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LOBECTOMY AND PNEUMONECTOMY FOR PULMONARY TUBERCULOSIS

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THE hope that it might be possible to treat tuberculosis of the lung by surgical excision is by no means new. It was attempted unsuccessfully by Bloch in 1811 and by Ruggi in 1883. Tuffier removed the apex of a lung containing a tuberculoma in 1891 and obtained a good result. In 1942 Thornton and Adams collected 29 cases from the literature and added 5 cases of their own. The mortality from pneumonectomy in this series was 44·83 per cent. and there were only 41·38 per cent. satisfactory results. The mortality from lobectomy was 25·49 per cent. and 68·62 per cent. satisfactory results were obtained. Following the development of the dissection technique for pulmonary resection by Blades and Kent in 1940, renewed interest in the possibilities of excision therapy was aroused. Since that time many reports have been published, particularly from American centres. More recent results have been influenced favourably by streptomycin therapy.

It was to be expected that the greatest problem following removal of part of the pulmonary tissue for tuberculosis would be a spread of disease to previously uninvolved areas or recrudescence of pre-existing disease. Tuberculosis is rarely confined to one side of the chest even on roentgenological evidence. Since thoracotomy has become a common procedure, it is evident that the X-ray examination gives less detailed information as to the extent of the disease than was supposed. It is not uncommon when the chest is opened in anticipation of doing a lobectomy to find many quite unsuspected lesions in the other lobe or lobes. It is probable that many so-called spreads are actually recrudescences of pre-existing lesions. A review of all available films of a patient will sometimes disclose an area of infiltration in earlier films that was not evident in those made immediately before operation.

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In the operations and the work described in this paper the author has been assisted by Dr N. S. Shenstone, Dr F. G. Kergin and Dr H. S. Coulthard at the Toronto General Hospital and the Toronto Hospital for Tuberculosis.

It is much more difficult than has been thought in the past to be sure of localised disease.

That excision would find a place in the therapy of pulmonary tuberculosis was inevitable, because certain forms of disease could not be treated successfully by other methods. Realisation of the shortcomings of these various forms of therapy should not lead to their being abandoned. Indeed, nearly every attack that has been suggested should find some place in our armamentarium of treatment. The indications for their employment, however, should become much more exacting, and excisions should be undertaken in some instances as a primary procedure, in others when older and more orthodox methods have failed. There has been an increasing realisation that even though the primary effect of pneumothorax be good, the end result may be unsatisfactory. Persistence in the maintenance of an inefficient pneumothorax frequently leads to complications. Intrapleural pneumonolysis, if used to divide extensive adhesions or when many tubercles could be seen beneath the visceral pleura, was followed by tuberculous empyema in a high percentage of cases. Operations on the phrenic nerve were of limited value even in lower lobe lesions. Extrapleural pneumonolysis proved unsatisfactory in the long-term view and should be reserved for adolescents and children when pneumothorax cannot be accomplished. Thoracoplasty failed to collapse some cavities even with a careful selection of patients and an apparently adequate resection of ribs. If done for a caseating lesion that had not yet excavated, subsequent evacuation frequently left an open cavity and all too often the disease became widely disseminated. Tuberculous bronchitis was not controlled by thoracoplasty and at best the sputum became negative only after a long period. The local lesion of bronchostenosis was unaffected by collapse and the co-existing pulmonary disease was often made worse.

The first lobectomy for pulmonary tuberculosis to be undertaken deliberately in Toronto was performed by Dr N. S. Shenstone on 14th November 1936. The patient had a cavity of two years' duration in a lower lobe. It had not been controlled by phreniclasia and pneumothorax could not be established because of pleural adhesions. A widespread thoracoplasty seemed the only alternative. The tourniquet technique was used and the post-operative course was complicated by an empyema for which a local thoracoplasty became necessary. The final result was satisfactory, but because of the morbidity in this case resection was not undertaken again for tuberculosis until the dissection technique of lobectomy and pneumonectomy had been established for non-tuberculous disease. Since 10th March 1940, resection has been given a gradually increasing place in the management of certain forms of pulmonary tuberculosis. The first 34 cases were reported in 1945. Sufficient time has elapsed to justify a further report upon our experiences.

The use of streptomycin seems to have made it possible to extend

somewhat the indications for resection. Its most important effect is upon the recrudescence or spread of disease immediately after operation to the ipsi-lateral lobe or contra-lateral lung. It hastens the healing of tuberculous bronchitis although it rarely cures it. It almost certainly lessens the chance of ulceration of the bronchial stump and decreases the incidence of tuberculous infection in the pleural space. Streptomycin should not be used in any case of tuberculosis without a definite indication, but when excision is contemplated it is particularly important that it be withheld, if possible, until near the time of operation in order that the maximum effect may be expected in the pre- and post-operative period. Penicillin has been of great value in the prevention of non-tuberculous infection of the pleural space, chest wall and remaining lung. It should be given to all patients for a few days before and after operation. When a secondary infection is present, it should of course be employed to control this before operation.

For some years it has been our practice to bronchoscope all patients for whom any form of collapse therapy or resection is contemplated. Pneumothorax should never be done in the presence of an active tuberculosis of the bronchus. Thoracoplasty should rarely be done when the main bronchus is involved but may be indicated when there is disease of the upper lobe bronchus without severe stenosis and there is too much disease elsewhere in the lung, or it is too unstable to consider primary excision. It has been considered from the beginning that neither lobectomy nor pneumonectomy should be undertaken when it would be necessary to divide the bronchus through an area showing tubercles or active ulceration. A granular appearance or scarring from healed disease need not be considered a contra-indication. Disease may be expected in the submucosal layer well proximal to obvious changes in the mucous membrane. The use of postural drainage of sputum is as important in these as in the non-tuberculous patients. The volume of sputum often may be reduced greatly and it tends to become less purulent and less viscid. Continuous drainage on an inclined plane is the most effective form, particularly when copious amounts of sputum are produced. Streptomycin has been very helpful in the reduction of sputum. When penicillin-sensitive organisms are present, penicillin should be given in addition.

Inhalation anaesthesia through an intratracheal catheter has been employed. The agent has usually been cyclopropane, although ether and oxygen is apparently quite as satisfactory. The maintenance of a free airway through the frequent use of catheter suction is essential. In rare instances, because of the quantity and tenacious character of the sputum, it has been necessary to use bronchoscopic suction during the operation. Facilities for this should always be available. An appreciation of the dangers of prolonged anoxia is of first importance in this as in the non-tuberculous cases. Vital capacity readings are not entirely reliable but they should be obtained in each case since they give an approximate idea of the respiratory reserve. Unfortunately

a lung may look quite good on X-ray evidence and yet have limited functioning capacity. In recent years the oximeter has been so helpful that it has come to be regarded as almost essential. The anæsthetist cannot recognise degrees of anoxia which, if continued over a long time, may be dangerous. It should be realised that lesser degrees of oxygen lack may, if prolonged, be as dangerous as greater degrees over a short period. Ability to withstand oxygen lack seems to vary from individual to individual. In general a 20 per cent. lack should be regarded as dangerous if prolonged, and if it cannot be corrected the operation should be discontinued.

The maintenance of blood volume and hæmoglobin level is essential. If this is not done, tissue anoxia of the anæmic variety will occur even though ventilation is adequate. Low blood volumes and hæmoglobin levels should be corrected by pre-operative transfusions. Blood loss should be replaced as it occurs from the moment the skin incision is made. Ideally, the amount lost should be calculated by weighing the sponges and the replacement should equal the loss. This, however, requires extra operating-room personnel, and the experienced surgeon can judge reasonably well from the amount of bleeding that occurs. It is nearly always greater than suspected.

Most of the patients in this series have been operated upon in the lateral position. There is probably some virtue, however, in the prone position, particularly when lung volume is limited and when there is a large amount of heavy sputum to be cleared. It is probable that the intra-bronchial catheter should be employed more often than it has been. If these precautions are observed, local and regional anæsthesia have not been thought necessary.

The dissection technique has been employed since 1940. The technical problems do not differ in most cases from those met with in excision of non-tuberculous lesions. Pleural adhesions are usually easy to divide by sharp dissection. In the region of cavities near to the surface of the lung it is wise to separate the parietal pleura from the chest wall in order to be quite certain to avoid entering the cavity. Separation of thin-walled cavities from large mediastinal veins may be hazardous and requires great care. Large tuberculous nodes are encountered at the hilum less frequently than would be anticipated, but, particularly when they are caseated extensively, they may present great difficulty.

In lobectomies the bronchus should be divided as far proximally as possible, but care should be taken not to encroach on the lumen of the bronchus to the remaining lobe. In pneumonectomies the division should be close to, or if necessary actually through, the side of the trachea. This is done in order to get as far proximal to active disease as possible and also in order that soft tissue may fall readily over the closed stump. The actual closure is probably best done as simply as possible, and a running suture of No. 0 chromic catgut on an atraumatic needle has been used routinely. Occasionally this suture line has

been reinforced by a few interrupted sutures of fine silk, but this is of doubtful value. Although a light clamp has been placed across the bronchus in most instances there is an increasing tendency to avoid the use of any clamp on the proximal end. It is felt that healing is brought about by the soft tissues that come to lie against the cut end of the bronchus, and that it is unwise to do unnecessary injury to it. Opinion regarding the necessity to approximate the pleura over the stump is divided. It is probably wise if it does not look as though soft tissue would come to lie against it, but otherwise it is unimportant.

Following all lobectomies, the chest has been drained by an underwater seal drain for a period of one to four days. A Foley urethral catheter works well. After pneumonectomy the chest is not drained but the intrapleural pressure is adjusted by aspiration of suitable quantities of fluid and air to keep the mediastinum in the mid-line.

POST-THORACOPLASTY LOBECTOMY OR PNEUMONECTOMY

A method has been evolved for entering the chest cavity, following a previous thoracoplasty, which is simple and quick and presents very little difficulty. It involves resecting a rib (either reformed or intact, depending on the extent of the thoracoplasty) at the level of the 6th or 7th rib, and then entering the pleural space, which is almost invariably obliterated. Commencing at the posterior end of the exposure and using a finger, with pressure against the chest wall rather than the lung, the lung is separated from the reformed ribs by finger dissection, to form a tunnel just anterior to the cut ends of the transverse processes. One blade of a heavy bone-cutting forceps is placed in this tunnel and the chest wall divided in an upward direction along the line of the tips of the transverse processes—for a distance corresponding to three or four ribs—and the chest wall is then levered out of the way. There is brisk bleeding from the divided intercostal vessels and these are clamped against the bone by Kocher's forceps, a small, heavy half-circle round needle is used to place a ligature of heavy chromic catgut in such a position as to occlude the vessel. This step seldom presents difficulty.

As the flap of chest wall is raised, the adherent lung is freed and then the rib spreader is introduced. Adequate exposure can usually be obtained by dividing three ribs. The lung is often extremely adherent at the apex, and after an efficient thoracoplasty this is a very narrow space in which to carry out a difficult sharp dissection. Rather than run the risk of entering a residual cavity or injuring the subclavian vessels or brachial plexus, it is wise to obtain better exposure by a further division of the chest wall.

Following the lobectomy or pneumonectomy, the chest wall is repaired by interrupted sutures of catgut. In no case has it proved unstable. The divided intercostal nerves are usually the 3rd to 6th inclusive and the resulting anæsthesia has not led to any difficulty.

DECORTICATION

As it applies to the question of lobectomy for pulmonary tuberculosis, decortication usually involves peeling a deposit of fibrin off the remaining lobe after resection of the other, and this fibrin is usually the result of an ineffective pneumothorax. Such a decortication is usually very easy, even though there has been a tuberculous pleuritis in the pneumothorax space. Whether the released lobe is to be allowed to fill the whole hemithorax or not, will depend on such factors as the state of the other lung, and whether or not the lobe shows evidence of disease. Over-expansion can be limited by a restricted upper thoracoplasty, with removal of the 2nd to 5th ribs inclusive. This may be done at the time of the lobectomy or a fortnight later.

PNEUMONECTOMY WITH PLEURECTOMY

Not infrequently a patient who has had a thoracoplasty for a tuberculous empyema eventually develops bronchial stenosis or bronchiectasis or some other complication that necessitates pneumonectomy. Such an indication for pneumonectomy may arise in the presence of empyema which has not been treated by thoracoplasty. In either case it is desirable to resect the infected pleural space along with the lung. It has been learned that even the most complete and apparently successful thoracoplasty for tuberculous empyema usually leaves a narrow residual space full of inspissated tuberculous pus in the " gutter " just above the diaphragm.

After resecting a rib it is possible to develop a line of cleavage between the dense fibrous tissue and the chest wall, and by a combination of blunt and sharp dissection, to free completely the chest wall aspect of the empyema cavity. As one meets the mediastinum anteriorly and posteriorly, the very dense envelope of fibrous tissue gives way to ordinary film adhesions, and the hilus can be approached from both directions. The adherence to the diaphragm is usually extremely dense and somewhat vascular and there is some danger of perforating it. Such wounds are repaired and lead to no difficulty.

The resection of such an empyema cavity with the lung is a very effective procedure. It is always difficult and attended by considerable blood loss, but has not in any case proved impossible.

POST-OPERATIVE CARE

Immediately upon completion of the operation, all sputum is aspirated and in most instances a bronchoscopy done. Patients are placed in a bed, the foot of which is elevated 12 to 15 inches in order to facilitate drainage of secretions, in particular at this stage drainage of saliva. All patients are placed in oxygen tents. They should be conscious immediately upon completion of the operation and should be encouraged to cough from this time. Reasonable sedation is allowed

to relieve the pain of coughing. Occasionally further catheter suction may be necessary to clear secretions, and infrequently further bronchoscopy. Care should be taken that the syphon drainage is working well in lobectomies. It may be necessary to aspirate the pleural space of pneumonectomies the evening of operation, and this usually has to be repeated two or three times on succeeding days. Post-operative roentgenograms should be obtained frequently and atelectasis should be relieved promptly by bronchoscopic suction.

Thoracoplasty has been done only occasionally in this series. The impression is that it should perhaps have been done somewhat more frequently when expansion of the remaining lobe or lobes has been slow in order to prevent over-expansion of ipsi-lateral or contra-lateral lung. It probably is necessary more frequently following lobectomy than pneumonectomy, but certainly need not be done routinely following either procedure. This aspect of the problem needs further study and particularly the following of patients over a longer period.

All patients should remain on sanitarium regime for a period of at least six months following operation. As in the case of all other patients who have had pulmonary tuberculosis, they should be followed carefully after discharge from an institution. They should not be looked upon as having had their disease excised and therefore as being in a special category. The long-term results in this as in other forms of surgical therapy depend in no small degree upon post-discharge management.

INDICATIONS FOR OPERATION

In a disease that is so varied in its manifestations as pulmonary tuberculosis, it is difficult to place indications for therapy under specific headings. In general, the lung that is to be left behind should be free from disease or it should be reasonably certain that any disease that is present has been quiescent over a long period of time. Occasions arise, however, when it is apparent that without further assistance the course of a particular patient is certain to run steadily downhill to a fatal ending. In such circumstances risks which would ordinarily be avoided should be accepted in spite of the fact that the salvage rate is bound to be poor.

SEGMENTAL RESECTIONS

It is difficult to believe that segmental resection has much place in tuberculous disease of the lung. Rarely the disease may seem to be so localised to a lingular process as to justify excision of this area only. One such case appears in this series. When conservation of lung tissue is of paramount importance, resection of the apical segment of the lower lobe along with an upper or middle lobe or of the lingular process with the lower lobe with preservation of the remainder may be justifiable. It is doubtful if it is often possible to do such local

excisions, except when dealing with old tuberculomas, without dissecting through tuberculous tissue and in consequence involving an unwarranted risk to the patient.

DISEASE IN ADJACENT LOBE

However carefully cases may be studied, one will sometimes be confronted, when the chest is opened, with previously unrecognised disease in the adjacent lobe. One then has to decide whether the operation should be discontinued, whether to proceed with the lobectomy originally contemplated, or whether a pneumonectomy should be done. A pneumonectomy may be impossible because of instability of the contra-lateral lung or co-existent collapse on the opposite side. If the disease in the adjacent lobe is thought to be active, it is probably wiser not to carry out the lobectomy under such circumstances. A few lobectomies have been done in the presence of apparently healed tuberculous nodules with satisfactory results. It would probably be wise to do an immediate partial thoracoplasty on such cases if the condition of the patient warrants it, and if not, to do the thoracoplasty as soon as possible after the lobectomy.

The following indications have been accepted in this series :—

(1) *Persistent Cavity*.—(a) Following adequate trial of pneumothorax ; (b) following good thoracoplasty.

Pneumothorax may fail to obliterate a cavity because of its position, the presence of adhesions, the density of its wall or the existence of positive pressure within the cavity. A complete atelectasis of a lobe may occur following induction of a pneumothorax, and the area remain a source of positive sputum either because of a persisting cavity or a tuberculous bronchitis. Such a lesion can be cured only by excision. When a pneumothorax fails to collapse a cavity in the upper lobe in a reasonable period of time, a thoracoplasty is unlikely to be successful and lobectomy should therefore be considered the treatment of choice (Figs. 1 and 2). When the disease appears to be confined to a lower or middle lobe, a thoracoplasty is very seldom to be preferred because of the unnecessary sacrifice of good lung. If further therapy in preparation for lobectomy is indicated because of the acuteness of the disease, it is wiser to substitute a pneumoperitoneum for the pneumothorax. Phreniclasia is seldom used now in such cases because it may interfere with the clearing of secretions and because too often the paralysis of the diaphragm is permanent. Cavities in the apex of the lower lobe, and indeed all those in close proximity to the major fissure, deserve special consideration because in a considerable proportion of cases the adjacent lobe is found to be involved and a pneumonectomy becomes necessary. It is unwise to continue an inefficient pneumothorax over many months since it may prove impossible to re-expand the lung because of fixed atelectasis or the development of a fibrous corset over the lung. Such cases may require

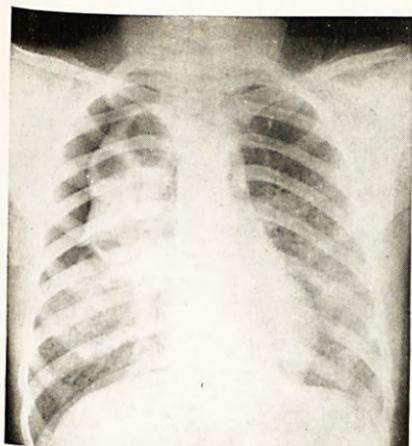


FIG. 1.—D. S. Cavities open despite 10 months' artificial pneumothorax.



FIG. 11.—R. A. Pneumothorax induced in presence of gross stenosis of main bronchus. Atelectatic lung. Tuberculous empyema.

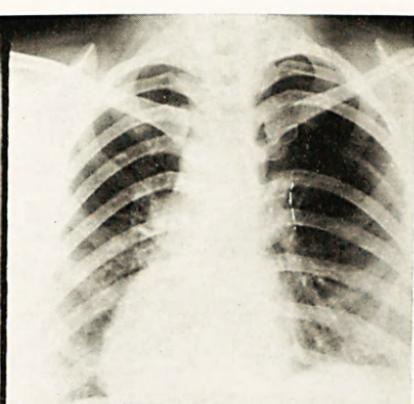
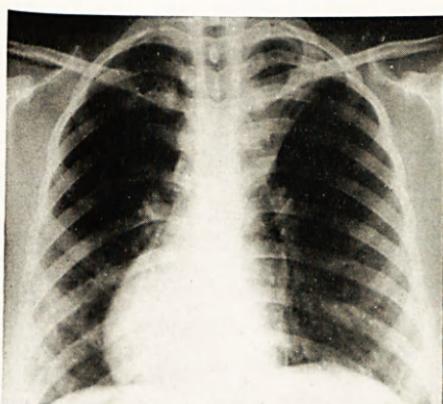


FIG. 2.—D. S. Left—upper lobe atelectatic, caseous and excavated. Right—following lobectomy.

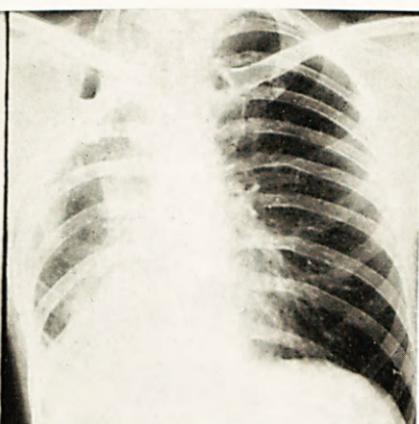
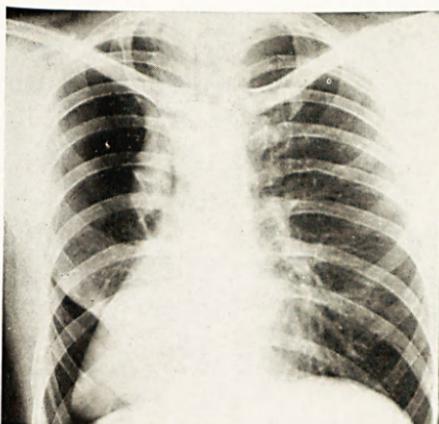


FIG. 3.—S. L. Left—pneumothorax 1½ years. Upper lobe caseous and atelectatic, lower inextensible. Right—upper lobe lobectomy, decortication of lower lobe and limited thoracoplasty. Pleural space obliterated.

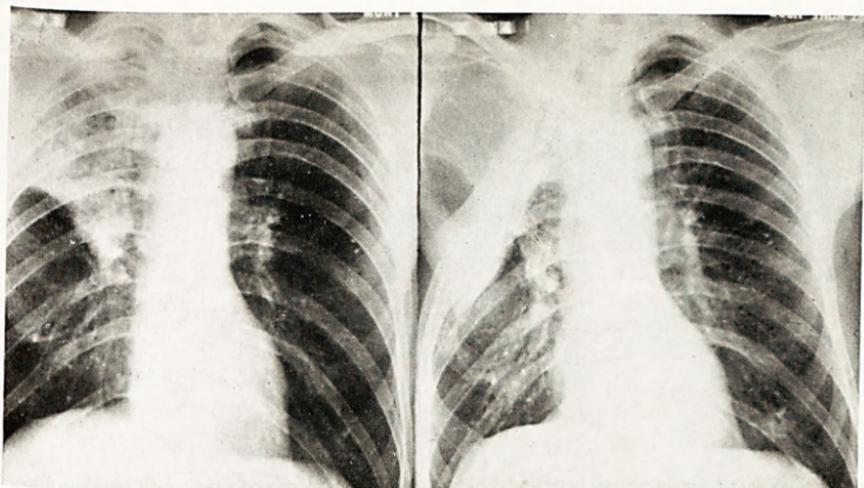


FIG. 4.—H. Mc. Left—before thoracoplasty. Right—10 months after.

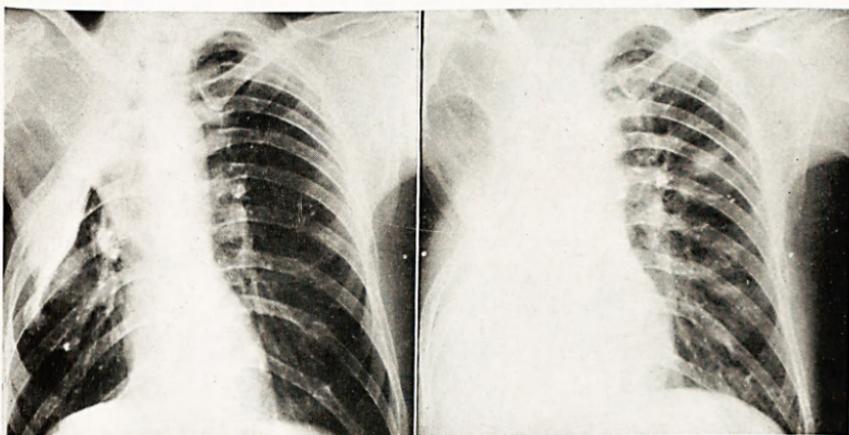


FIG. 5.—H. Mc. Left—cavity three years after thoracoplasty. Right—following lobectomy.

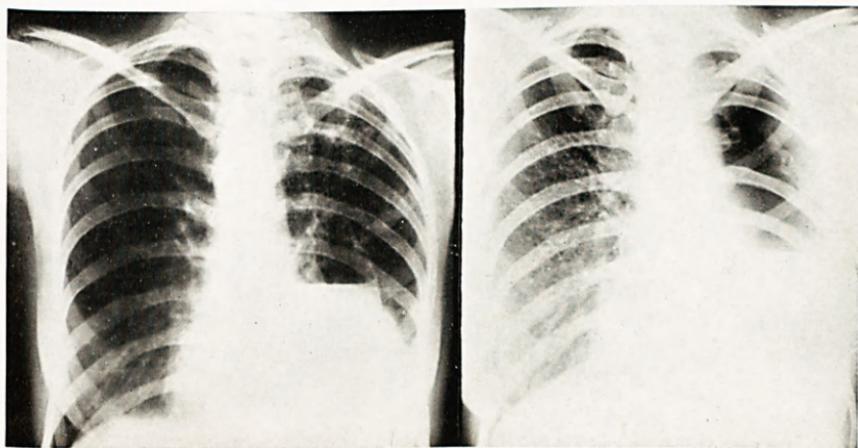


FIG. 9.—W. H. Left—large cavities upper and lower lobes. Gross stenosis of right lower and middle lobe bronchi. Right—following pneumonectomy.



FIG. 6.—Thick-walled cavity apex lower lobe.



FIG. 7.—Caseating lesion with central excavation in atelectatic lower lobe.



FIG. 8.—Widespread lesion with caseation and multiple cavitation (so-called destroyed lung).



FIG. 10.—Stenosis of main bronchus, bronchiectasis, cavitation.

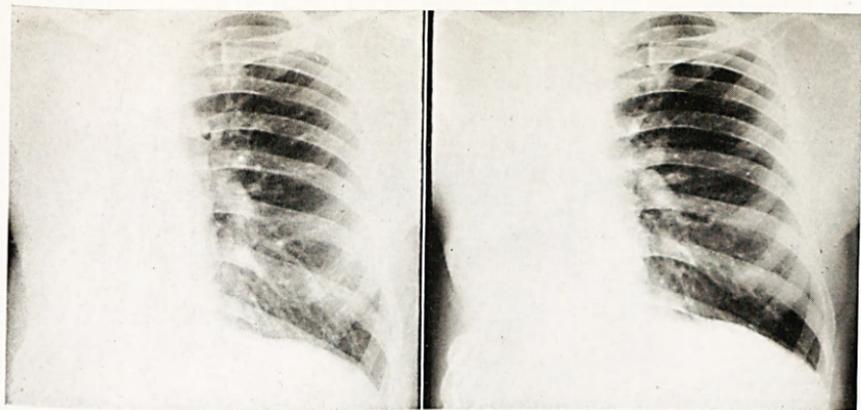


FIG. 12.—R. A. Left—complete thoracoplasty. Sputum positive, persistent empyema. Right—following extrapleural pneumonectomy.

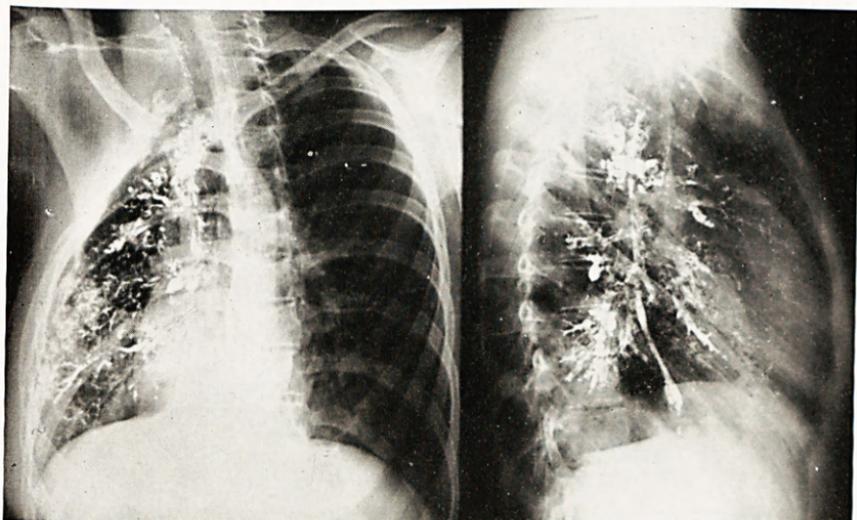


FIG. 13.—J. H. An upper thoracoplasty had closed cavity but sputum remained positive because of widespread tuberculous bronchiectasis. Sputum converted by pneumonectomy.

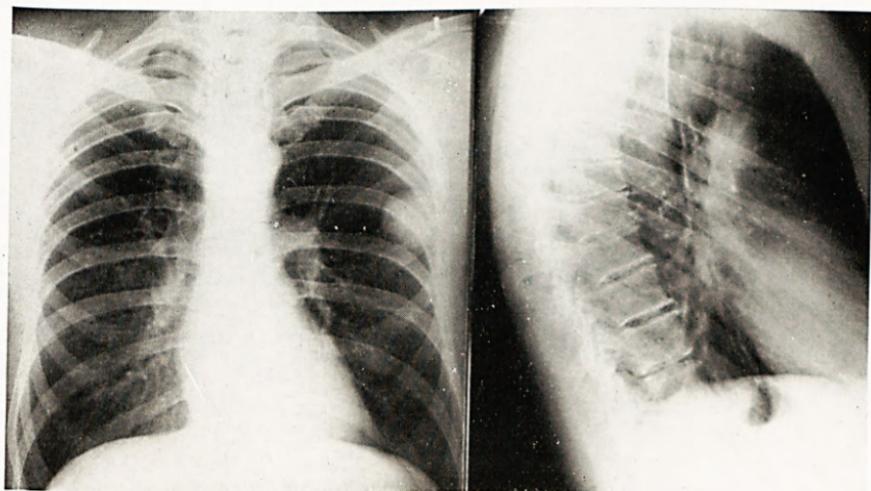


FIG. 15.—J. S. Tuberculoma, specimen shown in Fig. 16.



FIG. 14.—Atelectatic middle lobe with bronchiectasis.



FIG. 16.—Tuberculoma.

decortication of the good lobe preliminary to or at the same time as lobectomy (Fig. 3).

When positive sputum from the same side continues following a thoracoplasty, planograms may demonstrate an open cavity, or bronchograms may show bronchiectasis. In the past a considerable number of poor thoracoplasties were encountered with an open cavity beneath them. Revision of such thoracoplasties obliterated the cavity and rendered the sputum negative in a reasonable proportion of cases. Because of improvements in technique, very few inefficient thoracoplasties are seen to-day and excision of the underlying lobe or lung is undertaken in all such cases rather than further thoracoplasty. When thoracoplasty seems to offer a reasonable prospect of success in upper lobe lesions, it should be undertaken in preference to lobectomy and the patient told that, should this fail, removal of the lobe at a later date will be necessary. The danger of local complications, of spread or recrudescence of disease and of mortality, is several times greater following lobectomy than thoracoplasty. The results of excision in such cases are good, the technical difficulties have been discussed (Figs. 4 and 5).

(2) *Non-collapsible Disease (usually with Cavitations).*—Excision should be undertaken as a primary procedure when pneumothorax is impossible and when the disease is confined to one lobe and the cavity is in a position which makes it unlikely that thoracoplasty could be successful without the sacrifice of too much good lung. This applies to some upper lobe cavities close to the mediastinum, those in the antero-lateral position of the upper lobe and in the middle lobe, those close to the hilum and all lower lobe cavities (Figs. 6 and 7). Ordinary sanitarium regime is employed in most cases until the disease settles down. Pneumoperitoneum is used to control lower lobe disease and may be continued with advantage after the operation to assist in obliteration of the pleural space.

(3) *Widespread Lesions (usually associated with Multiple Cavitations).*—When one lung is involved extensively and the other free from active disease and an efficient pneumothorax cannot be obtained, a choice has to be made between a complete thoracoplasty and pneumonectomy. The outlook in these circumstances is poor, but without treatment is hopeless. This group includes lungs which contain multiple cavities widely distributed and frequently complicated by areas of consolidation or atelectasis (Fig. 8). An endeavour should be made to carry such patients to a reasonable stage of chronicity since results of operating in the acute stage are often disappointing. If this resistance is not demonstrated, a multiple stage thoracoplasty may be preferable. Should this fail to render the sputum negative, the destroyed lung may be removed at a later date.

(4) *Bronchostenosis.*—When a considerable narrowing of the lumen of a primary or secondary bronchus is present, excision of the related lung offers the best hope of cure (Fig. 9). In most instances there is

a tuberculous bronchitis in the more distal bronchi, and this continues to be the source of positive sputum (Fig. 10). If untreated, secondary infection of the bronchial tree distal to the narrowing is a frequent occurrence. Pneumothorax should not be induced in the presence of ulcerating disease in the primary or secondary bronchi since it produces a non-expandable lung, and may be followed by a tuberculous empyema, and because, distal to the narrowing, the lung becomes infected with pyogenic organisms so that any such tuberculous empyema is often complicated by a secondary infection (Figs. 11 and 12). In the presence of an unstable lesion in the adjacent lower lobe, an upper thoracoplasty may be justifiable in spite of tuberculosis of an upper lobe bronchus. Undoubtedly such lesions sometimes heal under a thoracoplasty, but very often a secondary lobectomy will be necessary.

(5) *Bronchiectasis*.—Bronchiectasis is a not uncommon sequel of tuberculosis (Fig. 13). When located in the upper lobe only, it may produce no symptoms other than a little morning sputum and in that case does not require any treatment. It may continue to be a source of tubercle bacilli or of recurrent hæmoptysis. Such lobes may be atelectatic (Fig. 14), and may be obscured beneath thoracoplasties. Nearly every series of lobectomies for apparently non-tuberculous bronchiectasis contains several cases in which the tuberculous nature of the disease was unsuspected before operation. The possible tuberculous origin of bronchiectasis should therefore be kept in mind. Lobectomy, or occasionally pneumonectomy, is the obvious treatment for this condition.

(6) *Tuberculoma*.—There is apparently still some difference of opinion as to whether operation should be undertaken for quiescent caseous lesions. In our experience at least 50 per cent. of these areas are evacuated sooner or later, and hæmorrhage and widespread dissemination of the disease at that time are not uncommon. There should be no hesitation about advising excision of such lesions in the quiescent stage. Routine chest films are disclosing considerable numbers of single lesions in the lung which must be explored because of the possibility that they are malignant (Fig. 15). If the tuberculoma is single, near the surface of the lung and apparently quite localised and quiescent, a segmental or wedge resection may be done (Fig. 16). If the lesion is deeply placed or if there is evidence of tuberculous involvement of the adjacent lung tissue, lobectomy is a safer procedure.

Our experience with excision of lung for pulmonary tuberculosis concerns 111 patients, one of whom had a tourniquet lobectomy in 1936, 110 of whom were operated upon by the dissection technique from 1940 to 1949 inclusive. Lobectomy was done in 55 instances, pneumonectomy in 48 and a segmental or local resection in 8. The over-all results that have been obtained are shown in Tables I to IV, in the preparation of which the various procedures have been considered together. Table III shows that there has been a gradually increasing use of excision therapy and that the results in recent years have been

more satisfactory. This improvement has been brought about mainly by the application of principles in anæsthesia and blood replacement, the avoidance of anoxia and advances in technique common to all

TABLE I

Indications.	Total No.	Well.	Active.	Dead.	Untraced.
Persistent cavity after pneumo- thorax	11	10	0	1	0
Persistent cavity after thoraco- plasty	10	8	0	2	0
Uncollapsible lesion	23	13	5	4	1
Widespread disease with multiple cavities	9	5	1	3	0
Stenosis of bronchus	27	19	3	5	0
Tuberculous bronchiectasis . .	16	8	4	2	2
Tuberculoma	15	10	2	1 (suicide)	2
Total	111	73	15	18	5

TABLE II
Complications

1. *Bronchopleural fistula*—
 - Early 7 (6.3 per cent.)—5 fatal
 - Late (6 to 24 months) 3 (2.7 per cent.)—1 fatal
2. *T.B. Stump* 4 (3.6 per cent.)—0 fatal
3. *Closed Empyema*—
 - T.B. only 5 (4.5 per cent.)—0 fatal
 - Mixed 2 (2 per cent.)—1 fatal
4. *Spreads*—
 - Opposite side 15—2 fatal, 3 active, 10 well
 - Same side 5—0 fatal, 1 active, 4 well
 - Bilateral 2—2 fatal
5. Death immediately related to operation 5 (4.5 per cent.)

TABLE III
Details of Operative Deaths

- 2—Anoxia from bronchial obstruction { 1.—on table
2.—3 hours post-operative
- 1—Shock
1—Non-tuberculous pneumonia
1—Pulmonary embolism

TABLE IV
Summary of Results in 111 Patients

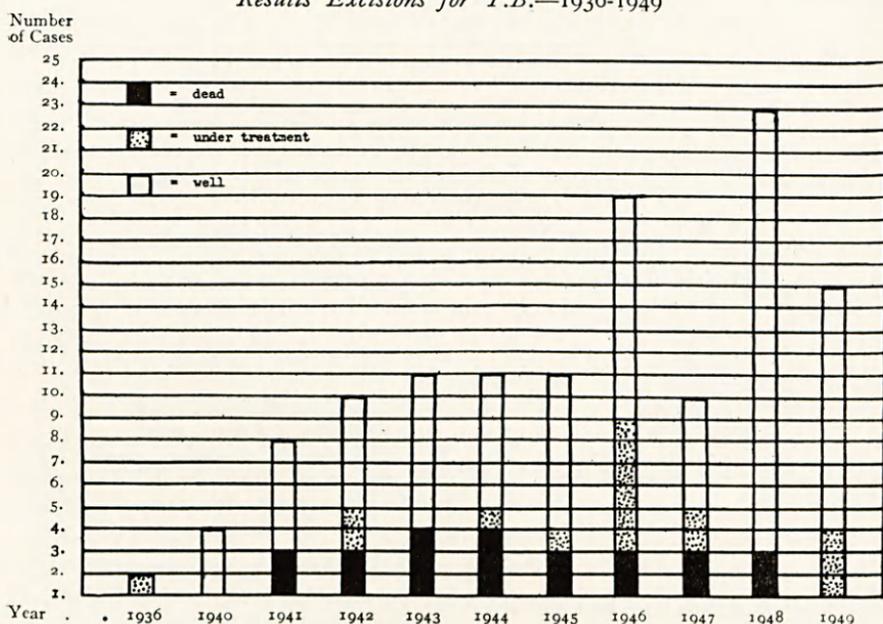
Well	73 = 66.0 per cent.
Still under treatment	15 = 13.5 "
Untraced	5 = 4.5 "
Dead { one suicide } { well case }	18 = 16.0 "

thoracic and indeed to all surgery. Streptomycin has, however, been a valuable factor in the control of acute exacerbations and spreads in the immediate post-operative period, of tuberculous infection of the pleural space and of tuberculous bronchitis. Poor-risk cases have

not been denied the possible benefits of this type of surgery when it seemed to offer them their only chance of recovery, even when it was realised that the outlook was poor.

There is a certain amount of shift in the classification as years go by, the group "under treatment" showing the greatest change. The single patient operated upon in 1936 had been well for 13 years but has recently developed a small bronchial fistula, and therefore although still in good general health, has fallen back to the "under treatment" group. A few patients who had been well for several years have developed a fatal recrudescence of the disease. The largest shift, however, with the passage of time, is from the "under treatment" to the "well" group.

TABLE V
Results Excisions for T.B.—1936-1949



The analysis has shown very little difference in the results of lobectomy and pneumonectomy. Post-operative spread or exacerbation of the disease occurred in 27 per cent. of the lobectomies and 29 per cent. of the pneumonectomies. It involved the same lung in 6 lobectomies, the contra-lateral in 8 and was bilateral in 3. One local resection of a tuberculoma was followed by a spread of the disease in the same lobe.

The immediate post-operative death from shock was due to insufficient blood replacement and was certainly preventable. One from non-tuberculous pneumonia occurred before penicillin was available and would probably be avoided to-day. An occasional death from bronchial obstruction is possibly inevitable in such cases, but if the complication is recognised and a bronchoscopy carried out

immediately, fatalities from this cause should be very rare. The death from pulmonary embolism occurred without evidence of peripheral thrombosis.

SUMMARY

This paper is based upon a review of 111 excisions for pulmonary tuberculosis. One patient was operated on in 1936, the remaining 110 in the years 1940-1949 inclusive. The results of the procedure can be regarded as reasonably satisfactory when it is realised that the group comprised patients in whom other forms of therapy had failed and those in whom no other kind of treatment was likely to be effective. A number of bad risk cases will inevitably be included. It should not be regarded as a substitute for the other forms of therapy, more particularly for thoracoplasty. The fact that the average mortality from 589 thoracoplasties done in the 6-year period from 1942 to 1948 was 1 per cent., illustrates the relative risk of the two procedures. The use of streptomycin has made possible a wider application of the procedure.