

Functional Results of Surgical Treatment of Bronchiectasis in a Developing Country

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BACKGROUND: The prevalence of bronchiectasis has decreased significantly over recent decades in developed countries. However, resection for bronchiectasis still plays an important part in thoracic surgery practice in developing countries such as Turkey. This study was designed to evaluate the outcomes of surgical treatment for bronchiectasis, particularly in aspects related to the effects on functional well-being.

PATIENTS AND METHOD: From January 1995 through December 2003, operations for bronchiectasis were performed in 81 patients. Demographic features, type of resection, and operative morbidity and mortality were evaluated. The outcomes related to overall "social" or nonpulmonary functional status were classified and compared according to a scale constructed to assess patients' well-being preoperatively and at the sixth postoperative month.

RESULTS: The mean age was 24.4 years and 47 patients (58%) were male. Surgical treatment was lobectomy in 37 (45%), pneumonectomy in 10 (12%), segmentectomy in 13 (16%), and lobectomy plus segmentectomy in 22 (27%) of the operations. Complete resection of disease was achieved in 69 patients (85%). There was no operative mortality. The rate of morbidity was 18.3%. Improvement to a functional status of excellent was observed in 81.7% and improvement to a status of good was seen in 12.7% of patients; 5.6% experienced no change. The results of complete resection were significantly better than those of incomplete resection ($P=.0015$).

CONCLUSION: Functional results of surgical treatment for bronchiectasis in this series suggest that the outcomes are favorable and promising, particularly in selected patients with sufficient pulmonary reserves and localized disease who are suitable for complete resection.

Key words: *Bronchiectasis. Surgery. Outcome assessment.*

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Resultados funcionales del tratamiento quirúrgico de las bronquiectasias en un país en vías de desarrollo

OBJETIVO: La prevalencia de las bronquiectasias ha disminuido significativamente durante los últimos decenios en los países desarrollados. Sin embargo, la resección quirúrgica de las bronquiectasias desempeña todavía un papel importante en la práctica de la cirugía torácica en los países en vías de desarrollo como Turquía. El presente estudio se ha diseñado para evaluar los resultados obtenidos con el tratamiento quirúrgico de las bronquiectasias, especialmente en lo que se refiere a sus efectos sobre el bienestar funcional de los pacientes.

PACIENTES Y MÉTODO: Entre enero de 1995 y diciembre de 2003 recibieron tratamiento quirúrgico debido a bronquiectasias 81 pacientes. Se evaluaron las características demográficas, el tipo de resección quirúrgica y la morbilidad y mortalidad operatorias. Los resultados relativos al nivel funcional global "social" o extrapulmonar se clasificaron y compararon con una escala creada para determinar el grado de bienestar de los pacientes antes de la intervención y a los 6 meses.

RESULTADOS: La edad media de los pacientes era de 24,4 años y 47 (58%) eran de sexo masculino. El tratamiento quirúrgico consistió en lobectomía en 37 (45%), neumonectomía en 10 (12%), segmentectomía en 13 (16%) y la combinación de lobectomía y segmentectomía en 22 (27%) de las intervenciones quirúrgicas. La resección completa se llevó a cabo en 69 pacientes (85%). No se produjo ningún fallecimiento a consecuencia de la cirugía. La tasa de morbilidad fue del 18,3%. Se observó mejoría hasta un estado funcional excelente en el 81,7% de los pacientes, así como mejoría hasta un estado funcional bueno en el 12,7%; en el 5,6% no se observaron cambios. Los resultados obtenidos con la resección completa fueron significativamente mejores que los conseguidos con la resección incompleta ($p = 0,0015$).

CONCLUSIÓN: Los resultados funcionales del tratamiento quirúrgico de las bronquiectasias obtenidos en esta serie de pacientes son favorables y prometedores, especialmente en pacientes seleccionados con una reserva pulmonar suficiente y con un proceso patológico localizado en quienes es posible la resección completa.

Palabras clave: *Bronquiectasias. Cirugía. Evaluación de resultados.*

Introduction

With improved health care, generalized use of antibiotics and of vaccines, and better control of tuberculosis, the incidence and severity of bronchiectasis have declined markedly. However bronchiectasis is still a major cause of morbidity and mortality in developing countries.^{1,4} Although the main difference between developed and developing countries lies in the prevention of the infectious causes of bronchiectasis, the availability of prompt medical treatment also favors avoidance of irreversible destruction of bronchial walls, known as bronchiectasis. It may be clear that contemporary management of bronchiectasis in highly developed countries does not need to consider surgical treatment as a cornerstone. Nevertheless, it has recently been suggested that clinical suspicion should be encouraged and that research activity on bronchiectasis should increase because this disease may be more prevalent than might be expected.⁵ Furthermore, it is also well known that when preventive and medical treatment approaches fail, bronchiectasis is a serious disease that can cause problems that are incompatible with a good quality of life.

In the context of many pulmonary disorders, quality of life is drawing more and more attention. It has been recommended that previously developed questionnaires be translated and validated for use in other communities.⁶ For example, recently, a Spanish version of St George's Respiratory Questionnaire was studied to assess its internal consistency and validity in stable bronchiectasis patients and the resulting instrument was reported to have excellent concurrent consistency.⁷ However, since there is no translated or original quality of life questionnaire for bronchiectasis in Turkish, we developed a surrogate scale for the present study with the aim of evaluating, before and after surgery, our patients' overall "social" functional status, incorporating aspects other than pulmonary function—specifically the ability to carry out professional/educational activities necessary for well-being.

The rationale for this study was an observational comment in our thoracic surgery section of a large respiratory diseases referral hospital that the ratio of resection for bronchiectasis to lung cancer surgery is 1:6. Given the frequency of this type of surgery in our practice setting, we considered it prudent to undertake a retrospective study of the outcomes of such surgery. The outcome measures were mortality and morbidity rates, as well as pulmonary and other functional results.

Patients and Method

From January 1995 through December 2003, therapeutic surgery was performed on 81 patients with bronchiectasis at the first department of thoracic surgery of the Chest Diseases and Thoracic Surgery Training Hospital in Izmir, Turkey. We obtained data retrospectively from computerized patient

records. The evaluated information for each patient consisted of a detailed history, physical examination, and results of mycobacterial and other bacterial cultures of sputum. The preoperative and postoperative (sixth month) pulmonary function tests were also compared when available. Thus, we were able to compare spirometric data for 64 patients, looking specifically at forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV₁). Of the patients with no spirometric data, the majority (88.2%) were children.

Radiologic information included chest radiographs and thoracic high-resolution computed tomography (HRCT) scans for all patients. Bronchoscopic findings were available for 63 patients (77.7%).

The indications for surgery were failure of medical therapy for pulmonary infection in 72 (88.8%), recurrent or massive hemoptysis in 7 (8.7%), and a nondiagnostic mass in 2 (2.5%) patients. Failure of medical treatment was defined as frequent exacerbations interfering with normal professional or social life, or requiring multiple hospitalizations.⁴ For patients reporting sputum production, chest physiotherapy and preoperative antimicrobial therapy were continued until the daily volume of sputum decreased to 50 mL or less.⁸ With the intention of timing the operation when tuberculosis was inactive, we performed elective surgery usually 6 months after the last positive sputum culture for acid fast bacilli and after completion of antituberculosis treatment. There were no cases of multidrug resistant tuberculosis.

Thoracotomy was performed in all patients. Segments and/or lobes that were apparently affected according to preoperative and perioperative assessments were resected. Complete resection was defined as an anatomic resection of all affected segments that were assessed preoperatively by HRCT and perioperative findings.^{4,9} If the resected lung area did not qualify as a complete resection, it was termed incomplete resection, i.e. a first resection for bilateral bronchiectasis patients in whom 2-stage operations were planned but were not undertaken either because of satisfactory results of the first resection or the patient's refusal. In a minority of the patients with disseminated bronchiectasis whose disease was predominantly in a well-defined part of the lung, limited resection might be performed to achieve symptom reduction when medical treatment failed.

Operative mortality was defined as a patient's death within 30 days after thoracotomy. All specimens had pathologic confirmation of bronchiectasis.

The duration of follow-up for each patient was calculated and the outcome of surgery according to social (non-pulmonary) functional status was assessed based on answers of yes or no to questions asked at the sixth postoperative month. The results were expressed on the scale constructed below:

- Excellent: marked improvement in social life and professional/school life after the operation, complete absence of preoperative symptoms that led to surgery.
- Good: improvement in social life and professional/school life after the operation, marked reduction in preoperative symptoms but needing antibiotic therapy occasionally.
- No change: no reduction in preoperative symptoms or social life, no decrease in hospital admissions or medical therapy requirements.
- Worse: frequent exacerbations of disease requiring hospitalization, worse professional or social life in comparison with preoperative condition.

All results were expressed and analyzed as means (SD) or medians and ranges, or absolute numbers and percentages. Fisher's exact test was used to compare parameters, and a *P* value less than .05 was considered statistically significant.

Results

The mean age of the 81 patients at the time of thoracotomy was 24.4 (12.0) years (range, 8-57 years). There were 47 (58%) male and 34 female patients. A total of 33 (40.7%) were pediatric patients (<16 years old). Mean duration between the onset of symptoms and surgery was 61.4 (77.1) months (range, 12-360 months). Symptoms were recurrent infections in 59 patients (72.8%), productive cough in 50 (61.7%), purulent sputum in 46 (56.7%), and hemoptysis in 16 (19.7%). Although all patients had received prior medical therapy, 58% of them had received antibiotics other than antituberculosis drugs (mean duration of 14.2 [6.4] days [range, 7-35 days]) just before the operation.

The most common etiology of bronchiectasis was found to be chronic respiratory infection (77.7%) (Table 1). Mixed bacterial flora, typical of the oropharynx, was common and *Streptococcus pneumoniae* was the most frequent pathogen in 7 (8.6%), followed by *Haemophilus influenzae* in 6 (7.4%), *Staphylococcus aureus* in 2 (2.5%), *Pseudomonas aeruginosa* in 2 (2.5%), and *Klebsiella pneumoniae* in 1 (1.2%) of the patients. Sputum became sterile in the postoperative period for all patients.

Bronchiectasis was unilateral in 68 patients (84%) and bilateral in 13 (16%). Saccular bronchiectasis was detected in 54 patients (67.6%). The locations of the areas of bronchiectasis are summarized in Table 2. The most common location was the left lower lobe (56.7%).

Thirty-seven patients (45.1%) had a lobectomy, 22 patients (26.8%) a combined lobectomy and segmentectomy, 13 patients (15.9%) a segmentectomy, and 10 patients (12.2%) a pneumonectomy (Table 3). Three patients in the segmentectomy subgroup had multiple segments removed with the aim of resecting only affected areas of different lobes.

Complete resection of all bronchiectasis was achieved in 69 patients (85%). Sixty-eight of 69 patients (99%) with unilateral involvement had complete resections. In contrast, 12 of 13 patients (92%) with bilateral involvement had incomplete resections (2 patients with disseminated bronchiectasis which predominated in a well-defined part of the lung).

The resection was classified as complete for only 1 of the 13 patients who had bilateral disease and had surgery on both lungs. Twelve patients had incomplete resections according to our criteria and all except 1 patient, who was lost, were followed postoperatively to determine whether further resection was indicated. In 7 of the 11 incomplete resection patients who were followed, no second operation was scheduled because of their reasonably good outcomes. The remaining 4 patients, to whom the second operation was suggested

TABLE 1
Etiological Factors in Bronchiectasis*

Cause	No. of Patients	%
Chronic respiratory infection	63	77.7
Tuberculosis	8	9.8
Foreign body aspiration	4	5
Congenital cystic malformation	2	2.5
Immunodeficiency (IgG, IgA)	2	2.5
Nondiagnostic mass	2	2.5
Total	81	100

*Ig indicates immunoglobulin.

TABLE 2
Location of Bronchiectasis

	Right Lung	Left Lung
Upper lobe	7	13
Middle lobe/Lingula	18	21
Lower lobe	15	46
Multilobar	7	10
Total	47 (37%)	80 (63%)

TABLE 3
Surgical Procedures

	Left Side No. of Patients	Right Side No. of Patients	Total, %
Pneumonectomy	10	—	10 (12.2)
Lobectomy	20	11	31 (37.8)
Double lobectomy	—	6	6 (7.3)
Lobectomy + segmentectomy	21	1	22 (26.8)
Segmentectomy	10	3	13 (15.9)
Total	61	21	82 (100)*

*One patient underwent staged thoracotomies.

based on their postoperative reassessment, did not give their consent.

There were no deaths in our series. Operative morbidity occurred in 15 patients (18.3%) and included prolonged air leak (longer than 7 days) in 7, pneumonia in 2, arrhythmias in 2, atelectasis requiring bronchoscopy in 5, and empyema in 1. The median duration of hospital stay was 15 days (range, 4-42 days).

The preoperative and postoperative pulmonary function tests available for 64 patients (79%) showed that most had a normal ventilatory pattern. In 15 patients (23%), a mixed obstructive-restrictive pattern was observed. Although there were slight decreases in FVC and FEV₁ after surgery, the differences were not statistically significant (*P*=.18) (Table 4).

Median follow-up, which was completed in 71 patients (87%), was 35 months (range, 10-96 months). According to the functional outcomes scale established, the status was excellent for 58 patients (81.7% of the 71 who were followed), good for 9 (12.7%), unchanged for 4 (5.6%), and worse for none. These results were found

TABLE 4
Spirometry Values Measured Before Surgery
and 6 Months Later*

	Preoperative		Postoperative	
	Liters	%	Liters	%
FEV ₁	2.3 (0.7)	75.0 (16.4)	2.2 (0.6)	74.1 (15.0)
FVC	2.9 (0.8)	78.0 (16.4)	2.9 (0.8)	77.8 (14.7)

*Differences were not significant. Values are means (SD). FEV₁ indicates forced expiratory volume in 1 second; FVC, forced vital capacity.

to be significantly better for patients having complete resections than for those having incomplete resections ($P=.0015$).

Discussion

In this study of 81 patients who underwent surgery for bronchiectasis, we found that complete resection of diseased tissue could be achieved in 69 patients with no operative mortality. Postoperative morbidity was low and outcome in terms of patients' overall functional status after surgery was excellent in the majority of cases.

Despite advances in thoracic surgery, the optimal treatment for bronchiectasis remains controversial.^{4,8,10} When medical treatment fails, the pneumologists working in our hospital tend to refer their bronchiectasis patients to a thoracic surgeon with the expectation of symptom reduction when there are persistent problems related to this chronic, irreversible disease.

In our study, the most common etiology of bronchiectasis was chronic respiratory infection, especially infections acquired in childhood as reported previously,^{1,4,8,10} even though some might argue that chronic infection is a result rather than a cause. Bronchiectasis has also been reported in an elderly immunocompetent patient in relation to *Flavimonas oryzihabitans*, a rare pathogen usually found in immunocompromised patients.¹¹ However, most cases of bronchiectasis in many parts of the world, especially in developing countries, are classified as idiopathic. Our finding of chronic infection in the medical histories of most of our patients seems to indicate the importance of taking childhood pulmonary infections seriously and treating them in a timely manner. In our series, the mean age was low and 40.7% of all patients were children. According to our results, success is higher in children and young people and it was possible to achieve low morbidity and no mortality in that group, possibly related to better compensation mechanisms in children.

Hemoptysis is generally mild in bronchiectasis. In 10% of patients, hemoptysis has been reported as severe, although it is rarely fatal.¹ We observed hemoptysis in 16 patients (20%). In our series, the rate of tuberculosis was 9.8% (8 patients) and 6 of those cases had severe hemoptysis.

Bronchoscopy is not a main diagnostic method for bronchiectasis, but it may be helpful in identifying and removing foreign bodies, for locating the site of bleeding in patients with hemoptysis, and for diagnosing narrowed bronchi or neoplasms.^{1,2,4,9,12,13} In our series, bronchoscopy was performed in 63 patients (77.7%), and in our opinion, it served as an essential tool for preoperative evaluation. It can also be useful for tracheobronchial cleaning when preparing selected patients for surgery.

The morphologic classification of bronchiectasis is cylindrical, varicose, or saccular (cystic).^{1,4,9} Pulmonary perfusion is retained in the area of cylindrical changes and therefore this type is not a primary indication for surgical management.³ According to our preference, the most suitable patients for surgery would be those with saccular bronchiectasis. In our series, saccular bronchiectasis was detected in 54 patients (67.5%).

The goals of surgical therapy for bronchiectasis are to improve the quality of life and to resolve complications such as empyema, severe or recurrent hemoptysis, and lung abscess. There is also consensus that, because bronchiectasis is a progressive disease, affected regions should be resected in a way that preserves uninvolved lung parenchyma, and early pulmonary resection while the disease is still localized is preferred.^{2,4,8,10,14} Medical treatment offers no chance for a cure, which is only possible with complete, anatomical resection of all affected segments, although such a cure remains impossible when there are systemic disorders (genetic, immunologic, etc). Most of our patients had localized disease and complete resection could be performed in 85% (n=69).

The principles accepted in our department for preparing for and carrying out successful surgery are as follows: the operation should be performed in a "dry period"; thorax CT or HRCT should be well interpreted, and all involved segments and/or lobes should be totally resected. According to our experience, the operative evaluation (atelectasis, depigmentation, crepitation, and dilatation of bronchi at palpation) in addition to preoperative CT findings are sufficient for determining all of the bronchiectatic areas. Bilateral disease does not constitute a contraindication to surgical therapy in selected patients.^{1,2,8,14} In keeping with suggested practice,¹ we initially operated on the side with the most severe disease, and surgery on the opposite side, if necessary, was tentatively considered for 2 to 3 months later. In our series, 13 patients (16%) had bilateral bronchiectasis. One procedure was on both lungs for bilateral disease and it was classified as a complete resection. The remaining patients underwent incomplete resections according to our criteria. In 7 of 11 patients who could be assessed postoperatively, we decided against performing the second operation since the outcomes were reasonably good; those patients therefore remained in the incomplete resection group. Four patients who refused completion of surgery were

classified as having no change in the functional assessment 6 months after the first resection.

In 3 patients who underwent segmentectomy, multiple segments were resected with the aim of taking only affected areas of different lobes (resection of the basal segments of the left lower lobe without the superior segment plus lingulectomy). The purpose was to protect as much pulmonary function as possible. In such patients, the superior segment had undergone a compensatory increase in volume and the affected basal segments became small. Thus, the functional value of the superior segment was similar to that of the lower lobe. In our technique, the diseased segment is usually identified at surgery by a small area of palpable bronchiectatic sacs or a small wedge of atelectasis. Beginning there, a retrograde open-wedge dissection (with or without the stapler) is carried out along the line of the diseased segment through its bronchus. This retrograde resection technique is not difficult, and the results are quite good. There was no morbidity in those patients and the surgery was well tolerated.

Six children and 4 adults underwent pneumonectomy because of total lung destruction. It has been our policy to operate on asymptomatic as well as symptomatic patients in the belief that diseased and destroyed lung tissue would act as a focus for further infections to threaten the unaffected lung, consequently making the patient inoperable. Nine patients were suffering from recurrent pulmonary infections and 1 had had tuberculosis. Saccular bronchiectasis was detected in all 10 patients who underwent pneumonectomy. All were asymptomatic after the operation. Children were seen to grow and develop normally after surgery, and they tolerated pneumonectomy well, with less functional disability than adults, as reported by Blyth.¹⁵

Morbidity rates in this type of surgery have been reported to be between 14% and 53%.^{1,8,9} In our series, the rate was 18.3%. Mortality ranges from 0% to 8.3% in the literature and current mortality is less than 1%.^{1,8,9} There was no operative mortality in our series (0%). In a series from a developed country, Agastian et al⁴ reported morbidity and mortality rates of 24.6% and 2.2%, respectively. The difference in mortality rates in our series and theirs may be related to the difference in mean ages, 48.4 years in their series and 24.4 in ours. Recurrent and untreated infections during childhood, a phenomenon characteristic of developing countries, may lead to a need for early surgical treatment of bronchiectasis. When necessary, this surgery can be performed with low morbidity and no significant mortality according to our results. Furthermore, well-localized childhood bronchiectasis is considered an indication for surgical treatment, because the residual lung can still grow to fill the space left in the chest after resection.^{2,8} It is also known that as few as 2 or 3 preserved segments can fill the hemithorax.¹²

Pulmonary function was evaluated periodically after operations, but surgery influenced neither FVC nor FEV₁, despite parenchymal resection. This was an

expected finding, since the excised lung segments contributed little to ventilation.

Although quality-of-life assessment would be a logical way to evaluate the outcomes of surgical treatment for bronchiectasis, the lack of a proper questionnaire in Turkish has limited that side of our study. However, we think the surrogate scale that we used for social functional assessment—covering symptoms and effects on social and professional lives as well as requirement for hospitalization—worked well for the general purpose of our work.

Marked (excellent) and substantial (good) improvement in functional status was achieved in 94.4% of all our patients. Of the 69 patients who had complete resections, 60 were examined in the postoperative period: 58 patients (96.6%) were asymptomatic, and the remaining 2 had marked improvement in their functional status. The patients with complete resection had better outcomes than those who had incomplete resection ($P=.0015$). In light of these findings, we would emphasize the importance of complete resection of diseased segments.

We conclude that the assessment of functional status as well as morbidity and mortality rates in this series support the surgical treatment of bronchiectasis, particularly in young patients with sufficient pulmonary reserves and localized disease who are suitable for complete resection. Unless further research helps to determine and influence the factors responsible for the ongoing problem of bronchiectasis in developing countries, surgery will keep its place among the treatment choices.

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