Received: 3 November 2021 | Accepted: 21 December 2021

DOI: 10.1111/1759-7714.14306

ORIGINAL ARTICLE

WILEY

Chronic obstructive pulmonary disease assessment test for the measurement of deterioration and recovery of health status of patients undergoing lung surgery

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Funding information

Buddhist Tzu Chi Medical Foundation, Grant/Award Number: TCRD-TPE-109-59; the Taipei Tzu Chi Hospital, Grant/Award Number: TCRD-TPE-108-RT-4(3/3

Abstract

Background: Patients with early lung cancer often undergo surgery. However, surgery usually results in a decline in health-related quality of life (HRQL). Several questionnaires have previously been used to assess HRQL but some are impractical for clinical use. The chronic obstructive pulmonary disease assessment test (CAT) is simple and has been widely used in respiratory diseases but not for lung cancer. We therefore conducted this study to clarify the role of the CAT in postoperative deterioration and recovery of HRQL.

Methods: Fifty-five patients who underwent lung resection were recruited into the study. Cardiopulmonary exercise tests and respiratory muscle strength were performed 1 week before surgery (pre-OP) and at post-OP 1 month. HRQL was assessed through the CAT and European Organization for Research and Treatment of Cancer Quality of Life Core Questionnaire (EORTC QLQ-C30) 1 week pre-OP and post-OP 1 and at 2 months.

Results: Fifteen (27.3%) patients underwent wedge resection, four (7.3%) underwent segmentectomy, and 36 (65.5%) underwent lobectomy. After lobectomy, exercise capacity decreased significantly. The deterioration of CAT symptoms (cough, phlegm, chest tightness, dyspnea, activity, confidence, sleep disturbance, and lack of energy) was more prominent in patients who had undergone lobectomy than wedge resection. Based on the EORTC QLQ-C30, physical, role function, fatigue, pain, sleep disturbance, dyspnea, and global health status worsened significantly, whereas there was no significant difference in other symptoms. HRQL recovered at post-OP 2 months in patients who had undergone wedge resection but not lobectomy.

Conclusions: Postoperative HRQL and exercise capacity in patients were significantly reduced, especially those who had undergone lobectomy. The CAT significantly reflected postoperative changes in HRQL.

KEYWORDS

COPD assessment test, exercise capacity, health-related quality of life, lung cancer, surgery

INTRODUCTION

Lung cancer is the most common type of cancer and a leading cause of death worldwide.[1] Although modern medicine is advancing, the incidence of lung cancer is still increasing.

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It is estimated that by 2035, the number of patients with lung cancer will increase to 3 million.[1] The annual death rate due to lung cancer worldwide is very high at approximately 1.8 million. Patients at advanced stages of lung cancer have a poor prognosis, with a 5-year survival rate of 1%–5%.[1] The treatment of lung cancer strictly depends on the cancer type and stage.[2] In patients with early stage lung cancer, the current main treatment is lung resection.[1,2]

Lung resection provides a possible cure in patients with early stage lung cancer.[2] However, surgery often results in a reduction in pulmonary function, which causes prominent cough, dyspnea, and chest pain.[1] Surgery has been reported to contribute to a rapid decline in activities of daily living and health-related quality of life (HRQL).[1] Therefore, assessing postoperative HRQL in patients with lung cancer is an important issue in clinical care.

Many questionnaires have been used to assess HRQL in patients with lung cancer.[3] However, several research tools are time-consuming and too complex to be used in clinical practice.[3] Some questionnaires are not widely used in real-world care and are only used in clinical studies. Therefore, it is important to develop a simple questionnaire for lung cancer.

The chronic obstructive pulmonary disease (COPD) assessment test (CAT) is a simple, self-administered questionnaire that is easy to use. It consists of eight symptoms assessing the impact of respiratory diseases on health status and was initially used for patients with COPD.[4] However, this questionnaire covers the main respiratory symptoms and is, therefore, widely used in several pulmonary diseases such as pulmonary fibrosis[5] and even COVID-19.[6] However, no study has explored its role in patients with lung cancer, although CAT symptoms focus on respiratory and non-respiratory symptoms, such as lack of energy, sleep disturbance, and activities. These symptoms are also important issues in patients with lung cancer.

Patients with lung cancer often experience a rapid decline in HRQL and daily activity after surgery.[1] Evaluating HRQL in patients undergoing surgery is important. Therefore, we performed this study to evaluate changes in postoperative HRQL, exercise capacity, and physiological function. We also aimed to clarify the role of CAT in measuring the postoperative health status of patients with lung cancer.

METHODS

Study design

Data and variables were collected retrospectively from a prospectively structured lung cancer database. Physiological and psychological conditions were evaluated before and after surgery. All experimental protocols involving human data were in accordance with the guidelines of the institution. Patients were further divided into wedge resection and nonwedge resection (segmentectomy and lobectomy) to assess the different changes after wedge resection and nonwedge resection.

Patient recruitment

A total of 55 patients who underwent surgery were recruited from August 1, 2018, to January 31, 2021. The inclusion criteria were as follows: (1) patients undergoing surgery for lung cancer or lung nodules and (2) those who could mobilize to complete the exercise test. The exclusion criteria were as follows: (1) physical or mental deficits adversely influencing the exercise test, (2) previous thoracic or abdominal surgery, (3) disseminated or nonresectable lung cancer, and (4) unwillingness to participate in exercise tests. The ethics committee of Taipei Tzu Chi Hospital approved the research protocol (approval number 10-X-030). Written informed consent was obtained from all patients.

Perioperative assessment

A pulmonary function test, respiratory muscle strength (RMS) test, and cardiopulmonary exercise test (CPET) were administered, and HRQL was assessed 1 week before surgery and 1 and 2 months after surgery.

Pulmonary function test

The pulmonary function test was performed with a spirometer (Medical Graphics Corporation), in accordance with the standards of the American Thoracic Society.[7]

RMS

The measurement of RMS, including the measurement of maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP), was conducted using a standard mouthpiece and a direct dial pressure gauge (Respiratory Pressure Meter, Micro Medical Corp.). Measurements were made with patients wearing a nose clip in a sitting position.[8] MIP was measured based on residual volume; patients were asked to exhale to the residual volume and then perform a rapid, maximal inspiratory effort, sustained for 1–2 s. MEP was measured from total lung capacity; patients were asked to inspire to total lung capacity and then perform a rapid, maximal expiratory effort, sustained for 1–2 s.[8]

CPET

The CPET was performed as an incremental, symptom-limited test on an electronically braked cycle ergometer (Lode Corival, the Netherlands). The MedGraphics cardiopulmonary diagnostic system (BreezeSuite 6.1, Medical Graphics Corporation) was used to analyze the breath-by-breath expired air with output of oxygen consumption (VO_2), carbon dioxide output (VCO_2), respiratory rate (RR), and tidal volume (V_T). In addition, we continuously monitored the electrocardiogram, hemoglobin saturation by pulse oximeter (SpO_2), heart rate (HR), and blood pressure. Patients were encouraged to do their best to achieve maximal possible performance. The anaerobic threshold (AT) was determined using a VCO_2 versus VO_2 plot.[9]

Dyspnea and leg fatigue score

The dyspnea and leg fatigue scores at peak exercise during the CPET were evaluated using a Borg scale with 10-point scores. Higher scores indicated more dyspnea or leg fatigue.[9]

HRQL

The HRQL was assessed using the CAT and European Organization for Research and Treatment of Cancer Quality of Life Core Questionnaire (EORTC QLQ-C30).

The Chinese version of the CAT questionnaire was provided by the Taiwan Society of Pulmonary and Critical Care Medicine and can be downloaded from www.tspccm.org.tw. The CAT consists of eight symptoms (cough, phlegm, chest tightness, breathlessness, limited activities, confidence leaving home, sleeplessness, and energy), each of which is scored on a scale from 0 to 5,[4] resulting in a total score ranging from 0 to 40 points.[4] A CAT total score of ≥10 points has been suggested to classify patients as highly symptomatic.

The EORTC QLQ-C30 is widely used worldwide. It has been validated for various types of cancers but not specifically for lung cancer.[10] It consists of 30 questions including physical functioning, role functioning, emotional functioning, cognitive functioning, social functioning, global health status, fatigue, nausea and vomiting, pain, financial impact, dyspnea, insomnia, appetite loss, constipation, and diarrhea. A high score for a symptom indicates a higher symptomatic level. However, a higher score for global health status indicates better functioning.[10]

Enhanced recovery after surgery (ERAS)

The ERAS program is known to decrease the length of hospital stay and cardiopulmonary complication rate in patients receiving video-assisted thoracic surgery (VATS).[11] All patients received ERAS programs that consisted of three phases: preoperative, perioperative, and postoperative.[11]

Before surgery, the lung mass status of all patients was reviewed, and their physical tolerance to surgery was checked. The patients were treated by a multidisciplinary team in an outpatient clinic. The clinical nurse provided information on ERAS programs to patients. All smokers were advised to quit smoking. Education on nutrition, mobilization, and the use of the incentive spirometer was provided. The anesthesiologist explained the analgesia procedures. The chest surgeon explained the surgical procedures, expected outcomes, and possible complications. All patients were admitted one day before surgery.

Cefazolin was administered within 30 min before surgery as an antibiotic prophylaxis. All procedures were performed under general anesthesia with selective intubation. All lung resections were performed using two-port VATS. The surgery duration was approximately 1.5–2 h. Thoracoscopy was inserted through the seventh or eighth intercostal space of the midaxillary line. The main access portion (3.5 cm incision) was placed along the anterior axillary line in the fourth intercostal space. If the lesion was small and in a peripheral site of the lung, wedge resection was performed. If the lesion was located near the center and could not be removed by wedge resection, segmentectomy or lobectomy was performed. Frozen sections were obtained after lung resection for pathological studies. If a malignant tumor was confirmed, mediastinal lymph node dissection was performed. At the end of the procedure, one intercostal drainage tube was placed in the pleural cavity, attached to underwater seals, and connected to a suction system with a negative pressure of 15 cmH2O.

TABLE 1 Clinical and demographic characteristics of the participants at baseline

Characteristics		
Age (year)		62.9 ± 10.1
BH (cm)		158.5 ± 8.4
BW(kg)		59.4 ± 11.1
BMI (kg/cm^2)		23.5 ± 3.5
Gender	Male	17 (30.9%)
	Female	38 (69.1%)
Smoking	Nonsmoking	47 (85.5%)
	Current smoker	0
	Ex-smoker	8 (14.5%)
Surgery area	Wedge resection	15 (27.3%)
	Segmentectomy	4 (7.3%)
	Lobectomy	36 (65.5%)
	Pneumonectomy	0
Surgery location	RUL	18 (39.1%)
	RML	5 (10.9%)
	RLL	3 (6.5%)
	LUL	12 (26.1%)
	LLL	8 (17.4%)
Pathological type	Adenocarcinoma	45 (81.8%)
	Squamous cell carcinoma	2 (3.6%)
	Other (HCC metastasis)	1 (1.8%)
	Not cancer	7 (12.7%)
Final stage ($N = 48$)	I	34 (75.6%)
	II	6 (13.3%)
	III	3 (6.7%)
	IV	5 (11.1%)

Abbreviations: BH, body height; BMI, body mass index; BW, body weight; HCC, hepatic cell carcinoma; LLL, left lower lobe; LUL, left upper lobe; RLL, right lower lobe; RML, right middle lobe; RUL, right upper lobe.

The patients were woken up and extubated on the operating table.

Postoperative pain management was achieved with intravenous infusion of Dynastat 40 mg for 3 days, and supplemented with nonsteroidal anti-inflammatory drugs or paracetamol. The chest tube was removed in the absence of air leaks and pneumothorax on chest radiography and was usually removed on the second to third postoperative day, except in cases of complications. All patients received postoperative respiratory physiotherapy consisting of breathing exercises, incentive spirometry, education on coughing and huffing, and early mobilization.

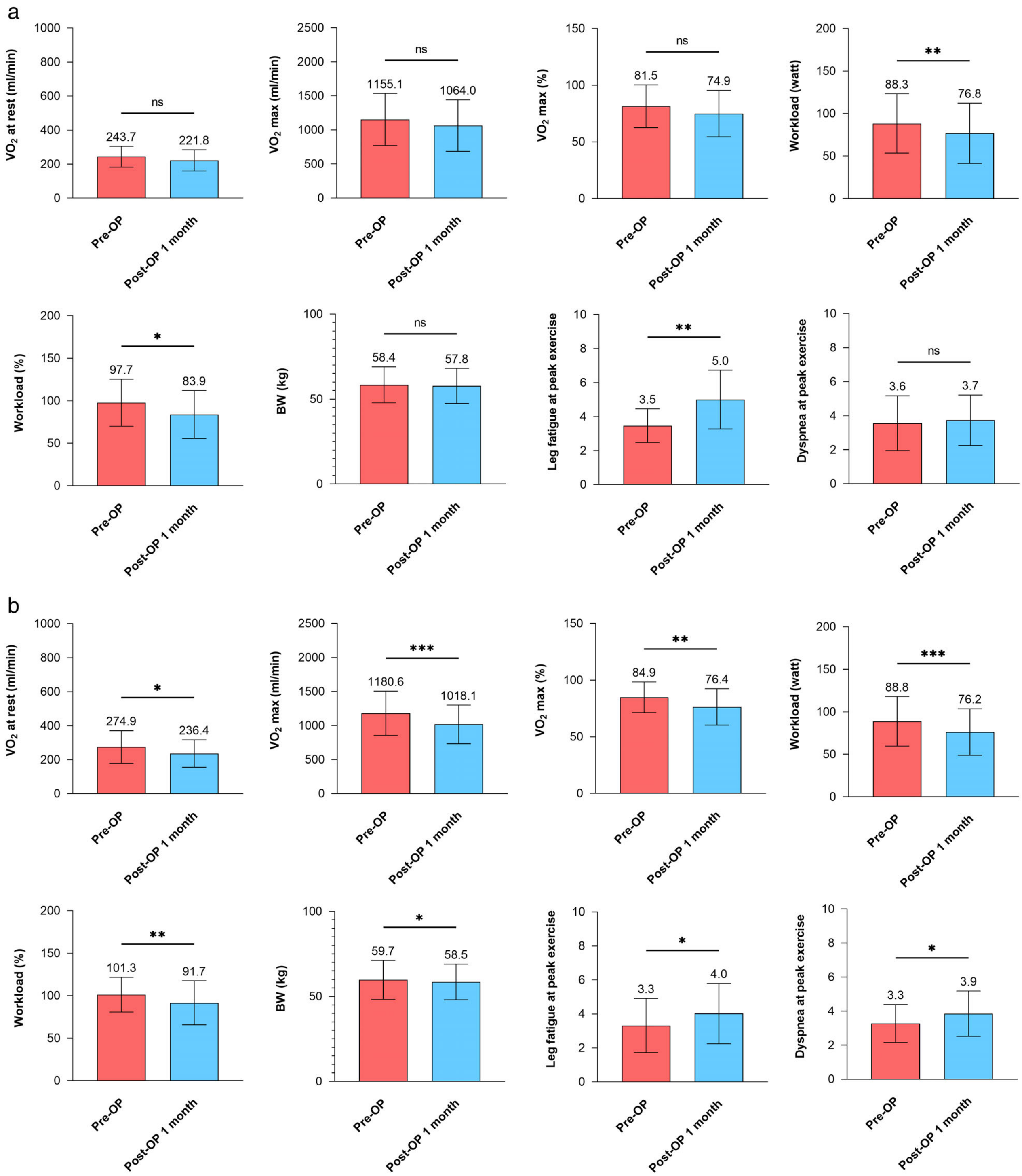

FIGURE 1 Postoperative body weight, exercise capacity, and other parameters. Postoperative bodyweight, exercise capacity, and other parameters in patients who underwent wedge resection (a) and nonwedge resection (b). *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$, ns: $p > 0.05$. BW, bodyweight; ns, nonsignificance; VO_2, oxygen consumption

Statistical analysis

All parameters are expressed as mean ± standard deviation. A paired t-test was used to compare the parameters of exercise capacity, body weight, respiratory function, and circulatory function before and after surgery. The CAT and EORTC QLQ-C30 scores 1 week before surgery and 1 and 2 months after surgery were analyzed by repeated-measures ANOVA. Statistical significance was set at $p < 0.05$. All statistical analyses were performed using Prism 9 software (GraphPad Software).

RESULTS

Anthropometric characteristics

Patient demographic data are summarized in Table 1. The mean age was 62.9 ± 10.1 years, and the mean body mass index was 23.5 ± 3.5 kg/cm^2. Fifteen (27.3%) patients underwent wedge resection, four (7.3%) underwent segmentectomy, and 36 (65.5%) underwent lobectomy. The postoperative pathological study revealed 48 patients with malignancy and seven patients without malignancy. The pathological cancer types were adenocarcinoma ($n = 45$, 81.8%), squamous cell carcinoma ($n = 2$, 3.6%), and one metastatic lesion of hepatocellular carcinoma. The final stages of the cancer patients were stages I ($n = 34$, 75.6%), II ($n = 6$, 13.3%), III ($n = 3$, 6.7%), and IV ($n = 5$, 11.1%).

Postoperative changes in exercise capacity and other health status

The changes in exercise capacity and bodyweight after surgery in patients who underwent wedge resection are shown in Figure 1a. Exercise capacity was assessed using the maximal VO_2 and workload. There were no significant changes in VO_2 at rest or exercise and bodyweight (all $p > 0.05$). However, the maximal workload significantly increased after surgery (both $p < 0.05$). There was no significant difference in the dyspnea score at peak exercise ($p > 0.05$), but the postoperative dyspnea score during exercise was assessed at a relatively low workload.

The changes in exercise capacity, bodyweight, and other health status after surgery in patients who underwent nonwedge resection are shown in Figure 1b. There were significant decreases in VO_2 at rest or exercise, workload, and bodyweight (all $p < 0.05$). Leg fatigue and dyspnea scores at peak exercise significantly increased after surgery (both $p < 0.05$).

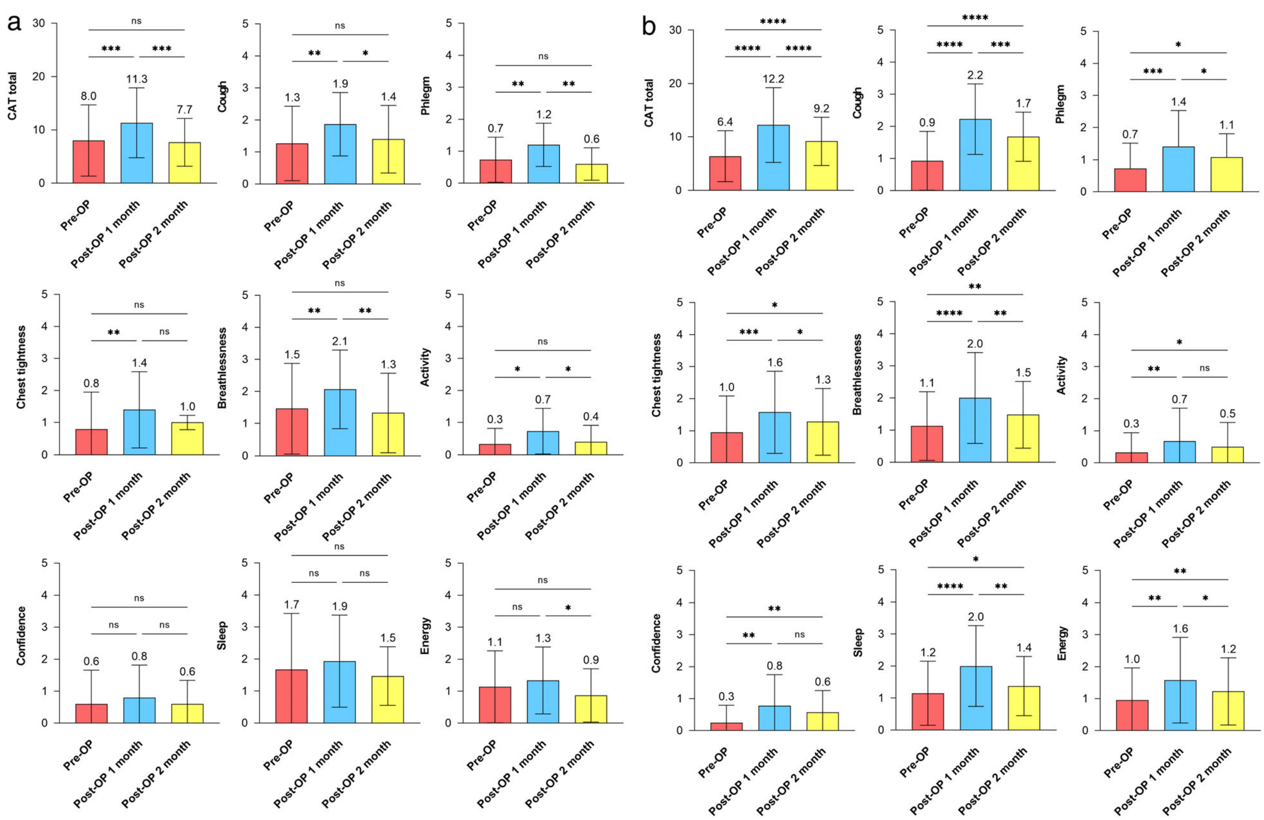

FIGURE 2 Postoperative health-related quality of life based on the CAT. The postoperative HRQL is assessed using the CAT in patients who underwent wedge resection (a) and nonwedge resection (b). *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$, ns: $p > 0.05$. CAT, chronic obstructive pulmonary disease assessment test. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$, ns: $p > 0.05$. ns, nonsignificance

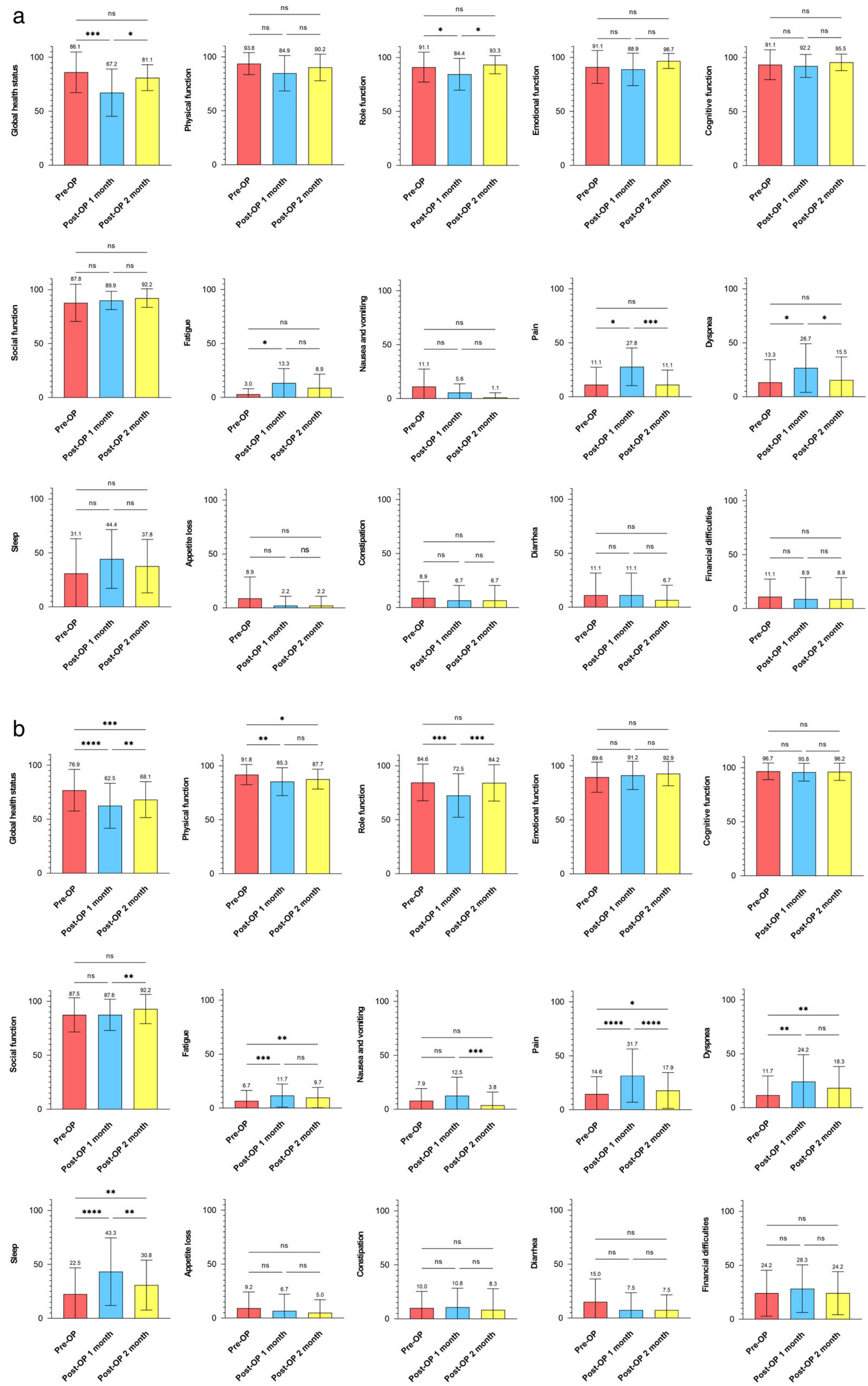

FIGURE 3 Postoperative health-related quality of life based on EORTC QLQ-C30. The postoperative HRQL is assessed using the EORTC QLQ-C30 in patients who underwent wedge resection (a) and nonwedge resection (b). *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$, ns: $p > 0.05$. ns, nonsignificance

Postoperative changes in the quality of life and dyspnea scores based on the CAT

The CAT scores in patients who underwent wedge resection are shown in Figure 2a. The CAT total score was 8.0 ± 6.7 preoperatively, increased to 11.3 ± 6.6 at post-OP 1 month ($p < 0.05$, compared with pre-OP), and then decreased to 7.7 ± 4.5 at post-OP 2 months ($p < 0.05$, compared with pre-OP 1 month, but $p > 0.05$, compared with pre-OP). The symptoms with significant deterioration at post-OP 1 month were cough, phlegm, chest tightness, breathlessness, and activity (all $p < 0.05$, compared with pre-OP and post-OP 2 months). These symptoms of cough, phlegm, breathlessness, and activity were decreased at post-OP 2 months ($p < 0.05$, comparing between post-OP 1 vs. 2 months). There were no significant changes in sleep disturbance, confidence, and energy between the pre-OP and post-OP groups (all $p > 0.05$).

The CAT scores after surgery in patients who underwent nonwedge resection are shown in Figure 2b. The CAT total score was 6.4 ± 4.8 preoperatively, increased to 12.2 ± 7.0 at post-OP 1 month ($p < 0.05$, compared with pre-OP), and then decreased to 9.2 ± 4.5 at post-OP 2 months ($p < 0.05$, compared with pre- or post-OP 1 month). All eight symptoms of the CAT showed significant deterioration at post-OP 1 month (all $p < 0.05$, compared with pre-OP). All these symptoms except confidence and activity were improved at post-OP 2 months ($p < 0.05$, comparing between post-OP 1 and 2 months) but were still higher than those at pre-OP (all $p < 0.05$, comparing between pre-OP and post-OP 2 months).

Postoperative changes in the quality of life and dyspnea scores based on the EORTC QLQ-C30

The EORTC QLQ-C30 scores in patients who underwent wedge resection are shown in Figure 3a. The global health status, role function, fatigue, pain, and dyspnea were significantly deteriorated at post-OP 1 month ($p < 0.05$). The other symptoms of EORTC QLQ-C30, such as physical function, emotional function, cognitive function, social function, nausea, sleep disturbance, appetite, constipation, diarrhea, and financial difficulties were not significantly different between pre- and post-OP 1 month (all $p > 0.05$). None of the symptoms of the EORTC QLQ-C30 were significantly different between pre- and post-OP 2 months (all $p > 0.05$), which indicated that all symptoms and functions recovered at post-OP 2 months in patients who underwent wedge resection.

The EORTC QLQ-C30 scores after surgery in patients who underwent nonwedge resection are shown in Figure 3b. The global health status, physical function, role function, fatigue, pain, dyspnea, and sleep were significantly deteriorated at post-OP 1 month ($p < 0.05$). These symptoms at post-OP 2 months were improved ($p < 0.05$, comparing between post-OP 1 and 2 months) but still higher than those at pre-OP ($p < 0.05$, comparing between pre-OP and post-OP 2 months). The other symptoms of the EORTC QLQ-C30, such as emotional function, cognitive function, social function, nausea, appetite, constipation, diarrhea, and financial difficulties, were not significantly different between pre- and post-OP 1 month (all $p > 0.05$).

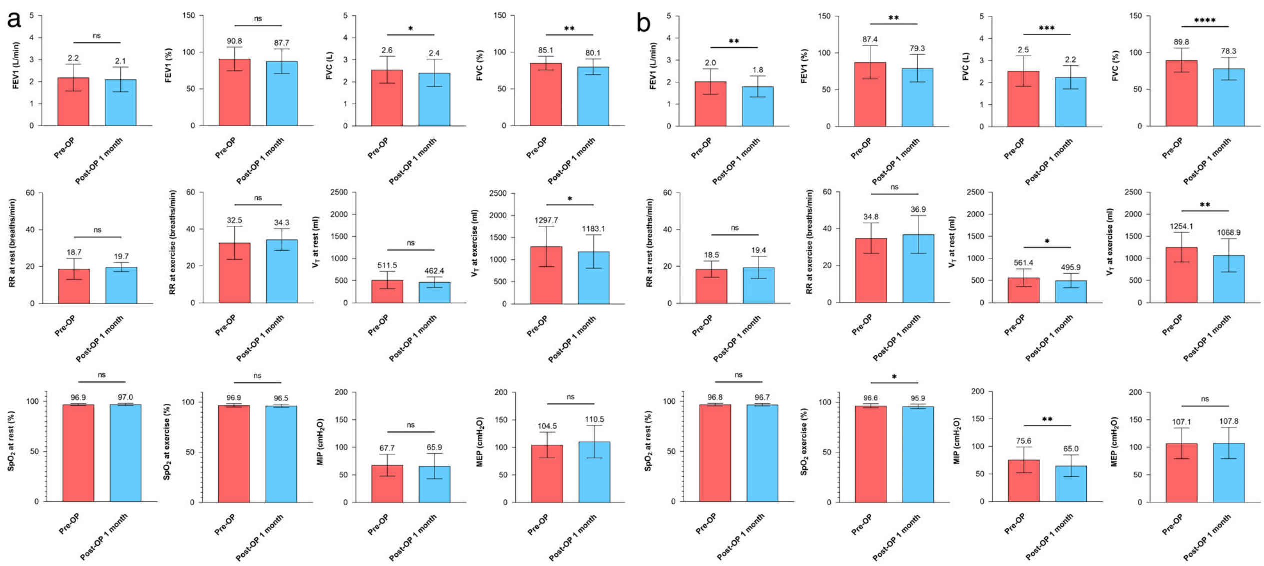

FIGURE 4 Postoperative respiratory parameters. Postoperative respiratory parameters at rest or during exercise in patients with wedge resection (a) and nonwedge resection (b). *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$, ns: $p > 0.05$. FEV1, forced expiratory volume in 1 s; FVC, forced vital capacity; MEP, maximal expiratory pressure; MIP, maximal inspiratory pressure; ns, nonsignificance; RR, respiratory rate; SpO_2, oxygen saturation; V_T, tidal volume

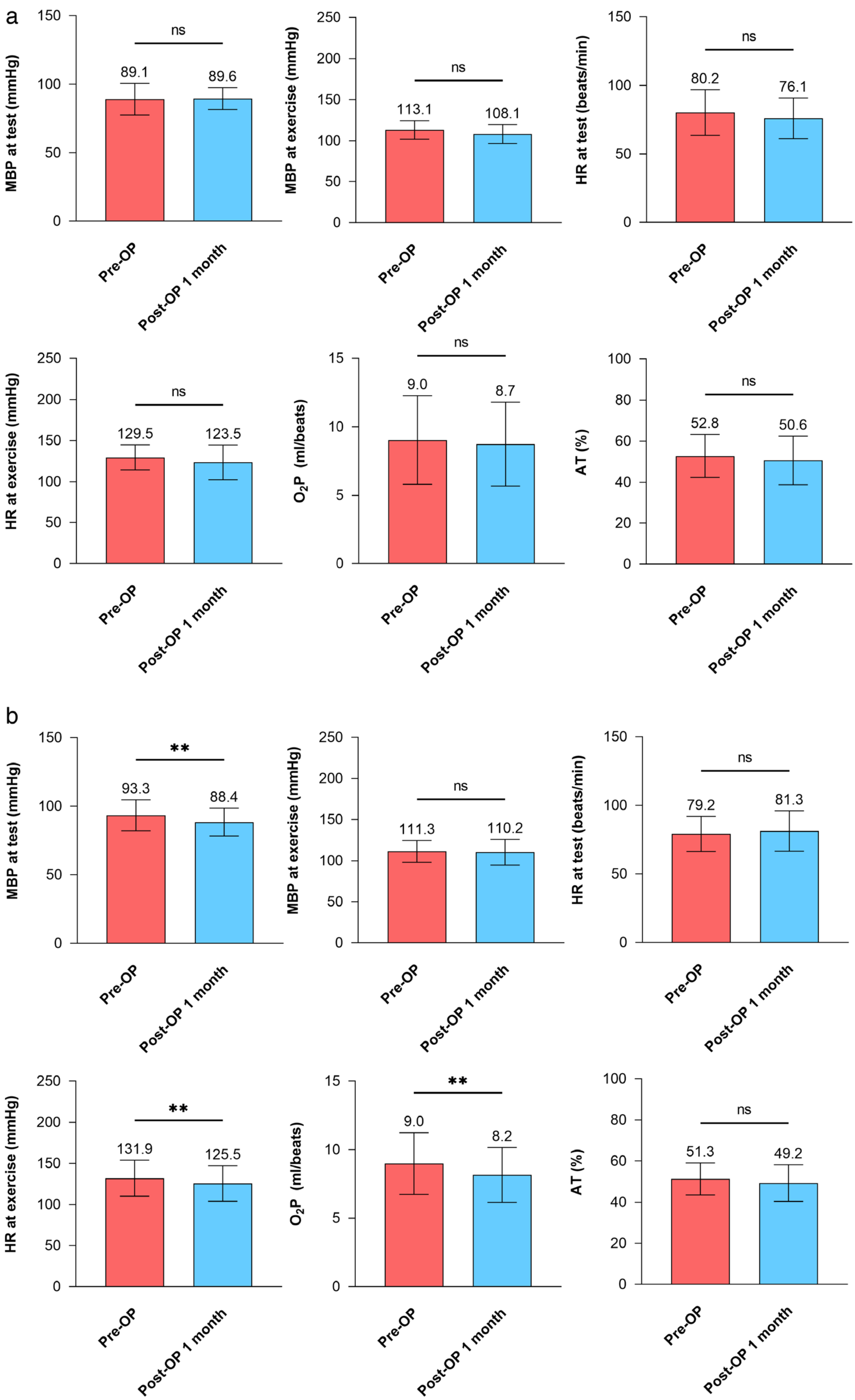

FIGURE 5 Postoperative circulatory parameters. Postoperative circulatory parameters at rest or exercise in patients with wedge resection (a) and nonwedge resection (b). *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$, ns: $p > 0.05$. AT, anaerobic threshold; HR, heart rate; MBP, mean blood pressure; ns, nonsignificance; O_2P, oxygen pulse

Postoperative changes in RMS, spirometric and ventilatory parameters

The changes in respiratory function after surgery in patients who underwent wedge resection are shown in Figure 4a. There were significant decreases in FVC and V_T at exercise at post-OP 1 month compared with those at pre-OP (both $p < 0.05$). However, there were no significant differences in FEV1, RR at rest or exercise, V_T at rest, SpO_2 at rest or exercise, MIP, and MEP (all $p > 0.05$).

The changes in respiratory function after surgery in patients who underwent nonwedge resection are shown in Figure 4b. There were significant decreases in FEV1, FVC, V_T at rest or exercise, SpO_2 at exercise, and MIP (all $p < 0.05$). The RR at rest or exercise, SpO_2 at rest, and MEP were not statistically significant ($p > 0.05$).

Postoperative cardiovascular parameters

The changes in cardiovascular parameters in patients who underwent wedge resection are shown in Figure 5a. There were no significant differences in mean blood pressure (MBP) at rest or exercise, HR at rest or exercise, O_2P, and AT after wedge resection (all $p > 0.05$).

The changes in cardiovascular status after surgery in patients who underwent nonwedge resection are shown in Figure 5b. The MBP at rest, HR at exercise, and O_2P decreased at post-OP 1 month (all $p < 0.05$).

DISCUSSION

There are several important and novel findings in this study. First, to the best of our knowledge, this is the first CAT study to assess HRQL in patients who have undergone lung resection. Patients undergoing lung resection often experience a rapid decline in HRQL. Here, we reveal that CAT could show different changes in HRQL after wedge or non-wedge resection (segmentectomy or lobectomy). We suggest that CAT can reflect postoperative changes in HRQL, even with low invasive wedge resection. Patients who underwent wedge resection still had cough, phlegm, chest tightness, breathlessness, and decreased activity after surgery. However, for patients who received nonwedge resection, all CAT symptoms, such as cough, phlegm, chest tightness, breathlessness, activity, sleep, confidence, and energy, deteriorated after surgery. This indicates that the CAT is sensitive to the different changes in the HRQL between wedge and non-wedge resection. Second, CAT could not only assess the deterioration of the HRQL but also assess the recovery status after surgery. CAT is a simple questionnaire[4]; however, it includes symptoms such as those addressing respiratory symptoms (cough, phlegm, chest tightness, and breathlessness) and nonrespiratory symptoms (activity, confidence, sleep, and energy) that are valuable for assessing patients receiving lung resection.

It is well known that lobectomy can cause a decrease in HRQL.[12] However, the impact of lung wedge resection has rarely been discussed. Lung wedge resection is often considered a minimally invasive surgery; therefore, its impact is often overlooked. In the current study, we found that even lung wedge resection could cause postoperative cough, phlegm, chest tightness, difficulty in breathing, and decreased activity. In fact, patients undergoing wedge resection still require tracheal intubation, general anesthesia, and endoscopic resection of the lungs. As a result, they also experience discomfort and decreased HRQL after surgery. Our study reminds clinicians to pay attention to this type of patient.

The EORTC QLQ-C30 is commonly used in cancer research to evaluate various aspects, including physiological (physical, cognitive), respiratory, gastrointestinal, and sleep functions as well as financial problems.[10] EORTC QLQ-C30 has been widely used in all cancers and is not specific to respiratory symptoms. Symptoms in some patients remained unchanged after surgery. According to our study, postoperative physical function, role function, fatigue, sleep disturbance, and dyspnea deteriorated. However, there were no differences in cognitive function, nausea, vomiting, appetite, constipation, diarrhea and financial issues after surgery. Taiwan has a good national health insurance system, and most surgical expenses are paid for by the National Health Insurance Bureau. Therefore, the cost of treatment is usually not a major problem in Taiwan. The EORTC QLQ-C30 is a comprehensive questionnaire, but it is also time-consuming. Therefore, it is more commonly used in cancer research but is not widely used in real-world cancer care. Avery et al. used the EORTC QLQ-C30 as a postoperative HRQL questionnaire and found that the questionnaire response rate was as low as 67% at some time point during follow-up.[12]

In comparison with the EORTC QLQ-C30, the CAT is relatively easy to complete. In this study, we showed that it is feasible to use the CAT to measure the HRQL in patients after surgery. Timely recognition of changes in a patient's health status is important for timely care. Based on this questionnaire, clinicians can understand the patient's condition in time and provide timely management plans. Therefore, a simple questionnaire such as the CAT to help clinicians understand changes in the patient's health status and symptoms is very important.

We also found differences in the physiological changes between wedge resection and non-wedge resection. For patients undergoing wedge resection, there were no significant changes in the maximal VO_2, bodyweight, or circulatory parameters. For patients undergoing nonwedge resection, the maximal VO_2, workload, and bodyweight were reduced. They also have more exertional dyspnea, more leg fatigue, and decreased SpO_2 during exercise, with concurrent poor respiratory function and worse O_2P after non-wedge resection.

The cause of impaired exercise capacity and lung function following lung resection is multifactorial, including the removal of lung tissues and alterations in chest wall mechanics due to the surgical incision.[13] Respiratory muscle dysfunction following surgery has been suggested to negatively influence postoperative pulmonary function.[14] In the current study, patients who underwent wedge and non-wedge resections presented different changes in exercise capacity and lung function after surgery. Patients who underwent nonwedge resection had more exertional dyspnea, more leg fatigue, and decreased SpO_2 during exercise, with concurrent poor respiratory function. Similar findings of decreased SpO_2 following a 6-min walking test have been described.[15]

The respiratory muscles are important for generating the strength required to maintain adequate ventilation.[14] Patients with respiratory muscle dysfunction cannot generate adequate strength to drive ventilation and often have lower V_T, which causes more dyspnea and unstable V_T during exercise.[16] Therefore, when respiratory muscle weakness develops, symptoms progress to dyspnea, tachypnea, and paradoxical respiration.[17] We found that the decrease in the MIP of patients who underwent lobectomy was greater than that of patients who underwent wedge resection, which is consistent with the reduction in V_T during exercise in patients who underwent lobectomy. The evaluation of RMS is a simple, rapid, and noninvasive test that is highly valuable for confirming respiratory muscle weakness.[17] Therefore, we suggest that a test of RMS should be one part of the assessment of patients undergoing thoracic surgery, especially for those with prominent postoperative dyspnea.

Clinical implications

Although lung resection is the only way to cure early stage lung cancer, exercise capacity and HRQL often rapidly decline after surgery. The goals for patient treatment should not only treat the disease but also maintain HRQL. Therefore, the postoperative evaluation of HRQL is important. For patients with HRQL deterioration after surgery, postoperative interventions such as exercise training, nutritional support, pain control, treatment of sleep disturbance, and psychological support may be helpful. Farrugia et al. performed a study which investigated the association between HRQL and survival outcomes in patients with early stage lung cancer and found that HRQL was associated with overall survival and progression-free survival.[18]

Since HRQL is important to patients, the development of simple, convenient, and sensitive questionnaires for respiratory condition in patients with lung resection is important. The CAT is simple and easy to complete, takes only a few minutes, and is not a burden to patients and medical staff. We suggest that it can be used in the postoperative evaluation of such patients in real-world care and not just research. Although there have been several cancer questionnaires in the past, many of these are time-consuming and not easy to use. Moreover, many of the symptom-related questions in these questionnaires are not common in patients undergoing lung resection. Here, we revealed that the CAT correctly reflects the symptoms and HRQL in patients undergoing lung resection. Our first study on the CAT in patients with lung resection may open up other studies of the CAT in lung cancer, such as studies on changes in the CAT in patients undergoing chemotherapy or radiotherapy.

The current study had several limitations. First, it was a single-center study with a heterogeneous group regarding the degree of resection of lung tissue and included patients with different diagnoses (lung cancer and nonmalignant disease). However, cancer and noncancer patients underwent the same perioperative evaluation and surgical treatment. Therefore, we did not exclude patients whose final pathology report was noncancerous. A total of 55 patients were included in the study. The small sample size may have affected the statistical significance of our results. Third, we only evaluated the CAT in the short-term postoperative period. However, it is still necessary to confirm its clinical implications in long-term follow-up. In addition, the evaluation of the CAT occurred only in patients undergoing surgery. It is important to evaluate its use in patients receiving chemotherapy or radiotherapy. Fourth, previous studies have shown that HRQL is related to survival outcome,[18] and studies related to the CAT and survival outcomes should be conducted.

In conclusion, after surgery, the patient's HRQL, exercise capacity, and lung function were significantly reduced. The CAT is a simple questionnaire that includes respiratory and nonrespiratory symptoms that can show obvious postoperative changes in patients. A high percentage of patients had high total postoperative CAT scores. We suggest interventions for patients with a rapid decline in HRQL and exercise.

ACKNOWLEDGMENTS

This study was supported by grants from the Taipei Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation (TCRD-TPE-108-RT-4(3/3) and TCRD-TPE-109-59).

CONFLICT OF INTEREST

The authors have no financial disclosures or potential conflicts of interest to declare.

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How to cite this article: Huang C-Y, Hsieh M-S, Wu Y-K, Hsieh P-C, Yang M-C, Tzeng I-S, et al. Chronic obstructive pulmonary disease assessment test for the measurement of deterioration and recovery of health status of patients undergoing lung surgery. Thorac Cancer. 2022;13:613–23. https://doi.org/10.1111/1759-7714.14306