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# Surgical Treatment of Bronchiectasis

Hidir Esme and Sevval Eren
*Konya Education and Researc Hospital,*
*Dicle University, School of Medicine,*
*Turkey*

## 1. Introduction

Bronchiectasis is pathologically defined as a condition in which there are abnormal and permanent dilatations of proximal bronchi with predominance at the level of the second to the sixth bronchial division. This definition differentiates true bronchiectasis from functional bronchiectasis or pseudobronchiectasis, which is expected to return to normal once control of infection has been achieved (Deslauriers et al., 1998). Bronchiectasis was first described by Laenec in 1819 and, before the antibiotic era, was considered a morbid disease with a high mortality rate from respiratory failure and cor pulmonale (Balkanli et al., 2003). With the development of antibiotics in the 1940s, this entity began to be seen less frequently, but, with the emergence of drug-resistant microorganisms and the increasing frequency of drug-resistant tuberculosis, an increased incidence of postinfectious bronchiectasis is being noted (Miller, 2000). The current increase in tuberculosis rates is directly related to insufficient and irregular medication. Additionally, irregular and inadequate treatment, the cessation of medication shortly after symptom improvement, and a lack of check-ups after treatment are factors accelerating recurrent pulmonary infection in developing countries. As the disease progresses, physical activities become increasingly limited, patients fail to thrive, and ultimately they suffer from social deprivation, intrinsic depression, and respiratory failure (Al-Kattan et al., 2005). Therefore, bronchiectasis is still a major cause of morbidity and mortality in developing countries.

## 2. Pathophysiology

Reid categorized bronchiectasis as having three main phenotypes: 1) tubular characterized by smooth dilation of the bronchi; 2) varicose in which the bronchi are dilated with multiple indentations; and 3) cystic in which dilated bronchi terminate in blind ending sacs (Reid, 1950). The current major form seen on High resolution computed tomography scanning (HRCT) is the tubular form of bronchiectasis. The most definitive study of the pathology of bronchiectasis was performed by Whitwell (Whitwell, 1952). Whitwell suggested that bronchiectasis should be divided into (1) follicular bronchiectasis, characterized by excessive formation of lymphoid tissue both in the walls of dilated bronchi and in enlarged lymph nodes and thought to be sequelae of whooping cough, measles, or bronchopneumonia, (2) saccular bronchiectasis, characterized by loss of bronchial structures in the sacculi and of alveoli around them, and (3) atelectatic bronchiectasis, in which lung collapse leads to

bronchiectasis. Follicular bronchiectasis was the dominant form and this corresponded to tubular bronchiectasis. In his study, he demonstrated marked inflammation of the bronchial wall, principally in the smaller airways. Bronchial dilation was characterized by deficiency/loss of elastin and more advance disease by destruction of muscle and cartilage. There was variable bronchial wall fibrosis, atelectasis and peribronchial pneumonic change (King, 2009).

Follicular bronchiectasis was characterized by the presence of lymphoid follicles in the bronchial wall. The inflammatory process commenced in the small airway. This small airway inflammation caused the release of mediators such as proteases which damaged the large airways causing loss of elastin and other components such as muscle and cartilage which resulted in bronchial dilation. With progression of the disease lymphoid follicles enlarged in size and caused airflow obstruction to the small airways. The final event was spread of the inflammation beyond the airways to cause interstitial pneumonia (King, 2009).

The dominant cell types involved in the inflammatory process in bronchiectasis are neutrophils, lymphocytes, and macrophages. Neutrophils are the most prominent cell type in the bronchial lumen (Loukide et al., 2002; Khair et al., 1996) and release mediators, particularly proteases/elastase which cause bronchial dilation (Khair et al., 1996; Zheng et al., 2000). The infiltrate in the cell wall is predominantly composed of macrophages and lymphocytes (Loukide et al., 2002; Lapa a Silva et al., 1989)

Bronchiectasis can occur as focal or localized disease, or in a diffuse manner. Localized bronchiectasis is usually the result of childhood pneumonia and often has a benign course characterized by recurrent pulmonary infections always in the same anatomic territory. By contrast, diffuse bronchiectasis is often related to immune deficiencies, is bilateral, and may lead to death from respiratory failure (Deslauriers et al., 1998). Karadag et al. found that bronchiectasis most commonly involved the lower lobes. Only one lobe was found to be diseased in 46%, bilobar involvement in 28.1%, and multilobar involvement in 31.9% (Karadag et al., 2005). Karakoc et al. found bronchiectasis affecting the left lower lobe in 30.4%, and multilobar involvement in 56.5% (Karakoc et al., 2001). Dogru et al. found the most common lobe affected by bronchiectasis was the left-lower lobe in the 204 children they evaluated (Dogru et al., 2005). Isolated upper lobe bronchiectasis generally relates to prior tuberculosis, bronchopulmonary aspergillosis, or bronchial obstruction. Overall, one-third of cases of bronchiectasis are unilateral and affect a single lobe, one-third are unilateral but affect more than one lobe, and one-third are bilateral (Figure 1) (Deslauriers et al., 1998).

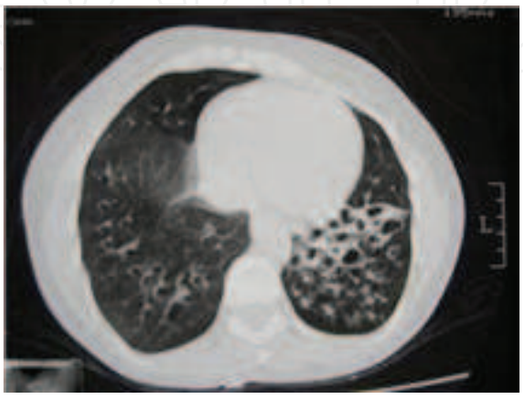

Fig. 1. Chest CT scan showing bilateral cystic bronchiectasis in the lower lobes.

The middle lobe syndrome consists of a small atelectatic lobe, often owing to extrinsic bronchial compression secondary to enlarged peribronchial nodes (Deslauriers et al., 1998). The right middle lobe bronchus is long, often bends sharply at its bifurcation and is of relatively small caliber. A collar of lymph nodes also surrounds the proximal bronchus and any condition that causes a prolonged enlargement of these nodes may lead to obstruction and secondary bronchiectasis. This may also occur in malignancy and in nontuberculous mycobacterial infection (Figure 2) (Bertelsen et al., 1980; Levin, 2002).

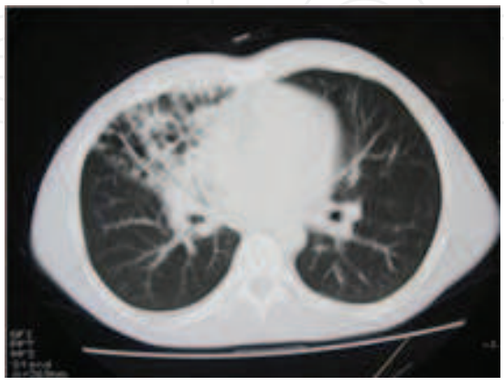

Fig. 2. Chest CT scan showing the bronchiectasis in the right middle lobe

## 3. Etiology

There have been a large number of factors that have been described as causative for bronchiectasis. A list of etiologic factors in different studies is given in Table 1. Recurrent pulmonary infection during childhood is an important factor in the etiology. Most of patients had recurrent infections in their histories and insufficient medication for pulmonary infection (Prieto et al., 2001; Agasthian et al., 1996; Fujimoto et al., 2001). The insufficient and inadequate use of medications for pulmonary infections and tuberculosis in patients, and the lack of follow-up over time, create a background for lung destruction (Figure 3). Bronchiectasis should not be mistaken with pseudo-bronchiectasis, temporary (up to 6 months) cylindrical dilatation of the bronchi accompanying lung infection in children (Sirmali et al., 2006). In developing countries, tuberculosis is still one of the most important causes of bronchiectasis. Bronchiectasis commonly develops between 1 and 3 months after the initial infection and usually in the same pulmonary region (Karakoc et al., 2001; Haciibrahimoglu et al., 2004).

Deficiencies in immune function, especially in humoral immunity, cause children to be at risk for recurrent sinopulmonary infections, which can lead to the development of bronchiectasis. This includes both primary immunodeficiency and secondary, or acquired, disease states (Boren et al., 2008). Cystic fibrosis is the most common cause of bronchiectasis among Caucasians of North America and Europe. Muco-ciliary clearance is a key defence mechanism against pulmonary infection. Its compromise is important in the development of the vicious cycle of bronchiectasis. The most prominent cilial disorder is primary ciliary dyskinesia which combines upper and lower respiratory tract infection, male infertility and in approximately 50%, situs inversus (King, 2009). Bronchial obstruction from either endobronchial pathology or external compression can also be an acquired factor predisposing to the development of bronchiectasis. Aspirated foreign bodies or gastric contents, slow-growing neoplasms, and mucous impaction can all cause local retention of secretions, secondary infection, and bronchiectasis (Deslauriers et al., 1998).

| Etiolgic factor | Balkanli n, % | Eren n; % | Sırmali n, % | Cobanoglu n, % | Giovannetti n, % |
|---|---|---|---|---|---|
| Pneumonia | 86 (36.1) | 22 (15.3) | 109 (61.9) | 18 (29.0) | 10 (22.2) |
| Childhood infection | 63 (26.4) | 19 (13.2) | - | 7 (11.3) | - |
| Obstruction due to foreign body | 1 (0.4) | 4 (2.7) | 23 (13) | 1 (1.6) | - |
| Pulmonary sequestration | 4 (1.6) | 2 (1.4) | - | 4 (6.4) | - |
| Postobstructive pneumonitis | - | 34 (23.7) | - | 2 (3.2) | - |
| Measles | - | - | - | 4 (6.4) | - |
| Pertussis | - | - | - | 3 (4.8) | 4 (8.8) |
| Tuberculosis | - | 22 (15.3) | 44 (25) | 11 (17.7) | 6 (13.3) |
| Immunodeficiency (IgG, IgA) | - | - | - | 1 (1.6) | - |
| Cystic fibrosis | - | - | - | 2 (3.2) | - |
| Unknown etiology | 84 (35.2) | 40 (27.9) | - | 4 (6.4) | 25 (55%) |

Table 1. Etiologic factors of bronchiectasis

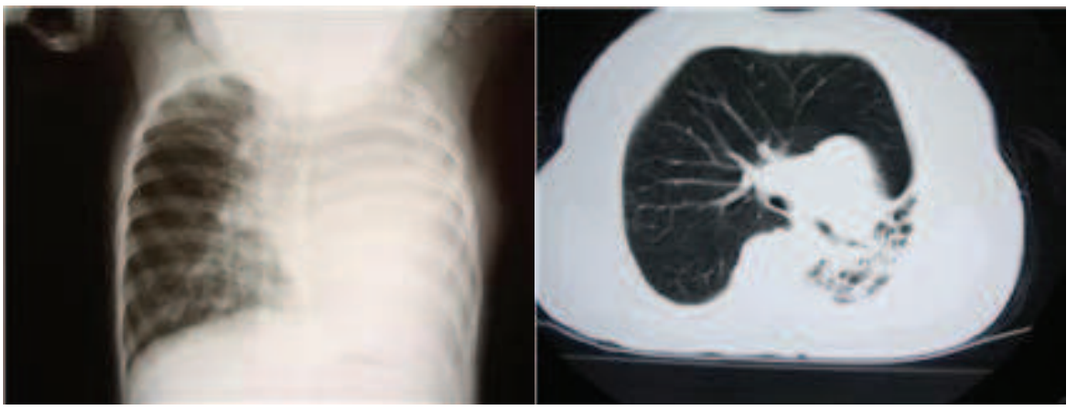

Fig. 3. Standart PA chest radigraph and Chest CT scan of a 4-year-old boy shows a destroyed left lung.

## 4. Clinical presentation

The clinical presentation of patients with bronchiectasis is variable and depends on the etiology of bronchiectasis and on whether the condition is localized of diffuse. Semptoms of the patients in different studies were presented in Table 2. The primary clinical symptom of bronchiectasis is a recurrent or permanent cough with ample sputum production. The sputum is frequently purulent and is often accompanied by hemoptysis in advanced stages of the disease (Nicotra et al., 1995). In the past, some bronchiectasis has been described as being nonproductive or "dry", although in retrospect these were mostly cases of post-tuberculous bronchiectasis located in the upper lobes (Deslauriers et al., 1998). Severe and life-threatening bleeding may result from erosions of the hypertrophic bronchial arteries or lesions in abnormal anastomoses between the pulmonary and bronchial arterial circulations.

Symptoms may be mild (eg, unproductive cough) or even absent if the disease is restricted to the upper lobes. Patients may also present with symptoms of the underlying disease that has led to the development of bronchiectasis (Zhang et al., 2010). Acute exacerbations of bronchiectasis are defined by symptomatic changes, including increased thick sputum production with change in color, shortness of breath, pleuritic chest pain, and generalized malaise. Chest roentgenograph (CXR) rarely shows new infiltrates, and the patient may lack fever and chills (Boren et al., 2008).

| Symptoms | Balkanli n, % | Eren n, % | Zhang n, % | Sirmali n, % | Cobanoglu n, % | Haciibrahimoglu n, % |
|---|---|---|---|---|---|---|
| Productive cough | 133 (55.8) | 94 (65.7) | 671 (85) | 167 (94.9) | 48 (77.4) | 32 (91.4) |
| Recurrence of pulmonary infection | 84 (35.2) | 69 (48.2) | - | - | 41 (66.1) | 33 (94.2) |
| Fetid sputum | 116 (48.7) | 72 (50.3) | 277 (35) | 139 (79) | 27 (43.5) | 28 (80) |
| Hemoptysis | 39 (12.1) | 21 (14.6) | 411 (52) | 78 (44.3) | 7 (11.3) | 4 (11.4) |
| Chest pain | - | 12 (8.3) | 56 (7.1) | - | 7 (11.3) | - |
| Fatigue | - | - | - | - | 17 (27.4) | - |
| Dyspnea | - | - | - | - | 34 (54.8) | - |
| Growth retardation | - | - | - | 34 (19.3) | - | - |
| Asymptomatic | 10 (4.2) | 2 (2.0) | 25 (3.2) | - | 10 (16.1) | - |

Table 2. Semptoms of the patients

Physical examination is often nonspecific. Crepitation, wheezing, and coarse expiratory rhonchi may be heard over the lung bases, whereas clinical signs of cor pulmonale and denutrition are uncommon and indicate advanced disease. Routine clinical assessment should include a careful recording of personal and familial history, which may indicate an inherited disorder (Deslauriers et al., 1998).

Pulmonary function testing can help determine the degree of lung damage because of bronchiectasis. Bronchiectasis typically results in obstructive lung function changes as the disease progresses. Typical obstructive changes on lung function testing include a reduced forced vital capacity (FVC), reduced forced expiratory volume in 1 s (FEV1), and reduced FEV1 to FVC ratio. Airway hyperresponsiveness with reversibility after the administration of inhaled bronchodilator should also be evaluated (Boren et al., 2008).

## 5. Imaging

Diagnosis of bronchiectasis is based on clinical history and imaging. CXR findings that are suggestive but nondiagnostic of bronchiectasis include stranding, cystic lesions, volume loss with crowding of vessels, air-fluid levels and honeycombing, and areas of infiltrates and atelectasis (Agasthian et al., 1996). Computed tomography scanning is currently the best technique to establish the presence, severity, and distribution of bronchiectasis, replacing Lipiodol bronchography, which is considered more invasive and more unpleasant to the patient as well as being occasionally associated with complications such as alveolitis or allergy to the local anesthetic agent or contrast medium. HRCT has replaced this procedure in the diagnosis of bronchiectasis, with only a 2% false negative and a 1% false positive rate (Young et al., 1991). The detailed images demonstrate bronchial dilatation, peribronchial inflammation, and parenchymal disease.

Perfusion isotopic lung scans using 99m Tc albumin particles in microspheres are considered important in the preoperative evaluation of patients with bronchiectasis because they may demonstrate abnormal territories considered normal on CT scans but representing potential areas of bronchial dilatations. This is explained by bronchial artery hyperplasia creating flow reversal through systemic to pulmonary artery shunting, thus causing areas of defective perfusion on the isotopic scan. Bronchial arteriography may be done to document the origin of hemoptysis. Esophageal studies if gastroesophageal reflux is suspected and ultrastructural examination of cilia from biopsy of the nasal respiratory epithelium if ciliary dyskinesia is suspected may be done (Deslauriers et al., 1998).

## 6. Therapy for bronchiectasis

Treatment options for the management of bronchiectasis include pharmacologic agents such as antibiotics, nonpharmacologic measures such as chest physiotherapy, and surgical procedures involving removal of the affected portion or portions of the lung. In general, treatment goals are to control infections and improve bronchial hygiene. General measures include avoidance of smoking and second-hand smoke, proper nutrition, and ensuring proper immunizations, including yearly influenza vaccinations. Depending on the specific cause of bronchiectasis, additional medical therapies may be warranted. This is especially true in patients with immunoglobulin deficiency, who could benefit from administration of intravenous or subcutaneous immunoglobulin for passive protection (Boren et al., 2008).

The goals of surgical therapy for bronchiectasis are to improve the quality of life for those patients in which medical treatment has failed and to resolve complications such as empyema, severe or recurrent hemoptysis, and lung abscess (Agasthian et al., 1996; Annest et al., 1982). There is a broad consensus concerning the indications for surgical removal. The surgical treatment is based on two physiopathologic hypotheses. First, the resection involves removal of lung tissue with destroyed bronchi that are no longer functional. Second, it permits the removal of a localized area of bronchiectasis, which could otherwise be involved in the infectious contamination of adjacent territories (Mazieres et al., 2003).

Mazierez and colleagues bring some arguments to help in the selection of patients who should be considered for operation (Mazieres et al., 2003). First, respiratory function and performance status must be compatible with the anesthetic risk. Second, the resection should be done quite early in the evolution of the disease because of the risk of contamination of healthy bronchi by an "active" territory and because of the low morbidity when the pulmonary function is good (Etienne et al., 1996). Third, operation is recommended for patients exhibiting disabling bronchiectasis with hemoptysis or a recurring infection that becomes resistant to medical treatment. Fourth, the etiology of bronchiectasis should not be considered in the decision for operation. Some studies showed the benefit of operation in primary ciliary dyskinesia (Simit et al., 1996), Kartagener's syndrome (Figure 4) (Mazieres et al., 2003), and in hypogammaglobulinemia (Cohen et al., 1994). Lastly, the ideal candidate has a nonhomogenous disease. Some territories are more severely involved and constitute real targets. The removal of an active infectious territory may protect the healthy bronchi from infectious contamination. Removal of diseased segments can break the vicious circle as described by Cole and colleagues, and stop the progression of the disease (Cole et al., 1985). In children growth retardation due to bronchiectasis and drop in school attendance secondary to the illness should be included in the indications for surgery as well (Sirmali et al., 2006).

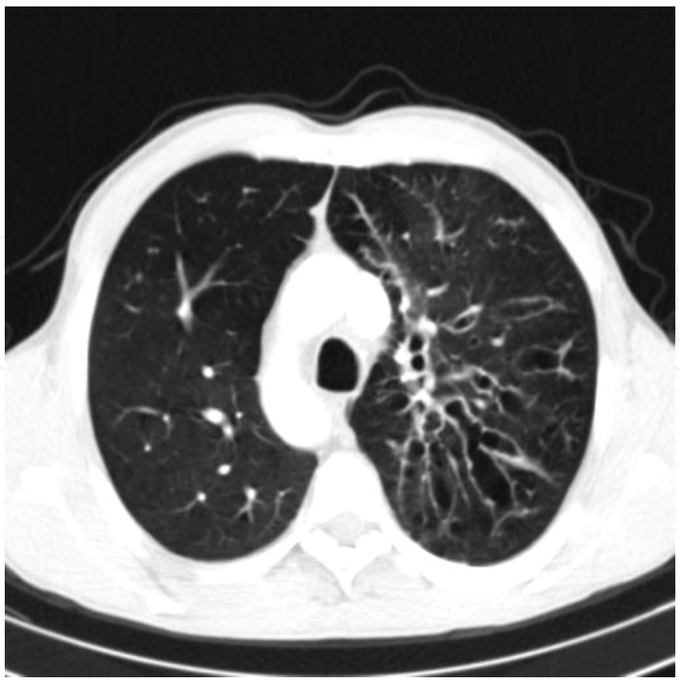

Fig. 4. Computed tomography scan showing the classic image of Kartagener's syndrome caharacterized by dextrocardia and cylindrical bronchiectasis in the right upper lobe (patient's left side).

## 7. Preoperative preparation

Careful preoperative preparations are of the utmost importance to reduce operation-related morbidity and mortality. The preoperative treatment should include reducing airway obstruction and elimination of microorganisms from the lower respiratory tract, which consists of antimicrobial therapy, postural physiotherapy, bronchodilators, and corticosteroids (Agasthian et al., 1996). Patients should be well prepared during the preoperative period with regard to infection to minimize postoperative complications. Bacterial infections, particularly those involving potentially necrotizing agents such as Staphylococcus aureus, Pseudomonas aeruginosa, Streptococcus pneumonia, and various anaerobes, remain important causes of bronchiectasis, particularly when there is a delay in treatment or other factors that prevent eradication of the infection (Deslauriers et al., 1998). Antimicrobial therapy is particularly true in the setting of mycobacterial disease, such as M. tuberculosis and various environmental mycobacterial species. Patients with focal bronchiectasis and M. avium complex infection typically are started on a three-or four-drug regimen for 2-3 months before surgery based on in vitro susceptibility testing of the isolated organism. The regimen is continued through the hospital stay and for several months thereafter, often to a total of 24 months (Kim et al., 2005).

Preoperative bronchoscopy should be routinely done to rule out benign or malignant cause of obstruction. Preoperative bronchoscopic examinations were performed in 117 (81.8%) of our patients as an adjuvant diagnostic method, to rule out benign or malignant bronchial obstruction, and for localization, collection of samples for microbiology, and bronchial toilet. We consider it essential in the preoperative evaluation and tracheobronchial cleaning of all

patients. In our study, patients in whom bronchoscopy was not performed had a significantly higher rate of postoperative complications (Eren et al., 2007). Patients should be preoperatively monitored until they produced less than 20 mL/day of sputum with little purulence. Operation should be not conducted until bronchofibroscopy showed no engorgement or edema in the tunica mucosa bronchiorum (Zhang et al., 2010).

Most patients with chronic suppurative disease of the lungs are malnourished, often to a considerable degree, as a result of the long-standing catabolic state these patients experience. If malnutrition is present, an aggressive preoperative regimen of nutritional supplementation is advised (Sherwood et al., 2005). Pulmonary function studies should be preoperatively performed in all patients. The patients with bronchiectasis are showed a mixed or obstructive ventilatory pattern. In patients with low FEV1 (<60% of the predicted value) the postoperative complication rate was significantly high. This indicated that surgery should be delayed in cases of severe inflammation until adequate control has been achieved (Eren et al., 2007).

In all patients undergoing pulmonary resection, it is imperative to clearly determine preoperatively the extent of resection to be done because at surgery it may be difficult to judge with great accuracy the segments that are involved.

Balloon tamponade of the bleeding bronchus, which can be performed under emergency conditions is an effective method to manage massive hemoptysis in bronchiectasis patients. Embolization of the bronchial artery is a good alternative, capable of stopping the hemorrhage in 75—90% of the cases ( Freitag et al., 1994). On the other hand, once the first episode of hemorrhage is stopped, preoperative assessment should be promptly undertaken because recurrence in the first month after the embolization is frequent and fatal (Fujimoto et al., 2001; Mal et al., 1999). Planning surgical operation in patients with hemoptysis should involve bronchoscopic as well as radiological assessments. Yielding 2% false negative and 1% false positive results, HRCT is a fairly reliable method for the diagnosis of bronchiectasis (Young et al., 1991). In such cases the most appropriate approach is to excise the pathological regions both depicted by HRCT and identified by bronchoscopy.

## 8. Surgical technique

A left-sided double-lumen endotracheal tube is used to avoid contralateral contamination of secretions. In children under 13 years old, in whom the double-lumen endotracheal tube is not used, bronchoscopy should be performed, and the bronchus of the side ready for resection should be cleaned by aspiration before the introduction of an endotracheal tube. A Fogarty embolectomy catheter may be used as a bronchus blocker in children (Eren et al., 2007). A thoracic epidural catheter is employed when an open approach is planned based on the extent of resection. In patients in whom a thoracoscopic lobectomy or segmentectomy is performed, the epidural is omitted. An arterial line and urinary catheter are placed.

Posterolateral thoracotomy or video-assisted thoracoscopic surgery (VATS) were performed for lung resection. Thoracotomy is performed so as to conserve as much muscle as possible. The resection type is selected according to the affected sides and cardiopulmonary reserve (Balkanli et al., 2003). Excessive bronchial dissection is avoided, and peribronchial tissues are preserved. The bronchial stump may manually be sutured with nonabsorbable materials or closed with a mechanical stapler. The bronchial stump is kept short. Stump covering with mediastinal pleura or tissue is performed. Complete resection is defined as an anatomic resection of all affected segments assessed preoperatively by either HRCT. Two silicon

drains are placed into the thoracic cavity before the thorax is closed. All resected specimens are examined histopathologically in order to confirm the diagnosis. At the end of the procedure, the bronchial suture is bronchoscopically checked, and secretions are removed from the airways. Patients are extubated in the operating room. When postoperative mechanical ventilation was necessary, a standard endotracheal tube is substituted for the double-lumen tube (Zhang et al., 20101).

## 9. Complete resection and preserved segments

Complete and anatomic resection should be done with preservation of as much lung function as possible to avoid cardiorespiratory limitation (Laros et al., 1988). It was reported that the symptoms persisted when incomplete resection was carried out (Campbell & Lilly, 1982). We performed complete resection in 82.5% of our patients and preoperative symptoms resolved completely in 75.9% and improved in 15.7%, i.e. 92.8% benefited from the surgery. In the light of these findings, we suggest that complete resection should be performed for the surgical treatment of bronchiectasis and that incomplete resection should only be used for the palliative treatment of certain life-threatening symptoms. In our study, postoperative complications were observed in 11% of patients that underwent complete resection and in 80% of those that underwent incomplete resection (Eren et al., 2007). When suspicious lung regions are not excised with the aim of sparing as much lung tissue as possible, a second operation that carries a higher morbidity and mortality might be required to remove the residual diseased tissues (Sirmali et al., 2007). Therefore, we suggest that, during intraoperative examinations, if suspected areas that could not be determined by radiological examination are present, these parenchymal areas should be resected to perform complete resection and to decrease relapse rates. Bronchopulmonary development continues during childhood and the space occupied by the resected segments would be filled by the healthy lung segments. Therefore, surgeons should not refrain from wide resection of the lung to achieve complete resection of the diseased area (Sirmali et al., 2007). Incomplete resection should not be preferred in children except for palliative treatment of life threatening complications.

The goal of surgery is to excise all diseased lung areas whenever possible and to preserve as much healthy lung parenchyma as possible. It is known that even 2 or 3 preserved segments can fill the hemithorax (Campbell & Lilly, 1982). As recommended, we suggested to protect the anatomic structure of the superior segment in cases of bronchiectasis of the lower lobe when the superior segment of this lobe was normal (Fujimoto et al., 2001). In such patients, the superior segment had undergone a compensatory increase in volume and the affected basal segments had become small. Thus, the functional value of the superior segment was similar to that of the lower lobe (Yuncu et al., 2006). Patients with an uninvolved apical segment were found to have better spirometric values than those with more extensive disease (Ashour et al., 1996).

## 10. Resection for multisegmental bilateral bronchiectasis

Surgical treatment is usually offered only when the diseased area is well localized and restricted to one or several segments within the same lobe. Multiple or bilateral bronchiectasis is generally regarded as a contraindication to operation. From the end of the 1970s onward, some thoracic surgeons have suggested that bilateral bronchiectasis is not a contraindication to

resection (George et al., 1979; Fujimoto et al., 2001). Nevertheless, the patients reported in the literature remained quite rare. The therapeutic options in nonfocal bronchiectasis are limited. Most of the time patients are treated with antibiotics and physiotherapy. Recently, progress has been made with the use of new antibiotics and inhalation of tobramycin solution in cases of Pseudomonas aeruginosa colonization (Barker et al., 2000). These therapies allow a good quality of life and symptomatic improvement for several years, but the usual evolution is a progression toward chronic respiratory failure with a poor prognosis and selection of resistant strains (Annest et al., 1982; Keistinen et al., 1997). Transplantation remains indicated for homogenous disease and for patients with advanced disease with seriously compromised pulmonary function and chronic respiratory failure (Hasan et al., 1995). The 3-year survival rate is 75% for patients undergoing double-lung transplantation (Barlow et al., 2000). Some investigators have proposed a radical operation for bilateral bronchiectasis (Kittle et al., 1985; Laros et al., 1988) but others report a higher mortality with pneumonectomy (McGovern et al., 1988). Considering the limited and palliative effect of medical treatment and the risk of transplantation or radical operation, it seems that a limited operation should be offered to some patients with diffuse bronchiectasis.

Mazierez and collegues suggested that surgical indications were offered to patients with multisegmental and severe bronchiectasis if (1) optimal medical treatment and physiotherapy were no longer efficient, (2) bleeding and sputum production were recurrent and abundant, (3) severely damaged territories could be identified, and (4) performance status and pulmonary function were compatible with the anesthetic risk (Mazierez et al., 2003).

Surgery in multiple segments on different lobes is technically more difficult, resulting in higher morbidity and mortality.[21] However, pulmonary resection is indicated early in patients with multisegmentar bronchiectasis, before other portions of the lung become grossly diseased. Our purpose in these patients was to protect as much pulmonary function as possible, with the aim of removing only the affected areas of different lobes. The types of procedures in different studies were presented in Table 3.

| Operation type | Balkanli n, % | Eren n; % | Zhang n, % | Sırmali n, % | Haciibrahimoglu n, % | Giovannetti n, % |
|---|---|---|---|---|---|---|
| Pneumonectomy | 13 (5.4) | 12 (8.3) | 90 (11.3) | 40 (19.9) | 7 (20) | 1 (1.7) |
| Lobectomy | 189 (79.4) | 82 (55.4) | 497 (62.9) | 90 (44.7) | 17 (48.5) | 33 (56.8) |
| Bilobectomy | | 7 (4.7) | 56 (7.1) | 21 (10.4) | 2 (5.7) | 2 (3.4) |
| Lobectomy & segmentectomy | 31 (13.0) | - | 110 (14) | - | 5 (14.2) | 11 (18.9) |
| Lobectomy & lingulectomy | | - | | 34 (16.9) | - | |
| Segmentectomy | 10 (4.2) | 17 (11.4) | 37 (4.7) | 16 (7.9) | 4 (11.4) | 11 (18.9) |
| Basal segmentectomy | - | 16 (10.8) | - | - | - | - |
| Basal segmentectomy & lingulectomy | - | 5 (3.3) | - | - | - | - |
| Basal segmentectomy & middle lobectomy | - | 4 (2.7) | - | - | - | - |

Table 3. Type of operation

## 11. Video-assisted thoracoscopic surgery

VATS for major lung resection has become a more frequent procedure in recent years with promising outcome. VATS represents a new approach; the indications for VATS major

resection remain the same as for conventional resection. But not all the patients with bronchiectasis who needed operations were suitable for VATS lobectomy; severe scarring and adhesions on computed tomographic scan should be considered . The severity of adhesions to the chest wall, the hilum, and especially in the fissure, typically seen in inflammatory disease, was the key limiting factor for a safe VATS lobectomy (Weber et al., 2001). Adhesions need to be dissected to explore the relevant anatomy. If there were dense adhesions (such as destroyed lobes mainly after tuberculosis with or without aspergillosis) or enlarged lymph nodes, especially calcified, open operations were required (Zhang et al., 2011).

Bronchiectasis was considered the best lung benign disease suitable for VATS lobectomy (Yim, 2002). The VATS major resection has demonstrated to be a safe procedure when performed by experienced physicians. Postoperative pain after VATS is uncommon as compared with open surgery. Other documented advantages include better preservation of pulmonary function in the early postoperative period, earlier return to full activities, and better quality of life after recovery. One major advantage of VATS resection is that it allows recruitment of older and sicker patients with multiple comorbidities who would otherwise not be candidates for resection through a conventional thoracotomy approach (Farjah et al., 2009; Gonzales-Aragoneses et al., 2009). In study of Zhang and collegeus, the patients with VATS had a shorter length of stay in the hospital, fewer complications, and less pain in the postoperative period than those with thoracotomies (Zhang et al., 2011).

## 12. Postoperative complication

Bronchiectasis is an inflammatory disease of the lungs and the risk of developing postoperative empyema is higher than in other cases. Empyema, on the other hand, is a risk factor for bronchopleural fistula (Sirmali et al., 2006). Therefore, we suggest reinforcement of the bronchial stump in all patients. Bronchopleural fistula can be observed in as many as 9.1% of the cases (Fujimoto et al., 2001). Fujimoto and colleagues argued that the bronchial stump should be reinforced when the inflammation in the lung of bronchiectasis patients could not be effectively controlled (Fujimoto et al., 2001). We, however, suggest reinforcement the bronchial stump in all cases. Additionally, to avoid empyema, we recommend postoperative bacterial culture of thoracic effusion if the remaining lung shows signs of persisting inflammation. Sputum retention is common because patients with this disease might have problems with ciliary motion and postoperative expectoration, which would be easily disrupted (Fujimoto et al., 2001). In our series, respiratory physiotherapy was re-initiated on the first post-operative day, and continued for 2 weeks after discharge. We used bronchoscopy for sputum aspiration during the early postoperative period if physiotherapy was not effective. Virtually all patients had specific or large-spectrum intravenous antibiotic therapy for 1 week (Eren et al., 2007).

In bronchopleural fistula, drainage of the infected space is a key initial step to limit damage to the remaining lung. Bronchopleural fistula noted very early after the initial resection may be treated with primary reclosure and rebuttressing of the stump; later bronchopleural fistula usually require rib resection and creation of an Eloesser flap, followed by bronchopleural fistula closure and subsequent Clagett procedure, for successful treatment (Sugarbaker et al., 2009). The presence of a significant intrathoracic "space" appears to be more common after major lung resection for infectious lung disease such as bronchiectasis compared with other indications for surgery. The use of transposed muscle such as

latissimus dorsi minimizes the potential complications in this setting, including postresection empyema or prolonged air leak (Sugarbaker et al., 2009). The rate of complications in the current literature varies between 9.4% and 24.6%. Mortality ranges from 0% to 8.3% in the literature (Fujimoto et al., 2001). Postoperative complications in different studies were presented in Table 4.

| Complication | Balkanli n, % | Eren n, % | Zhang n, % | Sırmali n, % | Cobanoglu n, % | Haciibrahimoglu n, % | Giovannetti n, % |
|---|---|---|---|---|---|---|---|
| Postoperative Pneumonia | - | 3 (2.0) | 24 (3) | 3 (1.7) | - | 3 (8.8) | 2 (4.4) |
| Atelectasis | 7 (2.9) | 11 (7.6) | 16 (2) | 8 (4.5) | 4 (6.4) | - | |
| Prolonged air-leak | 6 (2.5) | 7 (4.8) | 21 (2.7) | 3 (1.7) | 2 (3.2) | 1 (2.9) | 1 (2.2) |
| Residual air-space | - | - | - | - | - | - | 1 (2.2) |
| Sputum retention | - | - | - | - | - | - | 1 (2.2) |
| Bronchial infection | - | - | - | - | - | - | 1(2.2) |
| Bronchopleural fistula | 2 (0.8) | - | 3 (0.4) | - | 2 (3.2) | - | - |
| Postoperative hemorrhage | 4 (1.6) | 2 (1.3) | 9 (1.1) | 2 (1.1) | 1 (1.6) | - | - |
| Empyema | 2 (0.8) | 5 (3.4) | 5 (0.6) | 5 (2.8) | 2 (3.2) | 2 (5.8) | - |
| Severe supraventricular arrhythmias | - | 3 (2.0) | 32 (4) | - | 1 (1.6) | - | - |
| Respiratory insufficiency | - | 2 (1.3) | 10 (1.3) | - | - | - | - |
| Total | 21 (8.8) | 33 (23) | 128 (16.2) | - | - | 6 (17.6) | 6 (13.2) |

Table 4. Postoperative complications

## 13. Conclusion

Bronchiectasis is pathologically defined as a condition in which there are abnormal and permanent dilatations of proximal bronchi. Bronchiectasis can occur as focal or localized disease, or in a diffuse manner. Overall, one-third of cases of bronchiectasis are unilateral and affect a single lobe, one-third are unilateral but affect more than one lobe, and one-third are bilateral. Recurrent pulmonary infection during childhood is an important factor in the etiology. In developing countries, tuberculosis is still one of the most important causes of bronchiectasis. Bronchial obstruction from either endobronchial pathology or external compression can also be an acquired factor predisposing to the development of bronchiectasis.

Treatment options for the management of bronchiectasis include pharmacologic agents such as antibiotics, nonpharmacologic measures such as chest physiotherapy, and surgical procedures involving removal of the affected portion or portions of the lung. The goals of surgical therapy for bronchiectasis are to improve the quality of life for those patients in which medical treatment has failed and to resolve complications such as empyema, severe or recurrent hemoptysis, and lung abscess. The preoperative treatment should include reducing airway obstruction and elimination of microorganisms from the lower respiratory tract, which consists of antimicrobial therapy, postural physiotherapy, bronchodilators, and corticosteroids. Preoperative bronchoscopy should be routinely done to rule out benign or malignant cause of obstruction.

Complete and anatomic resection should be done with preservation of as much lung function as possible to avoid cardiorespiratory limitation. It was reported that the symptoms persisted when incomplete resection was carried out. When suspicious lung regions are not excised with the aim of sparing as much lung tissue as possible, a second operation that carries a higher morbidity and mortality might be required to remove the residual diseased tissues. Therefore, we suggest that, during intraoperative examinations, if suspected areas that could not be determined by radiological examination are present, these parenchymal areas should be resected to perform complete resection and to decrease relapse rates.

Surgery in multiple segments on different lobes is technically more difficult, resulting in higher morbidity and mortality. However, pulmonary resection is indicated early in patients with multisegmentar bronchiectasis, before other portions of the lung become grossly diseased. Our purpose in these patients was to protect as much pulmonary function as possible, with the aim of removing only the affected areas of different lobes. VATS represents a new approach; the indications for VATS major resection remain the same as for conventional resection. But not all the patients with bronchiectasis who needed operations were suitable for VATS lobectomy; severe scarring and adhesions on computed tomographic scan should be considered. When necessary, surgical treatment of bronchiectasis can be performed with acceptable morbidity and low mortality.

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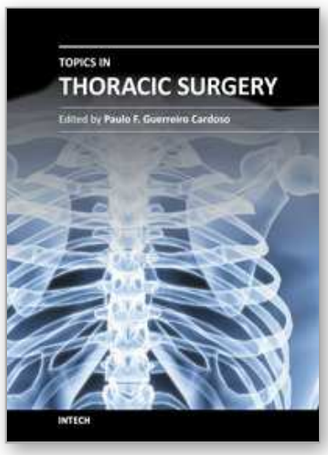


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