the targeted assessment of the specific conditions of different patients combined with corresponding respiratory muscle training can mobilize the subjective initiative of patients and prominently increase the nursing efficiency.

Conclusion

Above study clearly demonstrate that nursing intervention combined with muscle relaxation training based on respiratory muscle assessment can effectively enhance the pulmonary function and sputum excretion of patients undergoing thoracic surgeries, thereby improving the quality of life and facilitating postoperative recovery. The importance of this study is to provide valuable evidence for facilitating and establishing a crucial dimension in nursing care. Regardless, this study is limited. This is a single-center study with a small sample size. Thus, multicenter study with large sample sizes would establish the effective role of this strategy.

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Conflict of interest

Authors declare no competing interests.

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