Physical function and health-related quality of life after surgery for nontuberculous mycobacterium pulmonary disease: a prospective cohort study

Yuki Kuroyama (✉ y.kuroyama2022@gmail.com)

Nagasaki University Graduate School of Biomedical Sciences

Mitsuru Tabusadani

Fukujuji Hospital

Shunya Omatsu

Nagasaki University Graduate School of Biomedical Sciences

Kazumasa Yamane

Nagasaki University Graduate School of Biomedical Sciences

Satoshi Takao

Nagasaki University Graduate School of Biomedical Sciences

Yusuke Matsumura

Nagasaki University Graduate School of Biomedical Sciences

Kosuke Mori

Nagasaki University Graduate School of Biomedical Sciences

Kazuma Kawahara

Nagasaki University Graduate School of Biomedical Sciences

Kazuki Ono

Nagasaki University Graduate School of Biomedical Sciences

Miyako Hiramatsu

Fukujuji Hospital

Yuji Shiraishi

Nagasaki University Graduate School of Biomedical Sciences

Hiroshi Kimura

Nagasaki University Graduate School of Biomedical Sciences

Hideaki Senju

Nagasaki University Graduate School of Biomedical Sciences

Research Article

Keywords: nontuberculous mycobacterium pulmonary disease, surgical treatment, physical therapy, respiratory care, exercise capacity, health-related quality of life

Posted Date: April 5th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-362840/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

Version of Record: A version of this preprint was published at Annals of Thoracic and Cardiovascular Surgery on January 1st, 2021. See the published version at <https://doi.org/10.5761/atcs.aa.21-00125>.

Abstract

Background: Nontuberculous mycobacterium pulmonary disease (NTM-PD) is a progressive condition characterized by exercise intolerance and impaired health-related quality of life (HRQOL). NTM-PD is sometimes treated with surgery in combination with medication, but little is known about the postoperative physical function and HRQOL. This study aimed to investigate the exercise capacity and HRQOL of patients with NTM-PD preoperatively and 6 months postoperatively.

Methods: This prospective observational study included patients with NTM-PD and was conducted at Fukuji Hospital. The intervention was surgical resection plus perioperative and post-discharge physical therapy. The physical function was assessed preoperatively and 6 months postoperatively using the 6-minute walk test (6MWT). HRQOL was assessed preoperatively and 6 months postoperatively using the Short-Form 36 Health Survey (SF-36) and St. George's Respiratory Questionnaire. The postoperative HRQOL was compared between patients with and without preoperative clinical symptoms.

Results: In total, 35 patients were analyzed. Preoperative clinical symptoms were present in 20 of 35 patients (57%), and the preoperatively symptomatic group had significantly lower preoperative HRQOL than the preoperatively asymptomatic group ($p < 0.05$). Thirty-two patients completed the 6-month follow-up. Compared with preoperatively, there were significant improvements at 6 months postoperatively in the 6MWT ($p < 0.01$) and HRQOL, mainly in the SF-36 mental component summary ($p < 0.01$). The SF-36 mental component summary in the preoperatively symptomatic group was very significantly improved from preoperatively to 6 months postoperatively ($p < 0.05$).

Conclusions: The combination of surgical treatment and physical therapy for NTM-PD contributes to improvements in physical function and HRQOL.

Background

Nontuberculous mycobacterial pulmonary disease (NTM-PD) is a progressive lung disease that causes airway destruction and respiratory failure [1]. The incidence of NTM-PD is increasing worldwide and is rapidly increasing in Japan [2], [3], [4]. NTM-PD causes chronic cough and sputum production and is characterized by exercise intolerance, respiratory dysfunction, and impaired health-related quality of life (HRQOL) [5], [6], [7].

The treatment of NTM-PD is primarily medical therapy with a focus on multidrug regimens, although surgical treatment is sometimes required [1]. Surgical treatment is aimed at cure, palliation, and control of disease activity [8], [9]. An increasing number of patients are undergoing pulmonary surgery for NTM-PD in Europe and Japan [10], [11]. The HRQOL of such patients is assessed using a respiratory illness questionnaire at baseline and postoperatively [8], [12]. For patients undergoing surgery for lung cancer, the performance of pre- and postoperative physical therapy contributes to the prevention of postoperative complications and the improvement of HRQOL [13], [14].

Several studies have reported the changes in physical function and HRQOL over time after surgery for lung cancer [14, 15], [16], but only one study has examined the physical function and HRQOL outcomes after surgery for non-cystic fibrosis bronchiectasis, including NTM-PD [17]. Furthermore, there are no reports on the effects of combined surgical treatment and physical therapy for patients with only NTM-PD. The purpose of this study was to investigate the pre- and postoperative exercise capacity and HRQOL of patients who underwent surgery for NTM-PD.

Methods

Study population

This prospective study was conducted from August 2018 to April 2020 in a single hospital in Japan. The study was approved by the Institutional Review Board on Human Research of Fukuji Hospital (approval number 18022), and all patients provided informed consent for study participation. At our institution, patients in whom NTM-PD is sufficiently localized and who have sufficient pulmonary reserve are considered eligible for resection surgery. All 35 consecutive patients who underwent major lung resection for NTM-PD after unsuccessful medical treatment were prospectively enrolled in this study and met the diagnostic criteria of the 2007 ATS/IDSA guidelines [1]. Of the 35 patients who survived surgery, a total of 32 patients were assessed preoperatively and at 6 months postoperatively (Figure 1).

High-resolution computed tomography was used to identify the affected lung segments and the area requiring resection, with a discussion of the findings taking place at a multidisciplinary meeting. The presence or absence of preoperative clinical symptoms was assessed by questioning at the time of physical therapy assessment. The study exclusion criteria were: comorbidities or lung function and cardiopulmonary capacity that precluded the planned resection, musculoskeletal impairment that interfered with exercise performance, inability to understand the HRQOL questionnaires, active hemoptysis, two-staged bilateral lung resection, and age younger than 18 years.

Physical therapy

As part of standard perioperative care, all patients received an in-hospital physical therapy consultation 3 to 4 days prior to surgery. Patients were encouraged to meet the aggressive postoperative early mobilization recommendations for the prevention of postoperative complications and were given instructions on deep breathing and coughing exercises for airway clearance. After discharge from the hospital, exercise and respiratory care included the maintenance of physical activity levels using a pedometer, a home exercise program for the upper and lower extremities, airway clearance, nutrition support, mental health care, and routine hospital visits to see a physiotherapist.

Follow-up assessments of physical function and health-related quality of life

Patients performed the 6-minute walk test and underwent a HRQOL evaluation preoperatively (usually 2 to 3 days before surgery) and 6 months postoperatively. The main outcomes were the improvements in the 6-minute walk distance (6MWD) and HRQOL after resection. The 6-minute walk test was performed in accordance with published guidelines [18].

We assessed the HRQOL using the Short-Form 36 Health Survey Questionnaire (SF-36) and St. George's Respiratory Questionnaire (SGRQ), both of which are general questionnaires with validated self-reported versions translated into Japanese.

The SF-36 is a generic HRQOL instrument with 36 items that assesses eight health concepts (physical functioning, role limitation caused by physical problems, body pain, general health perception, vitality, social functioning, role limitation caused by emotional problems, and mental health) [19]. Scores standardized to norms and weighted averages are used to create a physical component summary (PCS) and mental component summary (MCS) on a standard scale. In functional scales with multiple items, higher scores indicate a higher level of health status.

The SGRQ is a disease-specific tool comprising 50 items that provides an individual score for each of three domains (symptoms, impact, and activity), as well as a total score [20]. The score for each domain ranges from 0 to 100, with lower scores indicating better HRQOL. Permission to use the Japanese version of the SGRQ was obtained from Dr Koichi Nishimura.

Statistical analysis

Data were expressed as means with SD or medians with interquartile ranges for continuous variables, and as counts with percentages for categorical variables. Normal distribution of the data was tested by the Shapiro-Wilk normality test. The 6MWD and HRQOL scores before and after lung resection were compared using the Student's t test or Wilcoxon rank sum test. A p value < 0.05 was considered significant, and SPSS v26.0 software was used for all statistical analyses.

Results

Patients

The characteristics of the enrolled patients are shown in Table 1. Preoperative assessment revealed pulmonary bacterial infection in all patients, and *Mycobacterium avium* complex was detected in the preoperative sputum of 27 patients (77%). Twenty patients (57%) had preoperative clinical symptoms such as cough, sputum, and chest pain. The baseline SGRQ scores and SF-36 of the patients with and without preoperative clinical symptoms are compared in Table 2. The baseline SGRQ symptom subscale score, total SGRQ score, and SF36v2 PCS score were significantly worse in the patients with preoperative symptoms than in those without preoperative symptoms (p < 0.05).

Surgical procedure

The types of anatomic lung resections performed for NTM-PD are shown in Table 3. Of the 35 patients who underwent surgery, 32 (91%) and three (9%) were scheduled to undergo video-assisted thoracoscopic surgery and open surgery, respectively; however, one patient was subsequently excluded due to postponement of the scheduled surgery, and another was excluded because they underwent two-stage bilateral surgery. Three patients had adverse events that required only clinical treatment: prolonged air leak (> 7 days) in two patients, and tachycardia requiring medication in one. There was no operative mortality.

All patients were ambulating with or without a gait aide in the intensive care unit with the assistance of a physiotherapist on the first postoperative day. All patients were finally discharged home with no adverse events. One patient was difficult to follow-up after 3 months postoperatively due to worsening disease.

Primary outcomes

Table 4 shows the results of the repeated measures analyses of variances comparing physical function and HRQOL from preoperatively to 6 months postoperatively. The exercise capacity (based on the 6MWD) was significantly improved at 6 months postoperatively compared with preoperatively. The mean change in the 6MWD at 6 months postoperatively (38.1 m) far exceeded the minimum clinically important difference (MCID) of 25 m [21]. The SGRQ activity score and the SF-36 PCS score were significantly decreased from preoperatively to 6 months postoperatively, and 66% of patients had not recovered to their preoperative level by 6 months postoperatively. In contrast, the SF-36 MCS score was significantly better at 6 months postoperatively than preoperatively. There were no significant differences in the pre- and postoperative HRQOL by preoperative disease type (nodular-bronchiectatic vs. other).

Table 5 shows the HRQOL score preoperatively and at 6 months postoperatively in the patients with and without preoperative clinical symptoms. Both groups had significantly decreased postoperative SGRQ activity scores compared with preoperatively. The preoperatively symptomatic group had a significantly better SF-36 MCS score at 6 months postoperatively than the group without preoperative symptoms.

Discussion

The present study evaluated the changes in exercise capacity and HRQOL after surgery plus perioperative and post-discharge physical therapy for NTM-PD. The findings demonstrated that lung resection significantly improved the exercise capacity and HRQOL of patients with NTM-PD. The MCID of the 6MWD after exercise training is 25 m in patients with bronchiectasis [21]. In our study, the 6MWD at 6 months postoperatively was significantly improved by more than the MCID compared with baseline. Previous studies of people with lung cancer have shown that better mobilization adherence during hospitalization is significantly related to a higher 6MWD postoperatively [16]. Therefore, in our study, physical function was also expected to improve by encouraging aggressive mobilization during hospitalization and after discharge. It is often assumed that ventilation/perfusion (V_A/Q) mismatch occurs during exercise in patients with chronic respiratory impairment and causes reduced exercise capacity [22]. Similarly, NTM-PD results in V_A/Q mismatch that shows as a focal defect of perfusion in the affected area on technetium perfusion scintigraphy [8]. In the present study, pneumonectomy may have improved V_A/Q impairment and contributed to improved exercise capacity. Patients who have undergone lung resection for cancer still have impaired respiratory function postoperatively; however, their exercise capacity is almost completely recovered by 12 months postoperatively [15]. There is a need for more detailed objective evaluation of the ventilation patterns of the respiratory system during cardiopulmonary exercise testing, including lung function.

A previous study reported that lung resection results in a significant improvement in HRQOL [17]. In our series, the HRQOL was improved at 6 months postoperatively compared with preoperatively, especially regarding the mental component. About 43% of patients in the present series had no preoperative clinical symptoms, which may explain why lung resection did not affect the non-mental components of HRQOL. Postoperative management of NTM-PD generally requires continuation of the same multidrug regimen used preoperatively, and it is recommended that patients receive chemotherapy for at least 1 year after conversion to a negative culture [23]. The continuation of chemotherapy may contribute to a lack of improvement in HRQOL after lung resection. In patients who undergo lung resection for cancer, HRQOL does not recover to the preoperative level by 1 year postoperatively [24], [25], and lower HRQOL is associated with continued postoperative chemotherapy [24]. Thus, continued chemotherapy might also decrease HRQOL in patients who undergo surgery for NTM-PD. A systematic review suggested that postoperative exercise training contributes to improved exercise capacity and an improved physical component of HRQOL score at 12 months postoperatively [14]. In addition, exercise capacity in surgical patients with NTM-PD is strongly correlated with a reduced HRQOL score for the domain of respiratory symptoms [7]. There are many reports of short-term effects of perioperative physical therapy for patients with lung cancer (specifically, reduced postoperative

complications or length of stay), but research on the long-term effects of physical therapy interventions is clearly lacking [26]. Longer-term observational studies are needed to determine which patients are more likely to benefit from postoperative physical therapy. In our study, the group with preoperative clinical symptoms had a significantly lower preoperative HRQOL and a significantly higher rate of improvement in HRQOL (SF-36 MCS) at 6 months postoperatively than the group without preoperative clinical symptoms. Previous studies have reported associations between respiratory symptoms (such as sputum and cough) and HRQOL [27], [28], and an association between the presence of a residual lesion and decreased HRQOL in patients with *M. avium* complex [5]. The effectiveness of airway clearance in patients with NTM-PD has been reported in several studies [29], [30], and our study showed that perioperative and post-discharge physical therapy improved the HRQOL of patients with symptomatic NTM-PD. The present findings indicate that surgical treatment and comprehensive physical therapy of patients strongly contributed to exercise capacity and HRQOL improvement.

The present study has several limitations. First, it was a single-center study that included a small number of patients who underwent surgical procedures for NTM-PD. Second, the postoperative follow-up period was relatively short. As NTM-PD is a long-term disease with a prolonged course, physical function and HRQOL need to be investigated over a period of several years. Third, there was no control group. There is a need for a comparison of the patients with a residual disease area versus those without a residual disease area, and a comparison of a surgical group versus a medical therapy-only group.

Conclusions

The present study demonstrated that patients with NTM-PD experience a significant improvement in their exercise capacity and HRQOL after lung resection, especially regarding the mental component of HRQOL. Moreover, preoperatively symptomatic patients achieve very large improvements in HRQOL (SF-36 MCS) after surgical treatment. However, we need to determine which patients will benefit the most from physical therapy. We suggest that appropriate surgical treatment combined with perioperative and post-discharge physical therapy improves the physical function and HRQOL of patients with NTM-PD.

Abbreviations

BMI: body mass index; CT: computed tomography; FEV₁: forced expiratory volume in 1s; FVC: forced vital capacity; HRQOL: health-related quality of life; IQR: interquartile range; MCS: mental component summary; mMRC: modified Medical Research Council dyspnea scale; NTM-PD: nontuberculous mycobacterial pulmonary disease; PCS, physical component summary; SF36v2: Short Form 36 Health Survey Questionnaire; SGRQ: St. George's Respiratory Questionnaire; 6MWT: 6-minute walk test.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the principles of the Declaration of Helsinki and received ethics approval by the Institutional Review Board on Human Research of Fukujuji Hospital (approval reference 18022, August 8, 2018). This protocol adheres to the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) Statement. All methods were carried out in accordance with relevant guidelines and regulations. All patients provided written consents for the study.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

This study was supported by the Daiwa Securities Health Foundation. The funder had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Author's contributions

YK, MH, YS, and HS made substantial contributions to study conception and design. YK, MT, SO, and KK contributed to data acquisition. YK, MH, YS, SO HK and HS contributed to data analyses and interpretation. MH, YS, HK, and HS contributed to the drafting of the manuscript. YK, MT, SO, KY, ST, YM, KM, KK, KO, MH, YS, HK, and HS critically revised the manuscript. All authors read and approved the final manuscript.

Acknowledgments

We thank Dr. Kiyomi Shimoda, Dr. Takeo Togo, and Dr. Jun Atsumi for their advice. We also thank Dr. Kelly Zammit, BVSc, from Edanz Group (<https://en-author-services.edanz.com/ac>) for editing a draft of this manuscript.

Authors' information

¹Department of Clinical Mycobacteriosis, Nagasaki University Graduate School of Biomedical Sciences, 1-12-4 Sakamoto, Nagasaki, Nagasaki 852-8523, Japan

²Respiratory Care and Rehabilitation Center, Fukuji Hospital, Japan Anti-Tuberculosis Association, Kiyose, Tokyo, Japan

³Section of Chest Surgery, Fukuji Hospital, Japan Anti-Tuberculosis Association, Kiyose, Tokyo, Japan

⁴Respiratory Disease Center, Fukuji Hospital, Japan Anti-Tuberculosis Association, Kiyose, Tokyo, Japan

References

1. Griffith DE, Akshay T, Brown-Elliott BA, Catanzaro A, Daley C, Gordin F, Holland SM, Horsburgh R, Huitt G, Iademaro MF *et al*: **An official ATS/IDSA statement: diagnosis, treatment, and prevention of nontuberculous mycobacterial diseases.** *Am J Respir Crit Care Med* 2007, **175**(4):367-416.
2. Quint JK, Millett ER, Joshi M, Navaratnam V, Thomas SL, Hurst JR, Smeeth L, Brown JS: **Changes in the incidence, prevalence and mortality of bronchiectasis in the UK from 2004 to 2013: a population-based cohort study.** *Eur Respir J* 2016, **47**(1):186-193.
3. Ringshausen FC, Rademacher J, Pink I, de Roux A, Hickstein L, Ploner T, Welte T, Diel R: **Increasing bronchiectasis prevalence in Germany, 2009-2017: a population-based cohort study.** *Eur Respir J* 2019, **54**(6).
4. Namkoong H, Kurashima A, Morimoto K, Hoshino Y, Hasegawa N, Ato M, Mitarai S: **Epidemiology of Pulmonary Nontuberculous Mycobacterial Disease, Japan.** *Emerg Infect Dis* 2016, **22**(6):1116-1117.
5. Asakura T, Yamada Y, Namkoong H, Suzuki S, Nijima Y, Kamata H, Funatsu Y, Yagi K, Okamori S, Sugiura H *et al*: **Impact of cavity and infiltration on pulmonary function and health-related quality of life in pulmonary Mycobacterium avium complex disease: A 3-dimensional computed tomographic analysis.** *Respir Med* 2017, **126**:9-16.
6. de Camargo AA, Boldorini JC, Holland AE, de Castro RAS, Lanza FC, Athanazio RA, Rached SZ, Carvalho-Pinto R, Cukier A, Stelmach R *et al*: **Determinants of peripheral muscle strength and activity in daily life in people with bronchiectasis.** *Phys Ther* 2018, **98**(3):153-161.
7. Kuroyama Y, Tabusadani M, Omatsu S, Shiraishi Y, Senju H: **Incremental Shuttle Walk Distance as an Indicator for Functional Exercise Capacity of Pre-Surgical Patients with Nontuberculous Mycobacterial Lung Disease.** *Tohoku J Exp Med* 2020, **250**(1):43-48.
8. Hiramatsu M, Shiraishi Y: **Surgical management of non-cystic fibrosis bronchiectasis.** *J Thorac Dis* 2018, **10**(Suppl 28):S3436-S3445.
9. Mitchell JD: **Surgical Treatment of Pulmonary Nontuberculous Mycobacterial Infections.** *Thorac Surg Clin* 2019, **29**(1):77-83.
10. Polverino E, Goeminne PC, McDonnell MJ, Aliberti S, Marshall SE, Loebinger MR, Murris M, Cantón R, Torres A, Dimakou K *et al*: **European Respiratory Society guidelines for the management of adult bronchiectasis.** *Eur Respir J* 2017, **50**(3).
11. Shiraishi Y: **Current status of nontuberculous mycobacterial surgery in Japan: analysis of data from the annual survey by the Japanese Association for Thoracic Surgery.** *Gen Thorac Cardiovasc Surg* 2016, **64**(1):14-17.
12. Diel R, Nienhaus A, Ringshausen FC, Richter E, Welte T, Rabe KF, Loddikenemper R: **Microbiologic Outcome of Interventions Against Mycobacterium avium Complex Pulmonary Disease: A Systematic Review.** *Chest* 2018, **153**(4):888-921.

13. Cavalheri V, Granger C: **Preoperative exercise training for patients with non-small cell lung cancer.** *Cochrane Database Syst Rev* 2017, **6**:Cd012020.
14. Cavalheri V, Burtin C, Formico VR, Nonoyama ML, Jenkins S, Spruit MA, Hill K: **Exercise training undertaken by people within 12 months of lung resection for non-small cell lung cancer.** *Cochrane Database Syst Rev* 2019, **6**:CD009955.
15. Nagamatsu Y, Maeshiro K, Kimura NY, Nishi T, Shima I, Yamana H, Shirouzu K: **Long-term recovery of exercise capacity and pulmonary function after lobectomy.** *J Thorac Cardiovasc Surg* 2007, **134**(5):1273-1278.
16. van der Leeden M, Balland C, Geleijn E, Huijsmans RJ, Dekker J, Paul MA, Dickhoff C, Stuiver MM: **In-Hospital Mobilization, Physical Fitness, and Physical Functioning After Lung Cancer Surgery.** *Ann Thorac Surg* 2019, **107**(6):1639-1646.
17. Vallilo CC, Terra RM, de Albuquerque AL, Suesada MM, Mariani AW, Salge JM, da Costa PB, Pego-Fernandes PM: **Lung resection improves the quality of life of patients with symptomatic bronchiectasis.** *Ann Thorac Surg* 2014, **98**(3):1034-1041.
18. Laboratories ATSCoPSfCPF: **ATS statement: guidelines for the six-minute walk test.** *Am J Respir Crit Care Med* 2002, **166**(1):111-117.
19. Fukuhara S, Bito S, Green J, Hsiao A, Kurokawa K: **Translation, adaptation, and validation of the SF-36 Health Survey for use in Japan.** *J Clin Epidemiol* 1998, **51**(11):1037-1044.
20. Jones PW, Quirk FH, Baveystock CM, Littlejohns P: **A self-complete measure of health status for chronic airflow limitation. The St. George's Respiratory Questionnaire.** *Am Rev Respir Dis* 1992, **145**(6):1321-1327.
21. Lee AL, Hill CJ, Cecins N, Jenkins S, McDonald CF, Burge AT, Rautela L, Stirling RG, Thompson PJ, Holland AE: **Minimal important difference in field walking tests in non-cystic fibrosis bronchiectasis following exercise training.** *Respir Med* 2014, **108**(9):1303-1309.
22. O'Donnell DE, Elbehairy AF, Berton DC, Domnik NJ, Neder JA: **Advances in the Evaluation of Respiratory Pathophysiology during Exercise in Chronic Lung Diseases.** *Front Physiol* 2017, **8**:82.
23. Togo T, Atsumi J, Hiramatsu M, Shimoda K, Morimoto K, Uchimura K, Shiraishi Y: **Residual Destructive Lesions and Surgical Outcome in Mycobacterium avium Complex Pulmonary Disease.** *Ann Thorac Surg* 2020.
24. Avery KNL, Blazeby JM, Chalmers KA, Batchelor TJP, Casali G, Internullo E, Krishnadas R, Evans C, West D: **Impact on Health-Related Quality of Life of Video-Assisted Thoracoscopic Surgery for Lung Cancer.** *Ann Surg Oncol* 2020, **27**(4):1259-1271.
25. Nugent SM, Golden SE, Hooker ER, Sullivan DR, Thomas CR, Jr., Deffebach ME, Sukumar MS, Schipper PH, Tieu BH, Moghanaki D *et al*: **Longitudinal Health-Related Quality of Life among Individuals Considering Treatment for Stage I Non-Small Cell Lung Cancer.** *Ann Am Thorac Soc* 2020.
26. Himbert C, Klossner N, Coletta AM, Barnes CA, Wiskemann J, LaStayo PC, Varghese TK, Jr., Ulrich CM: **Exercise and lung cancer surgery: A systematic review of randomized-controlled trials.** *Crit Rev Oncol Hematol* 2020, **156**:103086.
27. Oliveira C, Oliveira G, Gaspar I, Dorado A, Cruz I, Soriguer F, Quittner AL, Espildora F: **Depression and anxiety symptoms in bronchiectasis: associations with health-related quality of life.** *Qual Life Res* 2013, **22**(3):597-605.
28. Franks LJ, Walsh JR, Hall K, Morris NR: **Measuring airway clearance outcomes in bronchiectasis: a review.** *Eur Respir Rev* 2020, **29**(156).
29. Herrero-Cortina B, Vilaró J, Martí D, Torres A, San Miguel-Pagola M, Alcaraz V, Poverino E: **Short-term effects of three slow expiratory airway clearance techniques in patients with bronchiectasis: a randomised crossover trial.** *Physiotherapy* 2016, **102**(4):357-364.
30. Basavaraj A, Segal L, Samuels J, Feintuch J, Feintuch J, Alter K, Moffson D, Scott A, Addrizzo-Harris D, Liu M *et al*: **Effects of Chest Physical Therapy in Patients with Non-Tuberculous Mycobacteria.** *Int J Respir Pulm Med* 2017, **4**(1).

Tables

Table 1. Demographics of the 35 patients who underwent lung resection.

Variable	Value
Age (years)	54.8 ± 14.5
Female sex	29 (83%)
BMI (kg/m ²)	19.4 ± 2.4
Smoking status (never/former)	26/9
Disease duration ^a (months)	25 (12-82)
Current treat duration ^b (months)	11 (5-21)
Sputum culture	
<i>Mycobacterium avium</i> complex	27 (77%)
<i>Mycobacterium abscessus</i> complex	5 (14%)
<i>Mycobacterium kansasii</i>	2 (6%)
<i>Mycobacterium paraense</i>	1 (3%)
Preoperative sputum status positive	16 (46%)
Disease type	
Nodular-bronchiectatic	17 (48%)
Fibrocavitary	4 (11%)
Both	18 (51%)
Affected segments ^c	3 (1 - 5)
Disease extent	
	20 (57%)
Extensive	15 (43%)
Clinical symptoms	
hemoptysis	1 (2%)
cough	14 (40%)
sputum	13 (37%)
fever	1 (2%)
none	15 (43%)
Pulmonary function test	
FEV ₁ (L)	2.2 ± 0.5
FEV ₁ % predicted	89 ± 16
FVC (L)	2.7 ± 0.6
FVC % predicted	90 ± 15
mMRC	0 (range 0-1)

Data are reported as mean ± standard deviation, n (%), and median (interquartile range).

BMI, body mass index; FEV₁, forced expiratory volume in 1s; FVC, forced vital capacity; mMRC, modified Medical Research Council dyspnea scale.

a: Interval between the diagnosis of the disease and the time of surgery.

b: Interval between the start of the current treatment and the time of surgery.
c: Number of segments with irreversible lung damage.

Table 2. Comparison of baseline HRQOL between patients with preoperative clinical symptoms (-) and those without preoperative clinical symptoms (+).

Variable	Clinical symptoms (-) n = 15	Clinical symptoms (+) ^a n = 20	p value
SGRQ score			
Symptom	16.2 (8.8–22.9)	34.8 (23.6–56.2)	< 0.01
Activity	12.2 (0–29.6)	21.4 (12–41.7)	0.02
Impact	10.8 (5.9–20.6)	22.9 (10.3–34.7)	0.08
Total	13.2 (6.7–22.7)	27.7 (13.6–37.5)	< 0.01
SF36v2			
PCS	54.2 (52.5–56.0)	49.7 (33.9–54.9)	0.04
MCS	53.8 (45.2–58.4)	47.2 (38.4–54.2)	0.16

Data are reported as interquartile range. HRQOL, health-related quality of life; SGRQ, St. George's Respiratory Questionnaire; SF36v2, Short-Form 36 Health Survey Questionnaire; PCS, physical component summary; MCS, mental component summary.

a: Patients with cough, sputum, hemoptysis and fever at preoperative.

Table 3. Surgical outcomes.

Operation	n = 35
Surgical procedure	
Lobectomy	17 (49%)
Segmentectomy	8 (23%)
Bilobectomy	2 (6%)
Combined resection	7 (20%)
Right upper lobe + right S6	1
Right middle lobe + right S6	1
Left lower lobe + lingulectomy	4
Right upper and middle lobe + right S6	1
Pneumonectomy	1 (2%)
Surgical approach	
Video-assisted thoracic surgery	32 (91%)
Thoracotomy	3 (9%)
Postoperative hospital stay (days)	11 (9–17)

Data are reported as n (%) and median (interquartile range).

Table 4. Physical function and HRQOL from preoperatively to 6 months postoperatively for the 32 patients who completed the follow-up.

Variable	Preoperative	Six months postoperative	<i>p</i> value
6MWT, m	545.4 ± 51.8	583.5 ± 57.5 ^a	< 0.01
Dyspnea - Borg scale	2 (0.5-4)	3 (2-4)	0.02
Leg fatigue - Borg scale	1 (0.5-3)	2 (2-4)	0.59
SGRQ score			
Symptom	23.6 (16.2-43.7)	27.0 (11.8-47.3)	0.46
Activity	17.5 (5.3-35.6)	32.6 (11.5-48.3)	< 0.01
Impact	16.8 (8.4-29.3)	12.1 (7.0-23.4)	0.28
Total	20.7 (9.6-28.8)	20.6 (12.3-32.5)	0.56
SF36v2			
Physical functioning	50.6 (39.8-54.2)	47.0 (33.5-54.2)	0.2
Role limitation-physical	55.7 (39.1-55.7)	45.8 (39.1-55.7)	0.24
Bodily pain	61.7 (44.7-61.7)	54.6 (44.7-54.6)	0.11
General health	44.2 (36.2-52.2)	46.9 (39.5-51.5)	0.01
Vitality	49.8 (43.4-59.5)	53.0 (46.6-59.5)	0.1
Social functioning	50.6 (31.2-57)	57.0 (44.1-57.0)	0.02
Role limitation-emotional	56.1 (43.6-56.1)	56.1 (40.5-56.1)	0.54
Mental health	51.8 (43.8-57.2)	55.8 (46.5-59.9)	0.03
PCS	53.0 (38.9-55.5)	46.1 (37.7-54.0)	0.04
MCS	52.8 (41.5-57.2)	55.3 (49.5-59.6)	< 0.01

^aThirty-one patients did not complete the functional test at 6 months postoperatively.

Data are reported as mean ± standard deviation and median (interquartile range).

HRQOL, health-related quality of life; 6MWT, 6-minute walk test; SGRQ, St. George's Respiratory Questionnaire; SF36v2, Short-Form 36 Health Survey Questionnaire; PCS, physical component summary; MCS, mental component summary.

Table 5. Relationship between the change in HRQOL and preoperative clinical symptoms at 6 months postoperatively.

Variable	Clinical symptoms (-) n = 14			Clinical symptoms (+) ^a n = 18		
	Preoperative	Six months postoperative	<i>p</i> value	Preoperative	Six months postoperative	<i>p</i> value
SGRQ score						
Symptom	15.2 (8.5–19.9)	16.0 (10.5–35.1)	0.55	38.2 (23.6–58.3)	32.6 (16.2–52.4)	0.18
Activity	9.0 (0–29.8)	24.2 (6.0–43.2)	0.03	21.4 (10.4–43.3)	36.1 (11.9–55.6)	0.03
Impact	12.2 (7.7–21.1)	8.7 (7.1–18.1)	0.92	22.9 (9.5–34.5)	16.6 (3.9–27.5)	0.2
Total	12.1 (6.7–22.8)	14.6 (7.3–28.0)	0.25	27.7 (12.0–35.2)	26.9 (16.1–37.9)	0.88
SF36v2						
Physical functioning	52.4 (47.0–57.8)	50.6 (47.0–57.8)	0.75	47.0 (36.2–55.1)	41.6 (31.7–54.2)	0.2
Role physical	55.7 (51.6–55.7)	54.1 (42.4–55.7)	0.12	44.1 (31.7–55.7)	42.4 (31.7–55.7)	0.65
Bodily pain	61.7 (61.7–61.7)	54.6 (52.1–61.7)	0.23	51.5 (44.7–61.7)	47.0 (44.6–54.6)	0.17
General health	50.9 (40.5–55.5)	46.9 (38.6–56.7)	0.42	41.0 (35.1–46.1)	45.6 (40.9–49.5)	< 0.01
Vitality	49.8 (43.4–60.3)	54.7 (45.8–59.5)	0.1	49.8 (39.4–57.1)	51.4 (46.6–59.5)	0.09
Social functioning	57.0 (37.7–57.0)	57.0 (50.6–57.0)	0.06	37.7 (24.8–57.0)	50.6 (37.7–57.0)	0.09
Role emotional	56.1 (49.8–56.1)	56.1 (46.7–56.1)	0.93	49.8 (39.4–56.1)	43.6 (35.3–56.1)	0.35
Mental health	53.2 (46.5–59.9)	57.2 (46.5–57.9)	0.29	51.8 (43.1–55.2)	53.2 (46.5–59.9)	0.04
PCS	54.0 (50.2–55.6)	48.8 (43.3–56.0)	0.18	47.4 (33.2–54.8)	38.0 (28.1–51.5)	0.09
MCS	55.1 (46.0–58.9)	55.3 (48.9–58.5)	0.16	47.2 (40.0–54.2)	55.3 (49.0–59.7)	< 0.01

Data are reported as interquartile range, and expressed as wilcoxon rank sum test.

HRQOL, health-related quality of life; SGRQ, St. George's Respiratory Questionnaire; SF36v2, Short-Form 36 Health Survey Questionnaire; Role physical, role limitation due to physical problems; Role emotional, role limitations due to emotional problems; PCS, physical component summary; MCS, mental component summary.
a: Patients with cough, sputum, hemoptysis and fever at pre-operative.

Figures

Figure 1

Study flowchart illustrating patient inclusion and exclusion.