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Surgery for bronchiectasis ☆

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Abstract

Objective: The incidence of bronchiectasis has declined markedly in developed countries. However, a reasonable number of patients still need surgery, despite aggressive physiotherapy and antibiotic therapy. We have reviewed our patients to clarify the benefits from surgery and to analyse the complications. **Material and methods**: Between 1988 and 1999, we have operated on 119 patients with bronchiectasis, 71 female and 48 male, with a mean age of 42.2 years (range 11–77 years). Surgery was indicated because of unsuccessful medical therapy in 66 patients (55%), 31 (26%) had haemoptysis, 11 (9.2%) had lung abscess, 10 (8.4%) had lung masses, and three (2.5%) had pneumothorax. The most common manifestations were cough with sputum in 90 patients (76%), haemoptysis in 45 (38%) and recurrent infections in 57 (48%). The mean duration of the symptoms was 4 years (range 1–40 years). The lower lobes were diseased in 61 patients and bilateral disease was found in ten. The mean number of involved pulmonary segments was five (range 1–15). A lobectomy was performed in 75 patients (62%), a segmentectomy in 12 (10%), a pneumonectomy in nine (7.4%) and a bilobectomy in four (3.3%). Complete resection of the disease was achieved in 108 cases (91%). **Results**: There was no operative mortality and perioperative morbidity occurred in 15 patients (15%), including temporary broncho-pleural fistulae in 7 (5.8%), and post-operative haemorrhage and atrial arrhythmias in four (3.3%) each. After a mean follow-up was 4.5 years, 73 patients (68%) of this group were asymptomatic, and 31 (29%) had meaningful clinical improvement, while only four (3.7%) maintained or worsened prior symptoms. The best clinical improvement occurred in patients with complete resection of the disease ($P = 0.008$). There were no differences in the respiratory function, comparing pre- and post-operative data, with a 2-year of minimum interval. The VC was 91 and 89% and the FEV1 was 83% and 81% of expected, respectively before and after surgery, ($P =$ NS). **Conclusion**: Surgery of pulmonary bronchiectasis has few complications and markedly improves symptoms in the great majority of patients, especially when complete resection of the disease is achieved. Pulmonary resection of bronchiectasis does not alter respiratory function.

Keywords: Bronchiectasis; Pulmonary resection

1. Introduction

Bronchiectasis are anomalous and irreversible dilatations of the bronchi, caused by destruction of the elastic and muscular layers of the bronchial wall, most frequently by recurrent infection. Gradually, the pus-filled bronchial sacs make gas exchange impossible, resulting in an infected, non-functioning lung segment.

Laennec made the first description of this entity in 1819 [1]. In the pre-antibiotic era, it occurred frequently and was incapacitating in most of cases and mortal in some. With improvement of health care, the generalised use of antibiotics and of vaccines, and the control of tuberculosis, the incidence and severity were markedly reduced. Although bronchiectasis still constitute an important problem in the poorer regions of the world, the prevalence in developed countries is now estimated at less than 0.6/1000 persons [2].

Physiotherapy, with postural drainage, and antibiotic therapy are now widely used in the management of bronchiectasis but, despite improvements, medical management of bronchiectasis still led to mortality rates of 19–31% [3]. By contrast, the mortality rate of surgical treatment has been reported to be of 2–8%. Resection of the involved lung segments in patients with unilateral disease remains the only potential possibility of cure. Brunn and Nissen [4], in 1929, were the pioneers of the surgical treatment of bronchiectasis and, Jackson and Huber [5], in 1943, described the basic principles of the surgical technique still in use today.

In order to evaluate the role of the surgical treatment of bronchiectasis in our own conditions, we reviewed our recent experience with 119 patients operated on from 1988 and analysed the indications and the long-term results.

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2. Material and methods

2.1. Patients

Between January 1988 and 1999, 1194 patients, with a mean age of 49.6 years, were admitted for diagnosis and treatment of bronchiectasis. Of these, 119 underwent pulmonary resection. We analysed their in-hospital records retrospectively. The mean age of the patients was 42.2 years (range 11–77 years) and there were 71 females (60%). All patients had chronic symptoms for a mean time of 4 years (range 1–40 years), including productive cough in 76%, recurrent infections in 48%; haemoptysis in 38% and severe pneumonias in 15%. All patients had prior medical therapy for a mean 30 months (range 2 months–30 years).

Thirty-five (29.5%) patients had a history of pulmonary disease, including pulmonary tuberculosis in 21, asthma in 11 and silicosis in two. Several associated pathological entities contributed to the development of bronchiectasis (Table 1). In our country, there is still a high incidence of pulmonary tuberculosis; hence a significant number of our patients (21; 18%) had a history of tuberculosis.

The initial, presumptive diagnosis was based on the clinical manifestations. All patients were studied with a PA and lateral X-ray of the thorax and all but 12 had a computed tomography (CT) scan. Fiberoptic bronchoscopy was performed in 78 patients (65.5%) and a bronchography in 48 (40%). One hundred and one patients (91.0%) had respiratory function tests, the majority (66%) showing normal ventilatory patterns. The remainder showed a mixed or obstructive ventilatory pattern.

The disease was bilateral (evidence of involvement of both lungs on either chest-X ray or CT scan, or by contrast bronchography) in 10 patients (9%) and unilateral in 109 (92%), of the right chest in 63 (57%) and of the left in 46 (43%) (Table 2). It predominated in the basal segments (67% of the patients) and was localised to the middle lobe only in 34 (28%). The lingula was involved in seven patients and two or more lobes were diseased in 25 patients. There were a mean of five segments affected (range 1–15 segments).

Frequent exacerbations of the disease, interfering with normal professional or social life, or the need of hospitalisation were considered as failure of medical treatment and led to surgery in 66 patients (55%). We do not usually follow medically-treated patients, and the decision to present the patient for surgery was made by the respective physicians, but the final decision was reached together at the weekly medico-surgical meeting.

Other indications for surgery, usually urgent or emergent, were persistent or severe hemoptysis in 31 (26%), lung abscess in 11 (9%), lung mass in 10 (8%) and secondary pneumothorax in three (3%). Haemoptysis (14; 67%) constituted the most frequent indication for surgery in patients with a history of pulmonary tuberculosis.

Table 1
Predisposing factors for bronchiectasis in 119 patients

Chronic respiratory infection	35 (30%)
Pulmonary tuberculosis	21 (18%)
Severe pneumonia	17 (14%)
Pulmonary sequestration	3
Immunodeficiency (IgG,IgA)	4
α-1 antitrypsin deficiency	3
Congenital cystic adenomatoid malformation	2
Primary ciliary dyskinesia	1

Table 2
Localisation of the disease

	Right lung (73)	Left lung (56)
Upper lobe	10	8
Middle lobe/lingula	34	10
Inferior lobe	17	16
Multilobar	9	16
Basal segments	35	44
Total	105 (53%)	94 (47%)

2.2. Operative technique

Before surgery, the respiratory condition of the patients was optimised by respiratory-oriented physiotherapy, by therapeutic bronchoscopy and by a two-week course of antibiotic therapy, specific to the result of the bronchial aspirate. Most frequently, there was a mixed bacterial flora, typical of the oropharynx, the most frequent being the Hemophylus influenzae and the *Streptococcus pneumoniae*, followed by *Staphylococcus aureus*, gram-negative bacilli and *Pseudomonas aeruginosa*. Patients with the diagnosis of tuberculosis were subjected to specific treatment in accordance with the official protocols. There were no cases of multiresistant mycobacteria.

During anaesthesia, an epidural catheter was placed (L4–L5) for regional analgesia with morphine, which was continued for the first two or three post-operative days. Tracheal intubation with a double-lumen tube to avoid contralateral spillage of pus and secretions was carried out. Currently, toilet-bronchoscopy is performed routinely preoperatively, after intubation. With the patient positioned on a lateral decubitus, a posterolateral thoracotomy was performed through the fifth intercostal space.

A right thoracotomy was done in 74 patients and a left thoracotomy in 47. Surgical resection aimed at minimising the number of resected segments, without compromising the objective of elimination of the disease. The surgical procedures performed were pneumonectomy in nine patients (8%), bilobectomy in four (3%), lobectomy in 75 (62%), lobectomy plus segmentectomy in 17 (14%) and segmentectomy or wedge resection in 16 (13%). Pulmonary resection was considered complete if the patient was believed to be free of bronchiectasis after thoracotomy, and was achieved in 108 patients (91%). In the remaining 11 patients, in whom other pathology was present, resection

was considered palliative. Eight of these patients had bilateral bronchiectasis and three had tuberculosis. In addition, three patients had α-1 antitrypsin deficiency, two had chronic bronchitis and one had primary ciliary dyskinesia.

A pneumonectomy was required in five (24%) of the patients with a history of tuberculosis and a lobectomy in 12 (57%). Only two of the ten patients who had bilateral disease were operated on both lungs. In these cases the clinically or radiologically worst side is operated on first. To minimize the risk of fistulae, the bronchial stump was routinely covered by a flap of mediastinal pleura and/or tissue. All the lung specimens resected had pathologic confirmation of bronchiectasis (Fig. 1).

Respiratory physiotherapy was re-initiated in the first post-operative day, and continued throughout hospital admission and for at least one month after discharge. In the absence of drainage or air leakage, the drains were removed on the second or third post-operative day. Virtually all patients had specific or large-spectrum intravenous antibiotic therapy for 5 days. Although there were no cases of active infection, patients with a history of pulmonary tuberculosis were subjected to a minimum of three months of prophylactic specific antibiotics.

2.3. Definitions and statistical analysis

Statistical significance of non-continuous data was determined using the χ^2 test or Fisher's exact test. Functional results were compared pre and post-operatively for each follow-up patient, and statistical analysis was carried out by the paired *t*-test and/or Wilcoxon's rank test. A *P*-value greater than 0.05 was considered non-significant.

3. Results

There was no hospital mortality. Morbidity was observed in 15 patients (15%), including post-operative haemorrhage requiring re-exploration in four patients (3%) and persistent air leakage in seven (6%). Six of the latter were successfully treated by tetracycline-pleurodesis, around the 7th post-operative day, and one required surgical reintervention for closure of the fistula. Four patients (3%) had severe supraventricular arrhythmias, all controlled pharmacologically.

The length of hospital admission was 6–20 days (mean 8.5 days). The follow-up was complete for 108 patients (91%), 97 of whom had complete resection (90.7%) and 11 of whom had incomplete resection (100%), with a mean time of 4.5 years (range 1–10 years). The patients were subjected to direct clinical evaluation. Seventy-three (67.6%) were asymptomatic and 31 (29%) were improved with regard to pre-operative symptoms. Only four patients (4%) had shown no improvement (Table 3). The best clinical improvement of this group was observed in patients with complete resection of the disease (96 of 97 patients followed; 99%), where only one patient was not improved. By contrast, only one of 11 patients who had incomplete resection was asymptomatic and three (27%) had shown no improvement at all ($P = 0.008$).

The results of the functional respiratory evaluation of the

Fig. 1. All the lung specimens resected had pathologic confirmation of bronchiectasis.

Table 3
Symptomatic status of 108 follow-up patients (91%)

Symptoms	Complete resection	Incomplete resection	Total
Asymptomatic	72 (74%)	1 (9%)	73 (68%)
Clinical improvement	24 (25%)	7 (64%)	31 (29%)
No improvement	1 (1%)	3 (27%)	4 (4%)
Total	97 (100%)	11 (11%)	108 (100%)

follow-up group, with a minimum interval of two years, are shown in Table 4. There were no significant differences between pre- and post-operative data and the majority of patients had normal or near normal ventilatory function.

4. Discussion

In this study, we observed that the basal segments of the lower lobes were the most frequently affected (56%), especially the postero-basal segments. We would have expected it more frequently on the left side, because of a greater difficulty in drainage of the left main bronchus (due to its smaller diameter and greater angulation), and to its special relationship with the left pulmonary artery [7,8]. However, unlike other studies [6], we had more patients with right lung involvement. Nonetheless, 57% of the basal segments affected were of the left lung and the greater involvement of the right lung in our series resulted from a frequent involvement of the middle lobe. This is usually the result of regional lymphoid reaction to inflammatory and infectious processes, which cause lymph node enlargement, with extrinsic compression of the narrow intermediate bronchus, impairing drainage (middle lobe syndrome).

The presumptive diagnosis of bronchiectasis is still prompted by the clinical findings. Although the chest X-ray is a poorly sensitive diagnostic instrument, being normal in more than 20% of the limited forms, we have utilised it routinely as a screening tool. Indirect signs of bronchiectasis are circular and tubular shadows, loss of volume, compensatory hyperinflation, signs of pulmonary artery hypertension and parenchymal destructuration pattern (honeycombing) [9]. Classically bronchography was routinely used for confirmation of the diagnosis and for definition of the extension of the disease, but the unusual proportions of bronchography and CT scans used in our series reflects the transitory period covered. The use of bronchography has been steadily decreasing (it was used in 40% of our patients, mostly in the beginning of the series) and has been progressively replaced by computed tomography (CT) scans (used in 82%). Although bronchography achieves excellent topographical diagnosis of segment by segment from the surgical point of view, high-resolution CT scans, especially, have a high sensitivity and specificity and are easier to perform [10,11]. CT scans are also more appropriate for use in patients with severely affected pulmonary function, bronchospasm and acute infection.

Table 4
Spirometry values measured pre and postoperatively (in % of expected)[a]

	Pre-op	Post-op	*P*-value
FVC	90.8 ± 18.8	89.2 ± 13.6	0.70
FEV_1	83.1 ± 20.9	81.2 ± 18.2	0.57
MEF_{50}	58.6 ± 32.9	53.5 ± 26.1	0.26

[a] $P = 0.3$.

Fiberoptic bronchoscopy was performed in 78 of our patients (66%) as an adjuvant diagnostic method and to rule out benign or malignant bronchial obstruction, and for localization and collection of samples for microbiology. We now consider it essential in the pre-operative evaluation of all patients. In addition, it is currently routinely used for bronchial toilet preoperatively.

Finally, pulmonary angiography was seldom required, except in the cases with pulmonary hypertension, pulmonary sequestration and severe haemoptysis, but this may change, should the classification of Ashour et al. [12] prove to be of relevance in planning surgery.

Most of our patients underwent pre-operative ventilation spirometry as part of pre-anaesthetic evaluation of their respiratory function. As was the case with other series [13,14], we found a normal ventilatory pattern in the majority of the patients (66.3%) and an obstructive pattern in less than one third. Although the exact cause of airflow obstruction in these cases is not known, a multi-factorial aetiology is postulated, especially due to retention of thicken mucus or to immunologic abnormalities. However, we only had three cases of α-1 antitrypsin deficiency and we had no case of cystic fibrosis. Patients were physiologically evaluated again at a minimum of 2 years after the operation. Comparison of this data showed that surgery influenced neither FVC nor FEV_1, despite parenchymal resection, not an unexpected finding, since the excised lung segments contributed little to ventilation [14–19].

By contrast, we observed a considerable improvement of the clinical condition in 96% of the cases. Only four patients did not show improvement, three of whom had incomplete resection, which is in accordance with other authors' experiences [20]. Even among the nine patients who were subjected to pneumonectomy, five (56%) were asymptomatic and another two (22%) were improved, and none showed loss of ventilatory capacity. Seventy-five percent of the patients who did not improve had incomplete resection and all had tuberculosis or asthma. Only one of the 11

patients who had incomplete resection is asymptomatic. Patients with bronchiectasis of tuberculous origin required more extensive resection (24% had a pneumonectomy). Fifty percent were asymptomatic at follow-up.

As other authors [21] have demonstrated, bilateral bronchiectasis are not a contraindication to surgery and even incomplete resection often results in considerable benefit to the patient. In the small group of 10 patients with bilateral bronchiectasis, only two were operated on both lungs; hence the resection was incomplete in eight. In the majority of the cases, the decision to not perform a second thoracotomy was the patient's own and was a direct result of the clinical improvement after the initial procedure. Two of these patients remained asymptomatic at the time of follow-up.

In conclusion, surgical treatment of pulmonary bronchiectasis has few complications and can be carried out without or with very low mortality and morbidity rates. It improves symptoms, especially if all the diseased segments of the lung are removed. Surgery does not alter FVC and FEV_1 meaningfully, certainly because of the little contribution of the resected segments of lung to ventilation. Our results make us believe that surgery remains an excellent alternative in the treatment of bronchiectasis and its complications. It aims at avoiding recurrences, long periods of invalidating infectious symptoms and progression of the disease, and at prevention of complications.

We realise that a mean follow-up of 4.5 years is too short and that segments near the resected ones may become bronchiectatic in some patients 10–15 years later. Nonetheless, having in mind the benefits derived in terms of quality of life and of socio-economic impact (decreased hospital admissions, of medicine consumption, and of absence from work and loss of earnings), the attitude is evolving towards the early use of surgery [22], rather than as a last option in the treatment of the disease.

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Appendix A. Conference discussion

Dr K. Moghissi *(Yorkshire Laser Centre, UK)*: The thing I would want to ask you is that, in bronchiectasis it is not so clear-cut as in lobectomy or segmentectomy. The situation is that you have got a left lower lobe bronchiectasis, but probably the apical segment of the lower lobe is not bronchiectatic and the inferior branch of the lingula on the left side is bronchiectatic. There has been a lot of discussion about that. What would you do in the situation where you have left the apical segment of the lower lobe residual and now bronchiectasis has developed here after many years. A number of cases in my series have developed bronchiectasis after 10, 15, 20 years.

Dr Antunes: This is a historical series, and 11 patients were not considered to have had a radical resection of the bronchiectasis. For one reason or another, it was considered unwise to go further in the resection. As you saw, the majority of those patients were still symptomatic. Some were improved, but some were not improved at all. It may be that we did not do a correct surgery to start with, but at that stage we thought we had gone as far as we could go. I'm quite sure that some of those patients will eventually come up for further resection, if it can be done. In the majority of cases we thought that the restriction of ventilation precluded a larger resection, but it may be necessary to reconsider that option for further treatment.

Dr R. Khan *(Epsom, UK)*: I think you have probably answered my question to a certain extent. You knew which were your incomplete resections before the commencement of your trial. The other thing is, the principle of resection, it appears from your work, it has got to be very conservative. You do not remove all visible disease. You remove only

the totally damaged parts of the lung and the rest have got a high likelihood of improvement. Could you comment on those two points, please?

Dr Antunes: We had 11 patients who had incomplete resection, and this is a retrospective analysis, so we could only rely on the comments of the surgeons on their operative reports. We have not been able to go back on these patients who had incomplete resections to evaluate the three patients who had no improvement at all and the seven patients who were improved but were not completely asymptomatic. We don't know what their condition is, and the anatomical condition with regards to the disease, that is, if they have evidence of bronchiectases.

Dr A. Varela *(Madrid, Spain)*: I have two questions.

In bilateral disease what kind of approach do you use, and in this group of patients did you have cystic fibrosis patients and what kind of resection?

Dr Antunes: I didn't refer to it here, but it is referred to in the manuscript. Of the patients who had bilateral disease, and there were 10, only one had a bilateral operation. Currently we prefer to do bilateral operations sequentially, not in the same procedure. And the patients themselves opted for not having a second operation because they were already markedly improved from the first one. It was the patients' option and we can always go back to do the second lung operation, but we can only do that if the patients want it. I don't know if we were sufficiently persuasive to tell the patients: "If you are left with some disease, then you can only get worse at a later stage". But after 5 years, the patients appeared to have a functional and stable clinical condition. Again, at a much longer follow-up we may have to go back and do either resection on the same side, if there are still some signs of disease, or on the other side to tackle the disease, which was already present in 10 patients.

Dr Varela: How many patients diagnosed with cystic fibrosis?

Dr Antunes: There were 12 patients with cystic fibrosis.

Dr E. Ruffini *(Torino, Italy)*: Have you ever observed in case of lower lobe resection any recurrence of the disease in the lingular segment or in the middle lobe which rotate downwards?

Dr Antunes: For some unknown reason, we had a larger than usual number of patients with disease localized to the middle lobe. When we had disease which was localized to the lower lobe, we were usually able to resect the whole lobe and, therefore, completely eradicate the disease. But, again, the follow-up was made only by questionnaire and we looked into the functional assessment which had been done at one time or another for a mean of 2 years. So we did not assess clinically all the patients in the end. We wanted to know what the patients feel. I think we are now obliged to go to that next step, and, at least for the patients who consider themselves not asymptomatic, and that's one-third of the whole group, we will have to call them and submit them to CAT scans. If they have disease which warrants further surgery, this must be offered to them.