# SURGICAL TREATMENT OF BILATERAL BRONCHIECTASIS *

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The development of improved hilar dissection techniques in the performance of pulmonary lobectomy, combined with improvements in anaesthetic and blood-transfusion techniques and the ready availability of antibiotics, has given a tremendous impetus to the treatment of bronchiectasis. More recent developments in the resection of bronchopulmonary segments have enabled the surgeon to tackle the problem of diffuse bilateral bronchiectasis by resecting the involved segments and conserving the healthy ones. In this paper it is proposed to discuss the role of surgery in the treatment of bilateral bronchiectasis and to illustrate this with an analysis of a personal series of 50 surgically treated cases of bilateral bronchiectasis; 30 have had bilateral resection and 20 resection on one side only.

Bronchiectasis may best be defined as a condition of pathological irreversible dilatation of the bronchi; in most cases this is associated with infection, the production of sputum, and frequent episodes of pneumonitis or pneumonia. A few cases are almost symptomless, the so-called dry bronchiectasis; these usually manifest themselves by recurring episodes of haemoptyses.

Pathological dilatation of the bronchi associated with infection is a frequent aftermath of bronchial obstruction due to simple or malignant bronchial neoplasms or to the presence of inhaled foreign bodies which have not been recognized and removed. It is also associated with the healing of tuberculous lesions of the lung and with the healing of lung abscesses. It is not proposed to discuss these types of cases, which have an obvious primary cause; in general we employ the term bronchiectasis mainly to indicate the type of disease that has no obvious aetiological factors and which may perhaps be called 'idiopathic'.

Bronchiectasis, and particularly bilateral bronchiectasis, is a cause of continued ill-health and when encountered

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early in life may result in stunting of growth; in some cases there may be deformities of the chest. It is frequently associated with marked clubbing of the fingers and with the development of emphysematous changes in the lungs, resulting in progressive dyspnoea, and may eventually lead to the development of pulmonary hypertension and a terminal cor pulmonale. Rare cases may develop amyloid disease or brain abscess. Life expectancy is usually reduced.

A chronic cough and expectoration of foul sputum is usually present, although the text-book type of case, formerly associated with the creosote chamber, is rarely encountered today. However the foetid breath frequently results in these poor unfortunates becoming a social embarrassment both to themselves and to their contacts. They frequently appear unwell and in many cases are thin and poorly developed. The bronchiectatic segments of the lung are prone to frequent inflammatory episodes resulting in pneumonia and pleurisy, or in milder episodes which are, correctly or not, termed pneumonitis. In many cases the course is very much milder and the symptoms are far less marked. Many cases frequently appear to show natural remissions but these are usually only temporary.

The dry bronchiectatics may suffer quite considerable haemoptyses. This type of case may be asymptomatic and may be unrecognized for years. It is not uncommon to encounter a case of haemoptysis in later life in which malignancy is suspected and excluded by a full investigation. Bronchograms in this type of case will frequently reveal a bronchiectatic lesion as the causative factor.

Bronchiectasis is encountered at all ages and it is amazing how infrequently it is considered in the differential diagnosis. One frequently encounters cases masquerading as chronic bronchitics or considered to have 'weak chests'; their various episodes of infection are treated time and time again with antibiotics without further investigation being undertaken to demonstrate whether there is underlying bronchiectasis.

In cases of unilateral disease the results of surgery are very gratifying; the affected lobes or segments are removed without any noticeable loss in function, and there are few critics of this line of therapy. However, in approximately 50% of cases the condition is bilateral and this is naturally a much more serious problem. Most of the criticisms of surgical therapy for bronchiectasis are based on this type of case and I hope to be able to indicate that these criticisms are in the main unjustified, and that this type of case derives great benefit from surgery.

Many physicians and practitioners are very gloomy about the value of surgery in bronchiectasis. Most of these poor opinions are based upon the results of surgery of a past era and incomplete knowledge of the results obtainable at the present time.

It is not proposed in this paper to discuss the pathogenesis, pathology or symptomatology in detail, but mainly to indicate some of the misconceptions that exist regarding surgical therapy, and to stress that surgery has very much to offer these unfortunate people and is the only rational line of therapy.

## PATHOGENESIS

It is difficult to be dogmatic as regards the pathogenesis of bronchiectasis. The segments involved in the condition are such that the factor of inhalation of secretions cannot be held to be an important one. The segments commonly involved are the basal segments of the lower lobes, usually excluding the superior segment of these lobes. Whitwell[1] found the superior segment uninvolved in 78 cases of 114 lower lobe specimens removed for bronchiectasis. The middle lobe on the right side and the lingular segments on the left are frequently involved (Figs. 1a and 1b).

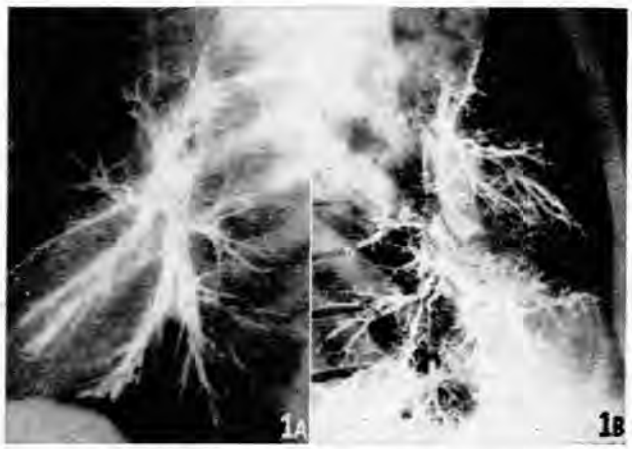


*Fig.* 1 (*a*). Left bronchogram demonstrating bronchiectasis of lingula and of basal segments of lower lobe.
*Fig.* 1 (*b*). Right bronchogram demonstrating gross atelectasis of right middle lobe. Contrast material has only entered the first inch of the grossly dilated middle-lobe bronchus.

The upper lobes are rarely affected apart from the occasional involvement of the anterior segment. It is thus seen that bronchiectasis tends to affect mainly the anterior portions of the lung, whereas lung abscess, which frequently follows on inhalation of foreign material and which is naturally influenced by gravitational factors, tends to involve the posterior portions of the lung. It is therefore unlikely that secretions from affected nasal sinuses trickling down the bronchial tree during sleep is an important factor.

The role of concomitant infection of the nasal sinuses is of interest and also is debatable. It has already been mentioned that it is not really valid to consider this as an aetiological factor. The para-nasal sinuses are frequently infected in bronchiectasis. Perry and King[2] found evidence of sinusitis in 66% of their cases. It is the prevailing opinion that the sinuses are involved secondary to the condition of the lung. This is suggested by the fact that one frequently encounters children with gross bilateral bronchiectasis before the para-nasal sinuses have developed. Riggins[3] found sinusitis in 30% of his cases and in over 50% the bronchiectasis was claimed to have appeared first. Unfortunately treatment of the sinuses is less effective than treatment of the bronchiectasis, but we have found that if the sinuses are treated at the same time as the bronchiectasis they frequently cause very little trouble in the future.

Cases are encountered where secretion from the nasal sinuses trickles down into the bronchial passages during the night and results in copious morning expectoration. These cases are frequently diagnosed as bronchiectatics. However bronchograms of these cases will frequently demonstrate a

normal bronchial tree. If this were an important aetiological factor one would anticipate that more of these cases would develop bronchiectasis and, in addition, that the bronchiectasis would affect the posterior areas of the lung more than it does. The most probable explanation is that the sinuses are infected secondary to the bronchiectasis; it is not feasible to treat the sinuses first, for they will simply become re-infected. Following surgical treatment of the bronchiectasis, therapeutic measures directed to the sinuses are more likely to prove successful.

A frequently recurring factor in the histories of these people is an episode in childhood of a severe chest illness, probably a bronchopneumonia, which appeared to have supervened on an attack of pertussis or measles. The onset of symptoms can frequently be traced back to this episode. The pathogenetic factor is probably bronchial obstruction due either to thick plugs of secretion in the lumen, or to external pressure on the bronchi from an associated lymphadenopathy. In many cases the lymphadenopathy is associated with a primary tuberculous complex; the glands may actually have ulcerated into the bronchus. The middle-lobe syndrome, or atelectasis of the middle-lobe associated with bronchiectasis, is generally accepted as being produced by this type of mechanism. During surgery for bronchiectasis one frequently encounters numerous peribronchial glands; in some cases these reveal evidence of healed tuberculosis and may even be calcified. However in many cases one can only assume that the glands that are present are secondary to the infection in the areas which they drain.

Following obstruction of the bronchi, either by thick viscid secretion in their lumen or by external pressure from the glands, atelectasis results in the segment or lobe. The bronchus itself, having a cartilaginous wall, is not able to collapse completely. As it is surrounded by an area of negative pressure there is a tendency for the walls of the bronchus to dilate. Infection is usually present and this leads to destruction of the bronchial mucous membrane and wall with scarring in the surrounding tissues, resulting in the changes becoming permanent and irreversible. This theory does not, however, adequately explain the development of bronchiectasis in cases in which the involved segments or lobes are not atelectatic. One may possibly hazard the view that in this type of case partial re-expansion has later occurred.

The advent of the new antibiotics and the new antituberculous drugs will probably result in a diminished incidence of bronchiectasis in the future. Untreated bronchiectasis is probably a progressive disease; infection in the involved segment is associated with enlarged regional glands which may then cause further atelectasis of uninvolved segments by pressure.

A congenital predisposing weakness of the bronchial wall may well exist and there frequently does appear to be a congenital tendency for the development of bronchiectasis. This is suggested by several cases of bronchiectasis which have been reported in identical twins; the interesting Kartagener complex, consisting of dextrocardia associated with sinusitis and bilateral bronchiectasis, supports this hypothesis. The rarely encountered congenital cystic bronchiectasis is considered by some to be a true congenital defect, but this is by no means universally accepted. Infants suffering from congenital cystic disease of the pancreas frequently have extremely viscid bronchial secretions and survivors may develop bronchiectasis. However the mechanism in this type of case is almost certainly one of bronchial obstruction and cannot be considered congenital.

## MORPHOLOGY AND PATHOLOGY

Bronchiectasis is frequently classified as saccular, cylindrical, tubular, fusiform or cystic. The saccular type is the most frequently encountered and its presence denotes an irreversible lesion. In many cases several varieties are present in the same patient and it does not appear that this distinction is of very much significance. The tubular or fusiform types can be just as permanent and irreversible as the saccular variety.

Dilatation of the bronchi may occur when portions of the lung are temporarily collapsed and by some this has been termed 'pseudo-bronchiectasis'. It is occasionally seen in temporary collapse of the middle lobe in children and may be seen in a lung collapsed by a pneumothorax or pleural effusion, and in some obscure cases of atypical pneumonia. This must not be mistaken for irreversible bronchiectasis. The appearances are due to relative shortening of the bronchi in the collapsed area with consequent broadening of their outline on the X-ray films. In most cases all or some of the bronchiectatic segments of the lung become atelectatic. This is not always the case and the volume of the bronchiectatic segments may not be diminished and may even be increased owing to obstructive or compensatory emphysematous changes. The bronchi are dilated with ulcerated mucous membrane frequently covered with exudate. The ciliated mucous membrane has usually disappeared and squamous metaplasia frequently results. The surrounding lung may be solid or emphysematous and usually reveals a round-cell infiltration and interstitial fibrosis, it is frequently very vascular, and there are said to be numerous communications between the pulmonary and bronchial vessels. When the involved segments are not atelectatic it may be very difficult at operation to recognize and delineate them unless adequate bronchograms have been obtained. However, an absence of the normal carbon pigmentation is an indication of the relative lack of function of these parts of the lung; if not atelectatic they frequently feel unhealthy and abnormal and may show emphysematous changes. There may be numerous adhesions to the chest wall, mediastinum or the diaphragm, particularly if there have been episodes of pneumonia or pleurisy. However the surgeon is frequently surprised in extensive bronchiectasis to find an absence of adhesions.

Clubbing of the fingers may be present but complications such as amyloid disease or brain abscess are but rarely met with today. However the danger of their development is very real in untreated cases. Cases of neoplastic degeneration have been reported but this possible outcome need not be seriously considered.

## DIAGNOSIS

Bronchiectasis can only be diagnosed with certainty by outlining the bronchi with radio-opaque oil. Routine X-ray films of the chest may be remarkably normal but will frequently indicate evidence of disease, particularly if the bronchiectasis is associated with atelectasis. X-rays taken

without the condition being in any way comparable to their status before operation.

The persistence after operation of a non-productive cough may even be due to habit in some cases.

Untreated bronchiectasis is more likely to cause new bronchiectasis from the constant bathing of adjacent segments in secretion, or by pressure on bronchi by the enlarged lymph glands resulting from infection.

4. *That operation is dangerous.*

Resections for bronchiectasis are now routine procedures in thoracic surgical clinics and in most series the mortality is very low indeed. In the present series there have been no deaths.

SURGICAL THERAPY (*cont.*)

*Bronchography*

The first requirement in surgical therapy is a full and adequate diagnosis. Bronchograms must be available and it is essential that they demonstrate every part of both lung fields to ensure that a diseased segment is not overlooked. In most cases the bronchograms will be performed under local anaesthesia, but in children a general anaesthetic is usually required to ensure satisfactory films. The advent of the short-acting relaxants has rendered the anaesthetic technique relatively safe and facilitates the operative procedure.

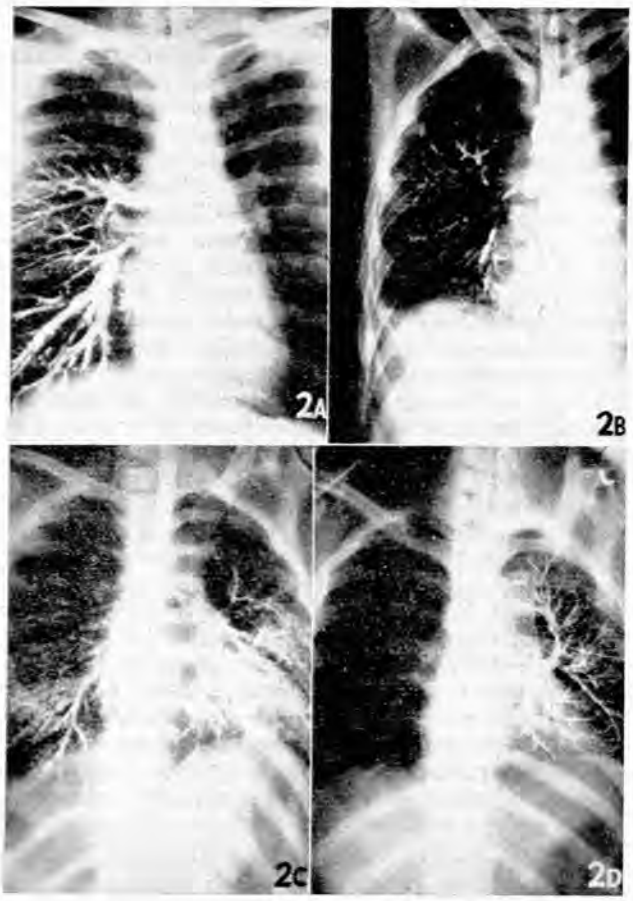


*Fig.* 2 (*a*). Bronchiectasis of right middle and lower lobe.
*Fig.* 2 (*b*). Following resection upper-lobe bronchi have swung down to fill the hemi-thorax.
*Fig.* 2 (*c*). Bronchiectasis of lingula and basal segments of left lower lobe.
*Fig.* 2 (*d*). P.A. bronchogram following resection, demonstrating downward displacement of superior segmental bronchus of lower lobe and of anterior segmental bronchus of upper lobe.

It is important to maintain an adequate airway throughout the procedure. The most suitable technique is to insert an intratracheal tube through which a small catheter is inserted so that the end protrudes beyond the tip of the larger tube. Thus the intratracheal tube is at no stage blocked by the radio-opaque oil and the anaesthetist is able to aerate the patient adequately.

I prefer the use of iodized oil that has been thickened with sulphanilamide in suspension, as first recommended by Dormer and Wiles.[7] This has the advantage that there is less dispersal of the oil into the alveoli of the lung. Dionosil is preferred by some, in aqueous or oily solution. The former is far too irritating to employ under local anaesthesia and while the latter is much more satisfactory, I personally feel that the films are not comparable with those obtainable by the use of sulphanilamide-thickened oil. In children, and in adults when a general anaesthetic is required, it is convenient to combine the bronchogram with a preliminary bronchoscopy and to aspirate all the bronchial secretions, thus permitting better filling of the bronchial tree.

To obtain good-quality bronchograms under local anaesthesia, considerable patience is required on the part of the operator, but it is not a difficult technique. Adequate anaesthesia of the pharynx, larynx and bronchi is essential. The oil can usually be dripped onto the base of the tongue held firmly forward to discourage swallowing; the oil then trickles down between the cords into the larynx and the subject is suitably postured to direct the oil. It is a simple matter to introduce a rubber catheter into the anaesthetized larynx *via* the mouth or the nose, and this is perhaps a more reliable method of instilling the oil. In my opinion the employment of the crico-thyroid route is unnecessary and unwise.

Bilateral bronchograms may be performed at the same sitting. If this is done, it is important to obtain bronchograms of the right side first; the essential films required are a lateral film and a postero-anterior film, and if the left side has been filled first it is not possible to obtain the required right lateral view of the right bronchial tree. The most informative view for the left side is a left posterior oblique film and therefore it is both feasible and desirable to do the left side after the right side has been completed. A right posterior oblique film should be obtained to demonstrate the condition of the superior segment of the left lower lobe.

*Choice of Side for First Operation*

There is no fixed rule in choosing the side for the first operation. In general I prefer to operate upon the more involved side and thus obtain the maximal improvement as soon as possible. In most cases this involves operating upon the left side first. However, in many cases one will find the disease on the left side associated with a simple right middle-lobe bronchiectasis and atelectasis. This

localized disease is often a greater source of secretion than is the disease on the left, and it is frequently the site of repeated infective episodes. In this type of case maximal improvement may be obtained by resecting the right middle lobe first.

Another fact to be considered is that during the second operation the anaesthetist may have to maintain the patient on the few segments remaining in the contra-lateral lung. This is probably merely a theoretical objection since usually only non-functioning segments have been removed. At times we have considered it would be necessary for the anaesthetist to partially inflate and utilize the lung that was being operated upon, with natural inconvenience to the surgeon. However in practice this inconvenience has never had to be tolerated and adequate aeration has been possible with the very few normal segments on the contra-lateral side.

In the majority of cases it will be more logical to do the worse side first; frequently this will suffice and then a second operation will not be required.

*Pre-operative Preparation*

The pre-operative preparation of these patients is important. They should be hospitalized at least a week before the operation. Naturally, a full clinical investigation and all the necessary pathological investigations must be done. It is always worth while seeking for any evidence of amyloid disease in the patient with long-standing disease and foetor.

While awaiting surgery they should continue with postural drainage at home and they should be adequately instructed in the correct postural drainage techniques required. Conscientious postural drainage, together with appropriate antibiotic therapy, will frequently assist in diminishing the quantity of the secretion. Instruction in breathing exercises by a trained physiotherapist is absolutely essential and many cases with apparently poor lung function can be vastly improved by these measures. The organisms in the sputum are investigated and their sensitivities to the various antibiotics determined and a course of the most suitable antibiotic started several days before the operation. The condition of the sinuses and tonsils will have been assessed at an earlier stage and any gross disease will have been corrected. It is our policy always to wash out the antra a day or two before surgery and again after the operation. After the completed resection there will be less tendency for antral disease to recur; the primary source of infection has been removed and purulent sputum will no longer spray into the sinuses with each cough. The blood grouping is determined and suitably compatible blood is obtained.

Considerable attention to detail in all aspects of the surgical management of these cases is obligatory. It is vital that this type of surgery be handled in institutions where the resident medical and nursing staff are fully conversant with all the aspects of the pre-operative and post-operative treatment.

*The Operation*

Certain problems associated with the actual surgery of bilateral bronchiectasis are worth mentioning. These people are frequently in rather poor condition and the respiratory reserve and pulmonary function have been frequently considerably reduced by the loss of the involved areas of the lung. Many show the effects of chronic toxemia and may be in very poor condition.

The anaesthetist is frequently handicapped by the profuseness of the bronchial secretions and may experience difficulty in obtaining adequate aeration of the patient. It is advisable to perform a preliminary bronchoscopy and to aspirate the bronchial tree as thoroughly as possible. Despite this precaution, however, the bronchial secretions usually re-accumulate in the bronchial tree once the lung is handled, and secretion in the more peripheral bronchi and diseased areas is expressed into the larger bronchi. At the time of division of the bronchus I usually insert a suction tube and aspirate as much bronchial secretion as possible, thus assisting the anaesthetist in his difficult and often trying task.

I prefer to employ the face-down position for all pulmonary work and in this type of case with profuse bronchial secretions it is almost essential. The patient lies prone with the head slightly lower than the feet and all secretions tend to drain automatically into the trachea, where they can be aspirated and removed by the anaesthetist. In the commonly employed lateral position the underlying lung is at a grave disadvantage, for all the secretions from the operated lung tend to gravitate and spill over into its bronchial tree. If the secretion is profuse then a bronchus blocker, with all its attendant difficulties, must be employed. A further disadvantage of the lateral position is that the weight of the mediastinum rests on the underlying lung and thus hinders its functioning. In the face-down or prone position the mediastinum remains central and the opposite lung is able to function more adequately.

At operation it is essential to remove all the segments involved, if possible without imperilling the blood supply of the segments which are to remain.

The bronchi to be removed should be sectioned as close as possible to the parent trunk to avoid leaving any blind pockets in which secretion may accumulate. Involved segments usually separate quite readily from their neighbours along the intersegmental plane. It is important to ensure that no unsutured intersegmental bronchi are left behind, for this may result in a persistent post-operative air leak; this may well lead to a complicating pneumothorax or empyema and may result in incomplete expansion and loss of function. These lungs are frequently emphysematous, and a fairly considerable alveolar leak may ensue, but this is of no consequence if it is dealt with by adequate water-seal drainage. At the completion of the operation a thorough bronchial toilette and, if necessary, a bronchoscopic aspiration should be performed.

Surgical shock is but rarely encountered after this type of surgery if adequate blood replacement has been maintained during the operation and if the surgical manoeuvres are gentle and undue traction on the mediastinum has been avoided. If post-operative shock does occur, suitable therapy must be given.

*Post-operative Care*

The immediate post-operative objectives are to achieve and maintain complete expansion of the remaining portions of the lung. The mediastinum will frequently tend to move

over to the operated side to compensate to some extent for the loss of tissue but it is desirable that this movement of the mediastinum be reduced to a minimum. Adequate water-seal drainage, combined occasionally with negative suction, will allow any air and fluid that may have accummulated in the pleura to escape. The drainage is usually maintained for 2 to 3 days.

It is essential to keep the bronchial tree free of secretions. The patient should be encouraged to cough, but this is frequently painful and he is naturally reluctant to indulge in free uninhibited coughing. He must be adequately bullied and must be assisted by the use of analgesics. There is no objection to giving morphia. Aerosolized detergents and the intravenous injection of sodium iodide may assist in loosening the sputum.

After surgery the sputum often tends to be thick and viscid and very tenacious. This may to some extent be due to dehydration. Moreover these patients have a natural tendency to bronchitis and tracheitis as the bronchi have been constantly bathed in foul secretions. The tracheobronchitis is aggravated by the inhalation of irritating anaesthetic gases and the fact that an indwelling intratracheal tube has been present. In addition there is a spill-over of the secretions from the opposite side, which may be very considerable. The patient often has too much pain and is too exhausted to adequately expel the tenacious secretions of his own accord. In a few cases Overholt has explored the possibilities of avoiding the spill-over of secretions by performing simultaneous bilateral resections at the one sitting. This procedure is probably too heroic for most surgeons.

Post-operative bronchoscopic aspiration is usually required and can be quite simply performed under local anaesthesia. With the bronchoscope in position it is possible and advisable for the patient to cooperate by coughing and thus expelling secretions from the more distal smaller bronchi. Post-operative bronchoscopic aspirations are usually well tolerated even in small children. Nasal suction may sometimes be of value and is worth trying before bronchoscopy is performed. It is frequently found that if the tongue is held forward a small catheter introduced into the nostrils can be passed down the larynx and trachea into the bronchi. Even if this technique is unsuccessful, its attempted performance is frequently valuable by causing paroxysms of free coughing. Post-operative physiotherapy is continued and postural drainage will often assist in the expectoration of plugs of secretion. These cases are encouraged to be ambulant as soon as possible.

*Post-operative Complications*

Post-operative empyema is rarely encountered. Occasionally a peribronchial abscess develops around the sutured bronchial stump; this is not surprising, for some contamination at this site is difficult to avoid. The peribronchial abscess usually drains spontaneously into the bronchus but may rarely involve the general pleural cavity. The abscess is usually spontaneously obliterated by the expansion of the surrounding lung tissue. Occasionally granulations form in the bronchus at the line of suture and may result in a late small haemoptysis. A loosened stitch may need bronchoscopic removal and the granulations may require cauterization.

The occasional development of a tuberculous lesion after lobectomy for bronchiectasis has been reported.[8] This is probably purely coincidental. No such complication has occurred in this series.

## PRESENTATION OF SERIES

This series comprises 50 consecutive European cases of bilateral bronchiectasis treated surgically during the 5 years 1952-56. The majority of these cases have been treated in the thoracic surgical wards of Wentworth Hospital, Durban. Non-European cases are not included because of the difficulty in obtaining an adequate follow-up.

The series is confined to cases of bilateral bronchiectasis in whom at least one operation has been performed. Cases in whom the symptoms did not warrant surgery have been excluded, as have cases not considered suitable for or refusing surgery. Patients with unilateral disease and mild dilatation of some of the bronchi on the opposite side were not regarded as cases of bilateral bronchiectasis; the series is confined to cases in whom the bronchiectasis on each side has been extensive enough to have required or warranted bilateral surgical resection, even though surgery on the second side has not always been later indicated or necessary.

The analysis and results in this series have been largely based on clinical assessment and appraisal. Complicated pulmonary function tests have not been employed, mainly because we have little faith in their practical value and we have considered that a clinical appreciation before and after surgery gives a more reliable and less controversial measurement of pulmonary function. This relatively small series is obviously not of great statistical value and is presented mainly to illustrate the type of cases presenting for surgery, the results of such therapy, and the almost negligible risk involved. No large series of cases of bilateral bronchiectasis has been reported.

Of the 50 cases, 30 have undergone bilateral surgery; 20 have only had one side operated upon. The reasons for not operating upon the second side are considered later. The principal factor in deferring further surgery has been the paucity of symptoms after the first operation. The decision to undertake bilateral surgery has usually been made at the original assessment, but all cases are reviewed before the second operation is undertaken.

These cases comprise 83 operations; this includes 3 cases in whom an additional resection of one segment has had to be performed later.

The period of post-operative observation is too short to permit of any valid statistical conclusions being drawn (Table I). In practice it has been found that the degree of

TABLE I. LENGTH OF POST-OPERATIVE OBSERVATION (BILATERAL RESECTION)

| | |
|---|---|
| 4 years or more | 5 |
| 3 years | 12 |
| 2 years | 4 |
| 1–1½ years | 5 |
| 6–12 months | 4 |

improvement can be fairly accurately estimated 6 months after completion of the bilateral surgical programme. At this time the majority of patients have become stabilized. The bronchitis resulting from the foul secretions has had an opportunity to subside, and in many cases the disease of

the sinuses has been treated and shown improvement; moreover it is possible to determine that no atelectatic segments remain and that no complications have ensued. In short, if the case is likely to prove disappointing it can usually be determined at this time.

The 17 cases that have been observed for at least 3 years after bilateral surgical resection have all confirmed the tentative assessment made 6 months after surgery.

*Sex.* Of the 30 cases who have had bilateral surgery performed, 19 are female and 11 male. Of the remaining 20 cases, 13 are female and 7 male.

*Age.* The majority of the cases have been between 10 and 40 years of age (Table II). Five children under the age of 10

TABLE II. AGE INCIDENCE

| *Age* | *Bilateral* | *Unilateral* |
|---|---|---|
| Under 10 .. .. .. .. .. | 5 | 2 |
| 10–19 .. .. .. .. .. .. | 11 | 3 |
| 20–29 .. .. .. .. .. .. | 8 | 8 |
| 30–39 .. .. .. .. .. .. | 5 | 3 |
| 40 and over .. .. .. .. .. | 1 | 4 |

have had bilateral surgery; 2 were only 2½ years old at the time of surgery. Operation on one side only has been performed in 2 other children under 10. Only one patient over 40 has had completed bilateral surgery; he was 48 years of age. Four in this age group have had the one operation, the eldest being 55.

In 41 operations in the bilateral group and in 12 in the unilateral group, the superior segment of the lower lobe was conserved. In 6 operations this segment was removed together with the basal segment of the lower lobe; in 4 cases because it was the site of obvious disease and in 2 instances becaused it failed to expand adequately after completion of the resection of the basal segments and it was considered advisable to remove it immediately. In 2 cases this segment required later removal at a separate operation and in one case more removal will probably prove necessary.

One case of the Kartagener complex with bilateral bronchiectasis has been seen but has refused surgery.

*Bilateral Resections—Segmental Distribution*

Table III indicates the number of segments removed in the bilateral cases. In three-quarters of these patients, 11, 12 or 13 segments were removed, out of a total of 19 segments. Fig. 3 indicates the full details of the segments

TABLE III. NUMBER OF SEGMENTS RESECTED. BILATERAL RESECTIONS

| *Segments* | *Cases* |
|---|---|
| 13.. .. .. .. .. | 4 |
| 12.. .. .. .. .. | 4 |
| 11.. .. .. .. .. | 15 |
| 9.. .. .. .. .. | 1 |
| 7.. .. .. .. .. | 5 |
| 4.. .. .. .. .. | 1 |

removed. Most cases have had symptoms for many years, chiefly cough, sputum and episodes of infection. It has been found impossible to accurately estimate the quantity of sputum but this has varied from 1 to 4 oz. per day to the almost incredible amount of more than a pint in one individual. The average has been 1-2 oz. Haemoptysis on one or several occasions has been noted in several patients; this has been insignificant in amount in most cases and it

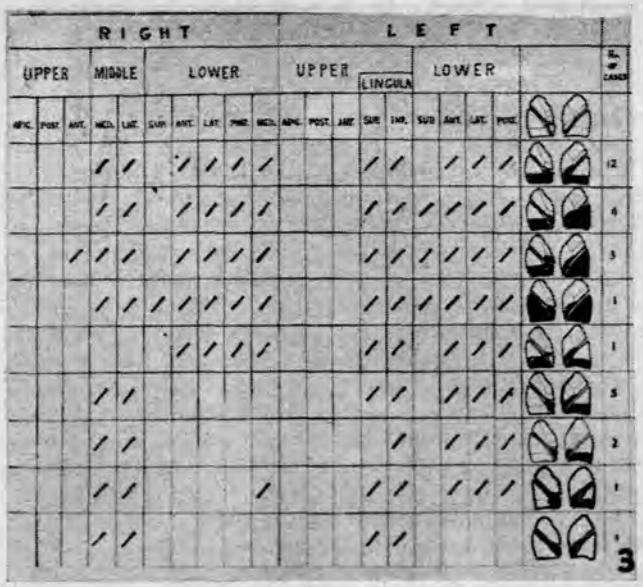


*Fig.* 3. Figure illustrating details of segments resected.

has not been possible to compile a complete record of this incidence. In only 2 cases was haemoptysis of significant quantity and the main symptom.

The time intervening between the two operations has on the average been 4 to 6 months. In 4 cases the interval has been more than a year; in one it was only 2½ months.

*End Results.*

The following factors have been considered in attempting to assess the degree of improvement: Persistence of cough and amount of sputum, degree of dyspnoea, general well-being, loss or gain of weight, and the incidence of infective episodes and haemoptyses.

In 8 of the 30 cases bilateral bronchograms have been performed since the completion of surgery; in 12 others post-operative bronchograms have been performed on one side only. In no instance was the patient embarrassed by the performance of post-operative bronchograms.

I have divided the cases into 3 groups in determining the degree of benefit following surgery. This classification is, of necessity, artificial:

*Group A*, cases that have shown maximal improvement and can be considered to be almost normal individuals. They have either less effort dyspnoea than previously or their effort tolerance has not been appreciably reduced below the pre-operative level. They are not conscious of any undue effort dyspnoea apart from that associated with particularly strenuous exercise. The amount of sputum produced is almost negligible. This group of patients are well satisfied with the operative procedures, have no regrets, and consider themselves cured. In this group there are 16 cases, approximately 53%. Several indulge in strenuous sporting activities, and one patient is playing rugby. Two cases included in this group have been lost sight of; they were last seen one year and 18 months respectively following surgery; at that time they were completely asymptomatic. Two cases have since had an uneventful pregnancy. Included in group A are two children aged 2½ to 3 years at

the time of surgery. In them the period of follow-up is 18 months and 2½ years. A child aged 6 in this group has been observed for 3 years.

*Group B*, consisting of patients with normal exercise tolerance, or at the most some slight reduction, particularly noticeable on fairly strenuous effort. In several cases their effort tolerance is greater than it was before surgery. This group differs from group A in still producing up to ½ oz. sputum daily; this is very much less than it was before surgery but it is more than would be anticipated in the normal person. There is no more than the normal incidence of intercurrent infection. Apart from still producing a certain amount of sputum they are relatively normal. There are 10 cases included in this group. Several of these patients have persistent sinus infection, which has either not responded to treatment or has not been persevered with. The sputum might well arise from this source. In 8 of these cases at least one post-operative bronchogram has been performed; 3 show some mild bronchial dilatation in the segments that have had to adjust most, viz. the superior segment of the lower lobe or the anterior segment of the upper lobe. Two children of 7 and 9 appear in this group; one case was aged 48. The distribution of the resected segments is basically the same as in group A. All cases in this group are well satisfied with the operative procedures. Several might almost be promoted to group A.

*Group C* comprising 4 cases in whom the degree of improvement must be qualified. They have all shown marked improvement but cannot be considered as satisfactory as the cases in groups A and B. The segmental distribution in each of these 4 cases was almost identical; they have each had a resection of the basal segments of both lower lobes together with resection of the lingula and the right middle lobe. In all 4 cases several post-operative bronchograms have been performed without causing them any distress. Following are short reports of these cases:

*Miss N., age* 23. *Bilateral resection* 1952.

Had been producing 2-3 oz. of sputum daily. Had several small haemoptyses several months following completed surgical programme. It was then discovered that a bronchiectatic anterior segment of the right upper lobe, which had been demonstrated on the pre-operative bronchograms had unfortunately not been removed. She is now completely symptom-free but is unable to undertake more than routine activities. Post-operative physiotherapy was not persevered with despite our encouragement. X-ray of chest reveals satisfactory inflation of both lungs.

*Mrs. v. d. V. Bilateral resection* 1953.

Had been producing 3-4 oz. of sputum daily with repeated episodes of infection. Superior segment of right lower lobe became atelectatic and required removal. She is well and working and is on an extended trip overseas. She still produces about ½-1 oz. of sputum a day but has not had any infective episodes for the past year. X-ray of the chest reveals satisfactory inflation of both lungs; post-operative bronchograms reveal no new bronchiectasis. She has a persistent sinus infection and some degree of allergic tracheobronchitis. She has recently had a partial thyroidectomy performed.

*Miss A. Bilateral segmental resection* 1954.

Had been producing 4-6 oz. of sputum daily together with repeated episodes of infection. Superior segment of left lower lobe became atelectatic and required later removal. She is well and working but still produces ½-1 oz. of sputum a day; she is unable to play games. X-ray of chest reveals satisfactory inflation of both lungs and post-operative bronchograms reveal no evidence of new bronchiectasis. She is very satisfied with her degree of improvement.

*Mrs. D. Bilateral resection* 1955.

She was one of the wettest cases of bronchiectasis I have ever seen and was producing 6-8 oz. of sputum daily. She had a history of repeated inflammatory episodes and was cyanosed even at rest. The superior segment of the left lower lobe became atelectatic and she has been observed for the past 18 months as this segment appears to be re-aerating. However I consider that removal of the segment will be necessary as she is still producing about 1 oz. of sputum daily. The remainder of the lung fields are well inflated. She is no longer cyanosed and her effort tolerance is considerably improved.

It can be seen that these 4 cases can certainly not be regarded as poor results but they have not measured up to the standards which have been attained in the remaining cases in this series.

*Unilateral Resections*

In 20 cases resection has been performed on one side only. Table IV indicates the reasons for not proceeding with the contralateral operation. All these cases have shown marked improvement. Apart from one patient who has since died as the result of a brain abscess they are all well and demonstrate considerable clinical improvement. Table V indicates the segments which have been resected in this group. In 5 cases the improvement following the first operation has been so very marked that further surgery has not been indicated. These individuals are almost completely asymptomatic; this status has been maintained for at least 2 years. The distribution of the disease on the opposite side comprises 3 cases with middle lobe disease, one with lingular involvement and one case with involvement of the basal segments of the left lower lobe and the lingula.

TABLE IV. REASONS FOR NOT OPERATING ON SECOND SIDE

| | |
|---|---|
| Inadequate symptoms | 5 |
| Unsuitable | 4 |
| Second operation 1957 | 3 |
| Untraced | 3 |
| Decision postponed—young children | 2 |
| Patient refused | 1 |
| Died | 1 |
| Right resection planned plus mitral valvotomy | 1 |

TABLE V. SEGMENTAL DISTRIBUTION IN OPERATED SIDE IN UNILATERAL CASES

| | |
|---|---|
| Left basal and lingula | 12 |
| Left basal and lingula and anterior segment of upper lobe | 1 |
| Right basal and middle lobe | 1 |
| Right middle lobe | 6 |

In 3 cases surgery has recently been completed on the second side. This second operation consisted of middle lobectomy in one and resection of the middle lobe and the basal segments of the right lower lobe in 2. The convalescence in each case has been uneventful and an excellent result is anticipated in each case.

Two cases were in very young children—aged 4 and 6 years respectively. Marked improvement has resulted and the decision regarding further surgery has been postponed.

Although they have very few symptoms it is probable that further surgical resection will be required later. This will necessitate resection of the middle lobe and the basal segments of the right lower lobe in one case and the lingula and basal segments of the left lower lobe in the other.

Four cases have not been considered suitable for further surgery. Two are over 40 years of age and are very emphysematous. One woman is an alcoholic; she has demonstrated considerable improvement but has returned to her dissolute ways and is not considered a suitable subject for further surgery. The other 3 cases demonstrate considerable improvement and have frequently requested the second operation. They have been disappointed at our refusal.

One case has since been diagnosed as having mitral stenosis. She had a left-side resection 5 years ago and the mitral stenosis was only diagnosed 2 years later. Her clinical records at the time of the original assessment indicate that the cardiovascular system was considered to be normal and the X-ray of the chest did not reveal any mitralization of the cardiac contour. She has no symptoms referrable to her mitral stenosis but I am reluctant to perform a right-sided resection until a mitral valvotomy has been performed. We are contemplating combining the right-sided resection with a mitral valvotomy performed through the right chest. One patient has refused the second operation. He demonstrated marked improvement following resection of the basal segments of the left lower lobe and lingula and I have recommended resection of the right middle lobe but he is so pleased with his improvement that he has refused. He is illiterate; he states that he was so ill as a child that the doctor would not allow him to attend school.

Three cases have not been traced. They all demonstrated considerable improvement but we have lost contact with them. One patient has since died; he was the grossest case of bilateral bronchiectasis I have ever seen. The foetor was indescribable and it was necessary to nurse him in the open. After a right-sided resection he showed marked improvement, but he developed a brain abscess 3 months later, from which he died.

One case has had 2 operations on the one side; lingulectomy was performed in 1952 and the basal segments of the left lower lobe necessitated resection in 1956. The original bronchograms were inadequate and misleading.

## COMMENT

The results obtained in these cases supports the beneficial role which surgery plays in the treatment of bilateral bronchiectasis.

Every one of the 30 cases who have had bilateral surgery showed marked improvement; 26 are almost normal individuals and the present condition of each of the remaining 4 is almost unrecognizable as compared to the status before surgery.

The 20 unilaterally treated cases also demonstrate equally gratifying results. The 3 that have since had a second operation this year are now free of symptoms. Even the 4 cases whom we did not consider suitable for a further operation have been considerably benefited by the unilateral procedure.

The one case who has since died also demonstrated almost fantastic improvement after his first operation; the foetor in his breath had almost disappeared and his presence indoors could now be tolerated. He was very fit on discharge.

The most outstanding feature noted in the later observation of these cases, apart from the marked diminution in sputum, has been the gain in weight in nearly every case and improvement in general well-being. The children seem to show a spurt in growth. In several cases with marked clubbing the fingers have become normal.

The degree of improvement in all these cases is even more remarkable when contrasted with the extremely poor and pitiable condition of many of them before surgery.

## SUMMARY

The rationale of the surgical treatment of bilateral bronchiectasis by means of multiple segmental resection of the diseased segments is discussed.

The pathogenesis of the disease is discussed and it is pointed out that the segments involved are usually the anterior ones. This suggests that inhalation of foreign material, which is a frequent cause of lung abscess, does not appear to be an important factor in the pathogenesis of bronchiectasis. Bronchiectasis probably develops from obstruction of the smaller bronchi, either by thick secretion blocking the lumen or from the external pressure of glands during an episode of bronchopneumonia; this is frequently associated with pertussis or measles or with a primary tuberculous complex. The possible role of concomitant infection of the nasal sinuses is discussed and the view is expressed that the disease of the sinuses is probably secondary to the disease of the bronchi. A congenital weakness of the bronchi may be a predisposing factor.

The commonest criticisms of surgical therapy are discussed. The argument that conservative therapy is adequate is not acceptable; any improvement resulting from this type of therapy is purely temporary and palliative.

The principles of surgical therapy, particularly the indications and selection of patients for operation, the pre- and post-operative treatment and some details of the actual surgery are discussed. The view is expressed that children withstand surgical resection very satisfactorily and that it is not necessary to wait if the symptoms indicate that surgery is worth while. Two children were 2½ years of age at the time of operation. The important role of physiotherapy is stressed.

This paper is illustrated by a series of 50 consecutive personally treated cases of bilateral bronchiectasis without operative mortality; 30 have had bilateral segmental resections and 20 have had surgery on the one side only. Of the 30 cases undergoing bilateral surgery the results in 16 are considered excellent, 10 are considered very satisfactory and in only 4 must the assessment of the degree of improvement be qualified. Even these latter 4 cases consider that they have been markedly improved and no case has been converted into a respiratory cripple.

There have been various reasons for not undertaking a second operation in the series of 20 patients. The most

common cause has been because of the degree of improvement resulting following the first operation. Several cases have since had the second operation in 1957.

I should like to express my appreciation of the untiring efforts of the resident medical and nursing staff and of the physiotherapy staff of the Wentworth Hospital, and my admiration of the contribution of the anaesthetists in their difficult and often trying task. Finally I should like to express my admiration of the patients for being so cooperative and patient in what is frequently a rather prolonged series of investigations and treatment.

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