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Original Article

22 years of surgical experience in non-cystic fibrosis bronchiectasis; what has changed in the last 10 years?

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ABSTRACT

Background: This study was conducted to examine the change and results of our experience in bronchiectasis surgery.

Materials and Methods: The records of the patients who were operated for bronchiectasis between January 2000 and January 2022 were analyzed retrospectively. Patients were grouped according to the time of surgery (Group I: Jan 2000- Jan 2012 vs. Group II: Jan 2021- Jan 2022) and surgical approach (thoracoscopy vs. thoracotomy). Demographic and clinical characteristics of the patients, localization of bronchiectasis, surgical interventions and postoperative follow-up results were recorded and analyzed using SPSS 25.

Results: A total of 220 operations were performed. Eighty-six patients (39.1%) were male, mean age was 34.89 ±12.68 years. Bronchiectasis was mostly located in the lower lobes (55.9%). The most frequently performed resection was left lower lobectomy (44.5%). The mean tube extraction time was 4.78 ± 4.13 days, and the mean length of hospital stay was 5.88 ± 3.18 days. Patients who underwent thoracoscopy had significantly shorter hospital stays and lower complication rates compared to those who underwent thoracotomy ($p = 0.001$ and $p = 0.004$, respectively). Patients operated on in the last 10 years (Group II) had significantly fewer complications compared to those operated in the earlier 12-year period (Group I) ($p = 0.028$). Multiple logistic regression analysis revealed that VATS reduced the complication rates by 82.5%. No surgical mortality was observed, and the overall morbidity rate was 26.8%.

Conclusions: Bronchiectasis surgery is very beneficial in patients who do not respond to medical treatment. Due to the effects of developing technology and experience gained, successful results have been achieved with minimally invasive approaches in recent years.

Keywords: videothoracoscopy, non-cystic fibrosis bronchiectasis, thoracotomy, logistic regression

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Introduction

Bronchiectasis is a progressive disease that develops as a result of impaired mucociliary clearance, accompanied by abnormal obstruction or dilatation in the bronchi, often due to chronic persistent infections [1]. Patients commonly present with cough, purulent sputum, halitosis, dyspnea, chest pain or recurrent episodes of hemoptysis. The primary goals of treatment are to prevent exacerbations, relieve symptoms, improve quality of life and halt disease progression [2].

Surgical intervention is considered a highly effective treatment option for patients with localized disease or those unresponsive to medical therapy [3]. In recent years, with advances technology, the use of video-assisted thoracoscopic surgery (VATS) in the treatment of bronchiectasis has become increasingly widespread. VATS is often preferred due to its association with improved patient comfort and acceptable complication rates and shorter hospital stays [4].

Although thoracotomy remains a well-established approach in bronchiectasis surgery and has been widely discussed in the literature, studies directly comparing thoracotomy with minimally invasive methods such as VATS are still relatively limited.

In this study, we aimed to present our surgical experience in the management of bronchiectasis, highlight the evolution of our perioperative approach, and evaluate the clinical outcomes of VATS and thoracotomy over a 22-year period.

Materials and Methods

The medical records of patients who underwent surgery for bronchiectasis at our thoracic surgery clinic between 1st January 2000 and 1st January 2022 were retrospectively reviewed. A total of 223 operations were performed. Two patients with cystic fibrosis who were operated for massive hemoptysis and one patient with a positive sweat test were excluded. The final study cohort included 220 patients.

To assess the clinical effects of the surgical approaches, patients were divided into two groups: those who underwent thoracotomy and those who underwent video-assisted thoracoscopic surgery (VATS). In a secondary analysis, patients were grouped based on the time of surgery: those operated on during the last 10 years (Jan 2012-Jan 2022) and those operated on in the preceding decade (Jan 2000-Jan 2012) to reveal how clinical experience was reflected in the results.

All patients were diagnosed based on high resolution computed tomography (HRCT) following detailed medical history and physical examination findings. Surgical treatment requirements were evaluated in the council held jointly with the pulmonologists. In the preoperative period, complete blood counts, biochemical parameters and pulmonary function tests (PFTs) were observed in all patients. In our clinic, attention was paid to ensure that the FEV1 (Forced expiratory volume in the first second) value was above 2L in patients who were planned for pneumonectomy, and lobectomy was avoided below 1.5L FEV1 level.

Indications for surgery included localized disease unresponsive to adequate medical treatment, hemoptysis, infections requiring hospitalization, and a history of more than three infections per year. In cases presenting with massive hemoptysis, embolization was the preferred initial intervention; elective surgery was scheduled once bleeding was controlled.

Patients with adequate functional capacity, as determined by radiological findings and PFTs were deemed eligible for surgery. Particularly over the past 10 years, patients with systemic symptoms underwent surgery after treatment of acute exacerbations. Routine sputum culture was taken from asymptomatic patients 2-4 weeks before the operation. Flexible/rigid bronchoscopy was performed in patients when deemed necessary, and sputum acid-fast bacilli (AFB) testing was studied. Among patients treated prior to 2012; sputum cultures were taken only if symptoms were present in the preoperative period. Antibiotic therapy was initiated two weeks prior to surgery based on culture results.

Surgical approaches included posterolateral thoracotomy or biportal VATS via the 4th and 7th intercostal spaces were preferred as incisions. The extent of resection -wedge resection, segmentectomy, lobectomy or pneumonectomy- was determined by disease severity. All patients were monitored in the surgical intensive care unit for 24 hours postoperatively before being transferred to the ward. Postoperative histopathological confirmation of bronchiectasis was obtained in all patients.

Patients were scheduled for outpatient follow-up on the 10th day after discharge. Subsequent annual check-

ups were conducted by pulmonologists. Clinical status and symptoms were documented during follow-up visits or by telephone interviews. The study was approved by the Ethics Committee of the Uludağ University Experimental Medicine Research Institute (2011-KAEK-26/553).

Statistical Analysis

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) for Windows version 25.0. The Shapiro Wilk test was used to assess normality of distribution. A p-value of <0.05 was considered statistically significant. Normally distributed variables were analyzed using Student's t-test, while non-normally distributed variables were using the Mann-Whitney U test. Categorical variables were compared using the chi-square test. When interpreting the results, p value <0.05 was considered statistically significant with a 95% confidence interval (CI). Preoperative deaths occurring within 90 days were classified as surgical mortality.Logistic regression analysis was used to identify independent risk factors for postoperative. In the logistic regression analysis, the postoperative complication was taken as the dependent variable and gender, age, FEV1 levels, VATS, pneumonectomy, presence of frequent infections, hemoptysis, cough and sputum as independent variables.

Results

The surgical outcomes and perioperative data of 220 patients who underwent bronchiectasis surgery were analyzed to assess the impact of different surgical approaches and changes over time.

Eighty-six of the patients (39.1%) were male, with a mean age was 34.89 ± 12.68 years. The mean duration of chest tube drainage was 4.78 ± 4.13 days, and the mean length of hospital stay was 5.88 ± 3.18 days. Histopathological examination confirmed the diagnosis of bronchiectasis in all resected specimens.

The most common symptoms were cough and sputum (66.4%), while 28.2% of patients underwent surgery due to hemoptysis. A history of infections (≥3 per year) was present in 39.1% of patients (Table 1). Bronchiectasis was mostly located in the lower lobes (55.9%) and in the left lung (51.4%), with bilateral disease observed in 25% of cases. Bilateral surgical intervention was performed in 9.4% of the patients (Table 1).

Table 1. Demographic data of the patients.

Age (Mean±SD) (Min-max)	34.89±12.68(11-69)
0-17 n (%)	16(7.3)
18-40	133(60.5)
41-64	70(31.8)
>65	1(0.5)
Gender	n(%)
Male	86(39.1)
Female	134(60.9)
FEV1 (L) (Mean±SD)	2.35±0.80
FEV1 (%)	75.19±19.93
DLCO (%)	75.65±13.59
Affected side	n(%)
Left	113(51.4)
Right	32(39.2)
Bilateral	55(9.4)
Symptoms	n(%)
Recurrent infection	86(39.1)
Cough, sputum	146(66.4)
Hemoptysis	62(28.2)
Childhood pneumonia attacks	31(14.09)
Smoking history	n(%)
Yes	55(25)
No	165(75)

Abbrev.; FEV1: Forced expiratory volume in 1 second, DLCO: Diffusing capacity of the lungs for carbon monoxide

While the patients were preparing for the operation in the preoperative period, flexible/rigid bronchoscopy was performed to detect the bleeding focus in 15 patients who presented with the complaint of hemoptysis and had bilateral bronchiectasis on thorax CT. One patient with AFB positivity was operated after antituberculosis treatment. Emergency thoracotomy and right lower lobectomy were performed in one patient due to massive hemoptysis. Other patients with hemoptysis were operated under elective conditions after the bleeding was stopped with medical treatment or embolization.

Thoracotomy was performed in 166 patients (75.7%), and VATS in 54 patients (24.3%), with conversion to thoracotomy required in six patients due to pleural adhesions (n = 4) or vascular injury (n = 2). In the last two years, all 18 VATS cases were completed successfully without conversion.

The most frequently performed procedure was lobectomy (79.1%), particularly left lower lobectomy. Pneumonectomy was required in nine patients (Table 2). Completion resections were performed in seven patients due to recurrence or progression. No perioperative or 90-day mortality was observed; late mortality occurred in seven patients, three of whom died due to pneumonia.

Table 2. Surgical data of the patients.	
Surgical Technique	n(%)
Thoracotomy	172(78.2)
VATS	48(21.8)
Conversion to thoracotomy from VATS	6(2.7)
Comorbidity	63(28.6)
Asthma	19(8.6)
Hypertension	15(6.8)
Diabetes	14(6.4)
İmmotile Cilia Syndrome	10(4.5)
COPD	3(1.4)
CAD	3(1.4)
Other	12(5.4)
Complication	62(26.8)
PAL	23(37.10)
Expansion deficit	9(14.52)
Hematoma	5(8.06)
Pneumothorax	3(4.84)
Atelectasis	10(16.13)
Pneumonia	6(9.68)
Surgical site infection	4(6.45)
Empyema, BPF	2(3.22)
Drain removal, day	4.78±4.13(1-40)
Hospitalization, day	5.88±3.18(3-23)
90 day mortality	0(0)
Late mortality	7(%3.2)
Postoperative complaints	
None	164(74.5)
Lessened	47(21.4)
Recurrence	9(4.1)

Abbrev.; COPD: Chronic obstructive pulmonary disease, CAD: Coronary Artery Disease, PAL: Prolonged air leak; persists for more than 5 days postoperatively, BPF: Bronchopleural fistula

Postoperative complication rates of the patients are presented in Table 3. Bronchoscopy was performed in cases with secretion-related atelectasis. Five patients required surgical exploration for hematoma.

Drain extraction times and hospital stays of patients who underwent resection with thoracotomy and patients who underwent resection with VATS were compared. Patients undergoing VATS had significantly shorter hospital stays (4.8 ± 1.8 vs. 6.2 ± 3.4 days, p = 0.001) and chest tube durations (3.3 ± 1.4 vs. 5.3 ± 4.6 days, p < 0.001), and lower complication rates (p = 0.004) compared to thoracotomy (Table 4).

Since 2012, a total of 106 bronchiectasis operations have been performed. During the preoperative preparation period, 41 patients with acute exacerbations were referred to the pulmonology department for treatment. Among 65 asymptomatic patients tested preoperatively, sputum culture positivity was detected in 27 cases (41.54%). Pseudomonas aeruginosa was isolated in 10 patients, while Haemophilus influenzae was identified in 9 patients. Following targeted antimicrobial therapy, no postoperative complications were observed in these patients, except for one case of prolonged air leak.

Compared to the earlier decade, the last 10 years showed significantly improved outcomes, with shorter chest tube durations (p = 0.013) and reduced complication rates (p = 0.028) (Table 5).

Table 3. Frequency distribution table of the resection characteristics of the patients.	
Resection	n(%)
Wedge	9(4.1)
Segmentectomy	16(7.3)
Lobectomy	186(84.5)
Pneumonectomy	9(4.1)
Lung resection type	
LLL1	98(44.5)
LUL2	7(3.2)
RUL3	11(5)
RML4 / LML5	39(17.7)
RLL6	19(8.6)
LP7	7(3.2)
RP8	2(0.9)
Segmentectomy	16(7.3)
Wedge	9(4.1)
Bilobectomy	12(5.5)

1: Left lower lobectomy, 2: Left upper lobectomy, 3: Right upper lobectomy, 4: Right middle lobectomy, 5: Left middle lobectomy, 6: Right lower lobectomy, 7: Left pneumonectomy, 8: Right pneumonectomy

Table 4. Comparison of patients by surgical technique.			
	VATS (n=48)	Thoracotomy (n=172)	p
Age, year (Mean±SD)	34.69±13.47	34.95±12.49	0.81
Gender, n(%)	15(31.25)	71(41.28)	0.21
FEV1 (L) (Mean±SD)	2.32±0.86	2.40±0.75	0.69
FEV1 (%)	79.13±19.26	72.47±20.10	0.11
DLCO (%)	76.33±12.57	74.71±15.14	0.66
Resection	n(%)	n(%)	
Wedge	1(2.1)	8(4.7)	
Segmentectomy	5(10.4)	11(6.4)	
Lobectomy	42(87.5)	144(83.7)	0.56
Pneumonectomy, n(%)	0(0.0)	9(5.2)	
Comorbidity	19(39.5)	44(25.6)	0.045
Smoking	10(20.8)	45(26.2)	0.29
Complication	6(12.5)	56(32.56)	0.004*
Drain removal, day(Mean±SD)	3.3±1.37	5.25±4.6	0.001*
Hospitalization, day(Mean±SD)	4.8±1.8	6.2±3.4	0.001*

Table 5. Last 10 years of experience vs. previous years.

	First 12 years (n=114) (Group I)	Last 10 years (n=106) (Group II)	P
Age (Mean±SD)	34.1±11.8	35.7±13.6	0.48
Gender, n (%)	50(43.9)	36(33.96)	0.086
FEV (L) (Mean±SD)	2.29±0.95	2.38±0.72	0.54
FEV1 (%)	68.26±19.60	78.66±19.32	0.03*
DLCO (%)	75±5.65	75.7±13.84	0.94
Surgical Technique	n(%)	n(%)	
Thoracotomy VATS Conversion to thoracotomy	113(99.1) 1(0.9) 0(0.0)	59(55.7) 47(44.3) 6(5.7)	0.001*
Resection	n(%)	n(%)	
Wedge Segmentectomy Lobectomy Pneumonectomy	7(6.1) 7(6.1) 93(81.6) 7(6.1)	2(1.9) 6(4.7) 93(87.7) 2(1.9)	0.16
Complications, n (%)	39(34.2)	23(21.7)	0.028*
Drain removal, days (Mean±SD)	4.96±3.1	4.63±4.85	0.013*
Hospitalization (Mean±SD)	6.03±3.1	5.75±3.3	0.1
Mortality, n (%)	7(6.1)	0	0.01*
Postop symptoms	n(%)	n(%)	
None Lessened Recurrence	82(71.9) 26(22.8) 6(5.3)	82(77.4) 21(19.8) 3(2.8)	0.28

The sweat test performed in the preoperative period was negative in all patients in the pediatric age group. Ten patients (4.5%) were diagnosed with immotile cilia syndrome, including eight with Kartagener's syndrome. Although their complication rates were higher, the difference was not statistically significant (p = 0.091). Drain removal times and hospital stays were comparable to those without the syndrome.

Considering the changes in postoperative patient symptoms; 74.5% of patients became asymptomatic, and 21.4% had partial symptom improvement. However, recurrence occurred in nine patients, seven of whom underwent completion surgical procedures (pneumonectomy or lobectomy).

Factors affecting postoperative complications were examined. The independent variables: based on a multiple logistic regression analysis, where independent variables were gender, age, FEV1, VATS, pneumonectomy, frequent knowledge of the etiology, hemoptysis attacks, productive cough and abundant purulent sputum, the odds of postoperative complications were 82.5% lower in those who underwent VATS than in those who did not (R = 0.192, p = 0.005, nagelkerke R = 0.281). The patients who had frequent infections were 4.3 times more likely to have postoperative complications with those who did not (R = 0.192, p = 0.021, Nagelkerke R = 0.281).

Discussion

Bronchiectasis is a disease that occurs as a result of the effects of infectious, congenital, acquired, autoimmune or environmental causes, often as an irreversible result of histopathological changes [5]. This disease, which significantly reduces a person's quality of life, is an important public health problem in developing countries, including Turkey [1]. As reported in our cohort, two-thirds of patients presented with chronic cough and sputum, while nearly one-third required surgery for hemoptysis, mirroring previous series [6].

The main goals in the treatment of non-cystic fibrosis bronchiectasis; involves identifying acute exacerbations, using antibiotics to suppress microbial load, treating underlying disorders, reducing excessive inflammatory response, maintaining bronchial hygiene, controlling hemoptysis, and surgical removal of segments that may be a focus of infection or bleeding [7]. In our clinic, surgical treatment decisions were made in a joint council with chest diseases in patients who could not respond to medical treatment in line with these goals. In our multidisciplinary council, surgery was reserved for patients experiencing ≥3 pneumonia episodes per year, recurrent hospitalizations, hemoptysis, or persistent symptoms despite optimal medical therapy.

As it is known, bronchiectasis is one of the most common causes of life-threatening hemoptysis. In recent years, the primary treatment is bronchial artery embolization. Success rates reaching 99% in the acute period have been reported in the literature [8]. In our clinic, the first option after medical treatment is embolization therapy in patients who apply for massive hemoptysis due to bronchiectasis. The operations were performed under elective conditions, since acute massive hemorrhage could be relieved in most of our patients after embolization. In our series, there is only one patient who underwent emergency thoracotomy due to massive hemoptysis.

In this study an important difference in the preoperative preparation period is that sputum cultures, which were previously taken only in symptomatic patients, are

now also taken in asymptomatic patients as much as possible, and antibiotherapy is applied to these patients in the preoperative period at the treatment dose specific to the isolated pathogen. The purpose here is to ensure a 'dry period' before surgery for optimal surgical success. Therefore, surgical treatment may be delayed until infection control is optimized [9]. In our study, we found that asymptomatic patients with sputum culture positivity and patients with frequent infections were positively correlated. Moreover, multiple logistic regression analysis demonstrated that a history of frequent infections independently increased the odds of postoperative complications by 4.3-fold (OR = 4.3, p = 0.021). For this reason, we think that sputum cultures should be routinely taken in patients with a history of frequent infections, even if they do not have any symptoms during the preoperative preparation period. As a matter of fact, in the study by Hiramitsu et al, it is reported that pseudomonas colonization increases the risk of surgical morbidity [10]. Also in the study by Yu-xing Jin et al, it is reported that gram-negative bacteria colonization is risk factor for successful treatment [11]. Another study emphasizing that bacterial colonizations should be clarified in the preoperative period was by Eren et al. This study states that one of the risk factors for postoperative complications is the lack of bronchoscopy in the preoperative period [12].

In our study, we observed that postoperative complication rates significantly decreased in the last decade compared to the earlier years (26.4%-17.0%, p = 0.028), along with shorter chest tube durations (5.3 ± 4.6 days-4.1 ± 2.2 days, p = 0.013). However, a direct year-by-year comparison for the entire 22-year period is limited by the lack of standardized preoperative protocols during the first decade. For example, routine sputum culture sampling in asymptomatic patients was not implemented in the early years, making direct comparisons with the later period less reliable. Since 2012, the adoption of standardized preoperative preparation - including routine sputum cultures and targeted antibiotic therapy - as well as the increased use of VATS, appears to have contributed substantially to these improved outcomes.

Surgical mortality has been reported very rarely in the literature [6, 13-16]. In our study, as in the study of Gülhan et al, no mortality was observed within the postoperative 90 days [1]. The early complications that can be seen after the surgical treatment of bronchiectasis may vary depending on whether the patient is adequately prepared for the operation in the preoperative period, comorbidities, perioperative performance and the extent of the resection performed, and the quality of the follow-up and treatment applied in the postoperative period. As in all thoracic surgical interventions, atelectasis, hemothorax, prolonged air leakage, pneumonia, wound infection, bronchopleural fistula, empyema, expansion defect, pleural effusion, chylothorax and cardiac rhythm disorders can be seen in patients after bronchiectasis surgery. Morbidity rates have been reported in the range of 0-25% in studies [17]. In our study, this rate was found to be 26.4%. The most important reason why morbidity is above the literature data is that the most common complication in our study, prolonged air leak, was not 7 days, unlike other studies; It is accepted after 5 days. However, there has been a statistically significant decrease in our complication rates in the last 10 years. Undoubtedly, increasing surgical experience has a great importance in this.

In addition, with the developments in VATS in recent years, we can say that the complication rates are gradually decreasing due to the fact that VATS is preferred more and more in major surgical procedures in our clinic. According to the literature, VATS is considered advantageous due to its low morbidity and mortality rates, rapid recovery, early relief of postoperative pain and cosmetic results [9, 16]. However, the effect of thoracotomy on postoperative morbidity was not investigated in these studies. In this respect, our study emphasizes an important point.

This study has some limitations. Although we have analyzes covering a long period of 22 years; this study was conducted retrospectively. Since detailed files could not be reached in hospital records due to its long duration, investigation of etiology and comorbidities was incomplete. In addition, since an objective scoring system cannot be used to determine the quality of life of the patients, long-term postoperative assessments are based on subjective data.

In conclusion, this study shows that; in the surgical treatment of bronchiectasis; thoracotomy is an important reason that increases the risk of complications. We think that VATS is a very safe method due to its low mortality and morbidity rates and should be preferred in every possible patient. We also recommend routinely obtaining sputum cultures from all asymptomatic patients to detect colonizations and reduce the risk of complications. This study also supports the literature; it reveals that surgical treatment is very effective for a curative outcome in bronchiectasis patients, however,

the surgery must be performed as anatomical lung resection. And, this study also highlights that clinical experience and effective preoperative patient preparation can be as effective as the minimally invasive approach at low complication rates.

Declaration of conflicting interests

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Ethics approval

The study was approved by the Ethics Committee of the Uludağ University Experimental Medicine Research Institute (2011-KAEK-26/553).

Authors' contribution

GT; Study design, data collection, statistical analysis, interpretation of data, manuscript writing, final approval of the version to be published, TES; Patient records management, ethics approval coordination, HM; Contribution to surgical cases, EY,EO; Patient follow-up, clinical data validation, NAAO; Statistical consultation, data modeling, AU; Data interpretation, literature review, CG; Operative technique design, critical revision of the manuscript, ASB; Critical revision of the manuscript, final approval of the version to be published

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