Pulmonary Resection in Tuberculosis
A Correlation of Clinical Indications and Pathology*

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The purpose of this paper is to attempt to correlate the clinical indications for pulmonary resection with the gross and microscopic pathological findings of the removed specimens. The basis of our study is a series of 34 consecutive pulmonary resections for tuberculosis performed at the Missouri State Sanatorium between April 24, 1946 and December 31, 1947.

Recent advances in the fields of anesthesia, pathologic physiology of intra-thoracic organs, and improvements in surgical skill and technic have established the operation of pulmonary resection in tuberculosis as being not only feasible but an essential addition to our present knowledge for combating this disease. In the short space of eight years since the somewhat discouraging report of Dolley and Jones† (1940), there has been a steady decrease in mortality and complications of pulmonary resections in tuberculosis with a corresponding increase in satisfactory results. Among the factors responsible for the improved results are (1) the universal adoption of the individual ligation technic and pleuralization of the bronchial stump; (2) improvements in the skill and technic of the surgeons and (3) improvements in anesthesia. To these may be added the use of streptomycin pre- and post-operatively. The reports following its use in the surgery of pulmonary tuberculosis have been encouraging.3,4

Most reports have been concerned primarily with the clinical indications for operation and the results of various series of cases. A presentation of the gross and microscopic examinations of the removed specimens has been absent with the exception of articles by Samson,5 Kinsella,6 Churchill and Klopstock,7 Lorge and Du-

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fault, and Overholt and Wilson. Single case reports including pathologic findings have been presented by several authors. Meissner, by his study of the pathology of 60 pulmonary resections performed by Overholt, has given us a picture of endobronchial tuberculosis which has aided in clarifying some aspects of the problem of this type of pathology being an indication for pulmonary resection. Although our series of 34 cases is too small to permit definitive or dogmatic statements, further studies would undoubtedly lead to a uniform classification of the indications and contraindications for pulmonary resections.

We have tried to correlate the roentgenographic and clinical picture with the gross and microscopic findings. Bronchi were carefully dissected and many sections of both bronchi and individual lobes were made. Sections were stained by Hematoxylin and Eosin and also by Verhoeff Van Gieson methods. This latter stain is ideal for study of the lung as it selectively stains the blood vessels, outlines alveoli, and gives much more information than the conventional H and E stains.

Of our 34 resections, 25 were pneumonectomies and 9 lobectomies.

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**Table I**

<table>
<thead>
<tr>
<th>Status of Patients on January 1, 1949</th>
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<tbody>
<tr>
<td>No. of Cases</td>
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<td>under 15</td>
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<td>16-25</td>
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<td>26-35</td>
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<td>36-45</td>
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<td>46-55</td>
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<td>56-65</td>
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**Table 2**

<table>
<thead>
<tr>
<th>Types of Operations</th>
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<tbody>
<tr>
<td>Left Pneumonectomy</td>
</tr>
<tr>
<td>Left upper lobectomy</td>
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<tr>
<td>Left lower lobectomy</td>
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<tr>
<td>Right pneumonectomy</td>
</tr>
<tr>
<td>Right upper lobectomy</td>
</tr>
<tr>
<td>Right upper and middle lobectomy</td>
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<tr>
<td>Right middle and lower lobectomy</td>
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<tr>
<td>TOTAL</td>
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</table>
A few pertinent statistics are presented in Tables 1 and 2. The youngest patient was a 10 year old colored boy who underwent pneumonec- tomy for a rapidly progressing caseous-pneumonic disease; the oldest was a 65 year old white female who had a residual cavity and bronchectasis following thoracoplasty. Twelve of these cases had previous thoracoplasty on the side of the resection of whom three had contralateral pneumothoraces and one contra- lateral oleothorax. Another case without thoracoplasty had pneu- mothorax on the contralateral side.

Preoperative preparation: Electrocardiograms were obtained and in some exercise tests were performed in order to evaluate the cardiac reserve. Ideally, all patients who are candidates for ex- cisional surgery should have respiratory function tests. Vital ca- pacity and bronchospirometric studies are misleading; often giving the surgeon a false index as to the efficiency of the remaining pulmonary tissue. In the final analysis, life depends on the dif- fusion of oxygen and carbon dioxide through the pulmonary alveol. Methods of determining ventilatory function and pulmonary dif- fusion have been described by Ornstein\textsuperscript{14} and others, and thoracic surgeons are increasingly realizing the importance of these tests in selected cases. Although we are now contemplating the use of these tests, they were not utilized in the present series.

Contralateral pleural fixation and disease and contralateral col- lapse therapy obviously reduce respiratory function. Clinically we have found that contralateral pleural fixation, as the result of adheisons, re-expanded pneumothoraces and hydropneumothor- aces, fibrosis from disease, and emphysema are the greatest of- fenders in diminishing the respiratory function.

The present series coincided with the increasing use of streptomy- cinc pre- and postoperatively. Of the nine lobectomies, three patients received streptomycin beginning one to two weeks pre- operatively for 120 days; four others received streptomycin in the late postoperatively period (after three months) for occasional positive sputa. Of these, three were converted to negative. Of the 25 pneumonectomy cases, three patients received streptomycin beginning six weeks preoperatively for 120 days for extensive tracheobronchial disease involving the stem bronchus where di- vision was anticipated. The tracheobronchial disease healed rapidly and resection was then performed without complications. Seven others were given streptomycin during the immediate pre- and postoperative period.

Four pneumonectomy cases were given streptomycin after the third postoperative month; the indications being wound infection, genito-urinary tuberculosis, late reactivation in the remaining lung, and positive sputa after resection.
Anesthesia: All but two of the patients were operated under epidural anesthesia; the remaining two received gas anesthesia (nitrous oxide) by facial mask. Postoperative bronchoscopic aspirations were not performed.

Technic of operation: All operations were performed with the patient in the anterolateral decubitus position. The posterolateral approach was used with individual ligation of the hilar structures, interrupted suture closure of the bronchial stump, and pleuralization of the hilar structures. Catheter drainage of the pleural cavity was utilized only in lobectomies in order to facilitate re-expansion of the remaining lobe or lobes. Nylon suture was used throughout. Between four and eight weeks postoperatively, a modified thoracoplasty was performed to obliterate the pleural space. In lower lobectomies, the space was obliterated by a phrenicilasis performed at the time of the resection.

Postoperative regime: Oxygen was given routinely postoperatively. Water-sealed suction bottles were connected to the patients with thoracotomy tubes. Except for a period of approximately 10 days before post-resection thoracoplasty, all patients were strict bed-patients for three months following resection; then they were allowed to increase their activity gradually so that by the end of the fourth month they were allowed full lavatory and dining room privileges. They were placed on graduated exercises in the ninth or tenth postoperative month and were discharged as arrested cases in the twelfth or thirteenth postoperative month. Thus we were able to observe these patients for at least a year following surgery.

Mortality and Complications: There were nine (26.5 per cent) deaths in the entire series, all occurring in pneumonectomy patients. The corrected mortality rate would be 36 per cent for pneumonectomy cases and none for lobectomy cases. These deaths were arbitrarily classified as "Early" or "Late", 90 days being used as the dividing line. Under this classification, there were four early and five late deaths.

Of the four early deaths, two occurred within 24 hours. Autopsy of the first patient who had previous thoracoplasty revealed a cor pulmonale and edema of the remaining lung. This patient was 65 years old, and was treated for congestive heart failure one year prior to resection (Case 11 in text). The second patient died of an unfortunate operative accident, the contralateral main bronchus having been injured during the resection, a partial stenosis resulting from the repair, and death caused by respiratory insufficiency. The third patient died on the 17th postoperative day. She had a contralateral oleothorax and the pneumonectomy was performed under a thoracoplasty. This was also clinically a
respiratory insufficiency. The fourth patient died on the 64th postoperative day; however, it occurred only two weeks following the postpneumonectomy thoracoplasty (Case 4).

Of the five late deaths occurring after the arbitrary 90 day period, the first patient died six months postoperatively. This patient had a one-stage thoracoplasty with apicolsis nine years before and had a severe empyema with a broncho-pleuro-cutaneous fistula. Clinically, there was evidence of amyloidosis. There had been frequent attacks of hemoptysis and the resection was undertaken as a desperate life-saving resort. The patient developed a gradually increasing cardio-respiratory failure which was undoubtedly the cause of death. Autopsy was not obtainable. The second death occurred in the seventh postoperative month. This patient had previous thoracoplasty and developed symptoms and signs of cardiac failure three months after operation plus a broncho-pleural fistula and empyema in the fifth postoperative month. Autopsy confirmed the clinical picture. The third late death occurred in the eighth postoperative month. This 62 year old male developed a wound infection, empyema and a large broncho-cutaneous fistula. The fourth death was in the 10 year old colored boy who had extensive caseous-pneumonic disease for which pneumonectomy was performed. Infiltration occurred in the contralateral lung in the eighth postoperative month and he died the following month (Case 12). The last death was in a 64 year old white female, who died one year postoperatively of a nontuberculous bronchopneumonia, confirmed at autopsy.

Two patients developed early postoperative spread of disease. Discounting the two early deaths occurring within the first 24 hours, this is an incidence of 6.2 per cent. There was only one early postoperative spread among those having epidural anesthesia—an incidence of 3.3 per cent. Spreading of a tuberculous process in the lungs during surgery is the result of spilling of infected sputa into previously uninvolved areas of the lungs. Streptomycin materially decreases the volume of sputum and number of bacteria resulting in lowering the incidence and gravity of spreads. However, we believe that epidural anesthesia is further responsible for decreasing the incidence of spreads as the patients are conscious, cooperative, and able to cough and expectorate throughout the operative procedure. Both of the patients with early spreads had extensive active endobronchial tuberculosis; one of these is presented in the text (Case 3). The spread in the second patient was controlled by further thoracoplasty and she has been discharged as an arrested case.

Four patients developed new infiltrations in the seventh to tenth postoperative months. One with apical thoracoplasty and
contralateral pneumothorax who had upper lobectomy under the thoracoplasty developed a new infiltration in the remaining lower lobe with a positive sputum in the seventh postoperative month. The lesion is clearing under rest and streptomycin regime and sputa have been negative the past three months. The 10 year old colored boy developed contralateral disease in the eighth postoperative month and expired shortly after. Two patients developed contralateral circumscribed lesions in the tenth postoperative month with positive sputa. The lesions disappeared under rest and streptomycin, and sputa were converted to negative.

There were four cases with bronchopleural fistulae (12.5 per cent). Of these, one was temporary and not associated with empyema. Two patients had persistent fistulae with empyema developing in the second and fifth postoperative months. The fourth developed intermittent bronchopleural fistula and empyema in the 14th postoperative month. This patient was in the hospital for genito-urinary tuberculosis. The incidence of empyema was 9.4 per cent. There were three cases with wound infections (9.4 per cent). One of them had empyema and died. The other two recovered.

Present Status of Patients: Of the nine lobectomy patients, five are now classified as arrested and have been discharged; two are quiescent with negative sputa; one who had previous thoracoplasty is now quiescent with an occasionally positive sputum. During the resection, the upper lobe which was the site of the major pathology could not be removed because of technical difficulties, and the source of the occasional positive sputum is thought to be from this remaining lobe. The last patient left the sanatorium in the fifth postoperative month and the status of her sputum is unknown; however, 27 months postoperatively she was radiologically negative.

Of the 16 living patients with pneumonectomies, 10 have been discharged as arrested; one is now on exercise preparatory to discharge; four are quiescent with negative sputa; and one is quiescent with positive sputum. This last case had contralateral pneumothorax which had to be re-expanded due to respiratory insufficiency. The source of the positive sputa is from this re-expanded lung. Table 3 illustrates the status of these patients at three month intervals.

Clinical Indications for Resections

In an attempt to simplify the indications for resection in our series, we have classified the cases under five primary headings as shown in Table 4.

In addition, there were two cases thought to be nontuberculous but which on pathologic examination proved to be tuberculous,
making a total of 34 resections. We emphasize that these were the clinical indications and not the pathologic diagnoses; being based mainly on radiographic, bronchographic, and laboratory evidence. These indications are not as clear-cut as Table 4 would seem to imply. Most of these cases had several associated conditions which in themselves have been listed as proper indications by many authors. We have attempted to reduce the indications to their lowest common denominator. For example, in Group I, there were three cases with previous thoracoplasties and associated tuberculous bronchiectasis. However, as the lesions for which the thoracoplasties had been performed were radiologically apparently

<table>
<thead>
<tr>
<th>TABLE III</th>
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<tbody>
<tr>
<td>STATUS OF CASES AT QUARTERLY INTERVALS</td>
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<table>
<thead>
<tr>
<th>LOBECTOMIES</th>
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<tbody>
<tr>
<td>No. of Cases</td>
</tr>
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<td>Satisfactory</td>
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<table>
<thead>
<tr>
<th>PNEUMONECTOMIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Cases</td>
</tr>
<tr>
<td>Satisfactory</td>
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<td>5</td>
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</table>
controlled, these cases were not classified under "Thoracoplasty Failures." In the same group, the two cases that did not have previous thoracoplasty or bronchographic evidence of bronchiectasis were pneumothorax failures. One of these developed massive atelectasis of the upper lobe with continuing positive sputa and the other developed tuberculous empyema, atelectasis, and suppuration of the lung. Thus we find there is considerable overlapping of indications, but all of these cases had high grade bronchial stenosis which was considered the primary indication for resection.

A breakdown of these primary indications is presented in outline form in Table 5 in order that the associated conditions may be better realized. Many authors have listed tuberculous bronchiectasis (Group II) as an indication for resection. The term has been

### Table 4

<table>
<thead>
<tr>
<th>Group</th>
<th>Indication</th>
<th>No. of Cases</th>
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<tbody>
<tr>
<td>I.</td>
<td>Bronchostenosis</td>
<td>5 cases</td>
</tr>
<tr>
<td>II.</td>
<td>Tuberculous Bronchiectasis</td>
<td>22 cases</td>
</tr>
<tr>
<td>III.</td>
<td>Destroyed Lung with Cavitation</td>
<td>1 case</td>
</tr>
<tr>
<td>IV.</td>
<td>Lower Lobe Cavities</td>
<td>2 cases</td>
</tr>
<tr>
<td>V.</td>
<td>Thoracoplasty Failures</td>
<td>2 cases</td>
</tr>
<tr>
<td>TOTAL</td>
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<td>32 cases</td>
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### Table 5

Clinical Indications for Resection

<table>
<thead>
<tr>
<th>No. of Cases</th>
<th>I. Bronchostenosis with Endobronchial Tuberculosis:</th>
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<tbody>
<tr>
<td></td>
<td>A. Tuberculous bronchiectasis, previous thoracoplasty</td>
</tr>
<tr>
<td></td>
<td>B. Pneumothorax failure,</td>
</tr>
<tr>
<td></td>
<td>1. Tuberculous empyema, atelectasis, suppuration</td>
</tr>
<tr>
<td></td>
<td>2. Atelectasis, U.L.</td>
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<tr>
<td></td>
<td>II. Tuberculous Bronchiectasis:</td>
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<tr>
<td></td>
<td>A. Without Cavitation</td>
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<tr>
<td></td>
<td>1. Atelectasis and fibrosis</td>
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<td></td>
<td>2. Previous thoracoplasties,</td>
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<tr>
<td></td>
<td>a. Without empyema or B-C fistula</td>
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<tr>
<td></td>
<td>b. With empyema and B-C fistula</td>
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<tr>
<td></td>
<td>3. Pneumothorax failure</td>
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<tr>
<td></td>
<td>B. With Cavitation,</td>
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<tr>
<td></td>
<td>1. Without atelectasis</td>
</tr>
<tr>
<td></td>
<td>2. With atelectasis and fibrosis</td>
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<tr>
<td></td>
<td>III. Destroyed Lung with Cavitation</td>
</tr>
<tr>
<td></td>
<td>IV. Lower Lobe Cavity</td>
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<tr>
<td></td>
<td>A. With tuberculous Bronchiectasis</td>
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<tr>
<td></td>
<td>B. Phrenic and pneumoperitoneum failure</td>
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<tr>
<td></td>
<td>V. Thoracoplasty Failure</td>
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<tr>
<td></td>
<td>Residual cavity and bronchiectasis</td>
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<tr>
<td></td>
<td>TOTAL</td>
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(In 2 additional cases, resections performed for other conditions proved on pathologic examination to be tuberculous.)
rather loosely applied in our series, patients having positive sputa and evidence of bronchiectasis being listed in this category. Our studies have led us to believe that this diagnosis is not easy to establish preoperatively and the condition is not as common as Table 4 would lead us to believe. A more thorough discussion of this subject will follow in the text.

All but four of these patients had positive sputa at the time of surgery. Two of the 22 tuberculous bronchiectasis patients were negative. One of them had extensive bronchiectasis and fibrosis with marked contraction of the affected lung; however, she had frequent small hemoptyses up to the time of surgery. The second patient had had negative sputa for 32 months, but during trial exercise she also had several hemoptyses. The third negative sputum patient was a 64 year old white female who was thought to have malignancy. The fourth patient was the 10 year old colored boy with extensive caseous-pneumonic disease involving the entire right lung (these last two cases make up the misdiagnosed group). His sputa were repeatedly negative and this diagnosis was not established until the pleural cavity was entered and caseous involvement of the mediastinal and hilar lymph nodes were found. There was no radiographic evidence of involvement in the contralateral lung so the decision to proceed with the resection was made at that time.

Tuberculomas and tension cavities are generally accepted indications for resection, but we had no cases of this type in our series. The preoperative diagnosis of tuberculoma is difficult to establish. Most cases of solitary circumscribed lesions are actually cavities filled with caseous material and tubercle bacilli. Some of these lesions excavate and refill intermittently. This type of lesion is suitable for resection as its thick walls usually withstand collapse therapy, and it is potentially dangerous as a source of tubercle bacilli. We have removed these “putty tubercles” on two occasions (one prior to and one subsequent to our series) and found rather thick cavity walls filled with caseous material and tubercle bacilli. More often, a solitary circumscribed lesion is removed with a preoperative diagnosis of “Possible Neoplasm.”

The management of tension cavities has been revolutionized since the introduction of streptomycin. These cavities are always due to a valve mechanism in the draining bronchus, and in most cases, endobronchial tuberculosis is the responsible factor. In our institution, tension cavities are an indication for streptomycin therapy. We have seen these cavities reduced to a fraction of their previous sizes during a course of streptomycin, and in many instances, have subsequently treated them by collapse therapy. In this respect, we are not in complete accord with Maier, who
states that in some cases, "thoracoplasty without streptomycin is indicated... The streptomycin should be reserved for the time of resection if the latter procedure is required."

**Group I — Bronchostenosis**

The studies of Samson, Wilson, and others have shown that fibrostenosis of the bronchus in a tuberculous patient is the end result of an extensive tuberculous ulcerative bronchitis. Samson was actually able to follow one case bronchoscopically from the ulcerative to the fibrostenotic stage. Apparently, the more destruction there is of the wall of a bronchus, the more extensive the resultant scar and stenosis will be. Auerbach described these ulcerations as being lenticular; that is, their long axes are at right angles to the long axis of the bronchus. This probably contributes to the circumferential character of the stenoses.

Bronchostenosis is probably the most widely accepted indication for resection in pulmonary tuberculosis. Several surgeons, among them Bally, O'Brien, Alexander, Brewer, Dolley and Jones, qualify this indication by stating that only in high grade stenosis with symptoms of retention is resection preferable to thoracoplasty, primarily because of the lower mortality and morbidity associated with the latter procedure. Many of these authors prefer thoracoplasty in cases with moderate bronchostenosis without associated bronchiectasis or suppuration, even dilating the strictures between stages of thoracoplasty if indicated.

The question arises as to how often bronchial stenosis can be present without associated suppurative or bronchiectatic complications; and if none are present at the time of operation, how long will it be before they develop, even with apparently satisfactory control of the parenchymal disease. Studies have shown that various stages of endobronchial tuberculosis can be present within the same bronchus draining an active parenchymal focus, so that it is entirely possible to have various stages of active endobronchial tuberculosis distal to the stenosis. Also, once the endobronchial disease becomes established, it can and does progress independently of the parenchymal focus. The two most common etiologic factors in the development of bronchiectasis, namely infection and obstruction, are present in cases of endobronchial tuberculosis with stenosis.

**I. Bronchostenosis**

**A. Tuberculous Bronchiectasis and Previous Thoracoplasty**

There were three cases in this group. All of whom had positive sputa, previous thoracoplasties, and bronchographic evidence of bronchiectasis distal to their stenoses.
Case 1: (17668-41) V.C., white female, age 25, duration of disease 5½ years. Patient was first admitted June 29, 1942 with far advanced disease and positive sputum. In July 1942, a left pneumothorax was instituted but abandoned, as it resulted in “ballooning” of the cavity (Fig. 1a). Left phrenemphraxis was performed in December 1942, followed by three stages of posterior and one stage of anterior thoracoplasty between January and May 1943. This resulted in sputum conversion and subsequent discharge as an arrested case in October 1944 (Fig. 1b, after completion of thoracoplasty). She was apparently in good health until December 1945, when she developed acute respiratory infection and positive sputa.

The patient was re-admitted in June 1946. Bronchoscopy revealed extensive granulation tissue and ulceration about the left main stem bronchus (which was almost completely occluded) extending up the posterior and lateral wall of the trachea. Repeated bronchoscopic treatments with 30 per cent silver nitrate resulted in only slight improvement of the endobronchial pathology. Streptomycin\(^{25}\) was administered from February 27, 1947 until June 27, 1947, a dosage of one gram daily for one week followed by 0.5 gm. daily thereafter in two divided doses being employed. Within four weeks after the institution of this therapy, the extensive endobronchial lesion completely cleared, leaving a clean, high grade bronchial stricture just below the carina in the left main bronchus (Fig. 1c, preoperative bronchogram demonstrating the stricture and the bronchectasis). Left pneumonectomy was performed on April 15, 1947 approximately seven weeks after institution of streptomycin therapy.

The pneumonectomy specimen showed numerous fibrous adhesions over the surface of the upper lobe. The lymph nodes at the hilum were not remarkable. On section there was a questionable thin-walled collapsed cavity at the apex. Rather prominent bronchectasis was found in the region of this cavity with evident increased fibrosis around the bronchi. The microscopic sections showed little active disease. The apex demonstrated secondary bronchectasis with a few rare submucosal tubercles. Rather prominent hypertrophy of the muscularis mucosa of the bronchi leading to the upper lobe was present. The point of stricture in the main bronchus was not included in the resection. The microscopic diagnosis was: encapsulated caseous foci and bronchectasis, predominantly non-specific, with occasional submucosal tubercles.

Postoperative course was uneventful. Sputa remained negative and the patient was discharged one year later as an arrested case (Fig. 1d).

Comment: The other two cases in this group were quite similar preoperatively, having apparently satisfactory thoracoplastic collapses without sputum conversion. The second case, a 33 year old colored girl, also received streptomycin pre- and postoperatively. The pathologic specimen also showed encapsulated caseous foci and predominantly non-specific bronchectasis. Although this patient had a high grade bronchial stenosis, there were no symptoms of secondary suppuration or infection. This type of pathologic process, however, seems to us to be an ideal indication for pneumonectomy with eradication of a non-functioning lung which remains a focus of positive sputum. In the third case, streptomycin was not given preoperatively. Pneumonectomy was attempted, but
Fig. 1a. 7-10-42: Note large cavity at apex which ballooned out following institution of pneumothorax—Fig. 1b. 8-11-42: Three stage posterior and one stage anterior thoracoplasty completed—Fig. 1c. 2-7-43: Ligation demonstrates bronchocele and bronchial stricture—Fig. 1d. 7-9-43: Postsurgical film (15 months).
due to technical difficulties, only the lower and middle lobes were removed. This specimen contained acinous and acinous nodose foci and fibrosis in addition to the encapsulated caseous foci. Within the ectatic bronchi, there was extensive tuberculous involvement of the medium and small bronchi. The hilar lymph nodes were also involved with tuberculosis (Fig. 2). We felt that the pathologic findings in this case justified the removal of these lobes. However, the major pathology in the beginning was in the upper lobe which originally was atelectatic and contained a cavity. This lobe was left behind. As the contralateral lung was radiologically negative and as the bronchial stump was healed, it is highly probable that the occasional positive sputum this patient developed one year after resection was coming from the remaining lobe or its bronchi.

In case 1, streptomycin produced a marked change in the visible endobronchial disease, and the pathologic specimen revealed practically no active disease in the parenchyma or bronchi.

Mild to moderate endobronchial disease that responds to streptomycin therapy is per se not an indication for resection, as other forms of collapse therapy may suffice in arresting the disease process. In healing severe endobronchial disease with streptomycin, varying degrees of cicatrization and stenosis will occur. Such

**FIGURE 2:** Pneumonectomy specimen. Note complete collapse of the lung with encapsulated caseous foci and bronchiectasis.
FIGURE 3a

Fig. 3a, 8-2-43: Note soft infiltration in left apex.

FIGURE 3b

Fig. 3b, 4-9-45: Ineffective pneumothorax with deviation of the mediastinum to the left.

FIGURE 3c

Fig. 3c, 11-9-45: Collapsed lung, left, with high diaphragm due to phrenempyraxis.

FIGURE 3d

Fig. 3d, 12-1-47: Six months post-pneumonectomy.
stenoses will lead to pulmonary suppuration and bronchectasis, which in themselves are indications for resection. As in case 1 above, streptomycin is now converting cases formerly considered unsuitable for surgery into suitable risks by lowering the operative risk and decreasing operative morbidity and mortality.

B. Pneumothorax Failure

There were two patients in this subgroup, both having high grade bronchial stenoses. Pneumothorax was instituted in both cases with varying consequences. In case 2 presented below, atelectasis and suppuration of the lung and tuberculous empyema occurred. In the second case, atelectasis of the upper lobe resulted immediately after institution of the pneumothorax.

Case 2: (16374-61) R.L.V. White female, age 45; duration of disease five years. Onset was accompanied by laryngeal symptoms in October 1942. She entered the Missouri State Sanatorium in July 1943, but left against medical advice three months later (Fig. 3a). While at home, symptoms became worse so she re-entered in April 1944. X-ray on second admission showed considerable progression of the disease in the left lung with multiple areas of rarefaction throughout.

Left pneumothorax was instituted on April 20, 1944. Closed intrapleural pneumonolysis was attempted in May 1944, but the adhesions could not be cut. The pneumothorax was re-expanded and a left phrenempharaxis was performed on June 7, 1944, resulting in a marked rise of this hemidiaphragm. The patient continued to be quite toxic with wheezing and severe cough. Bronchoscopic examination January 12, 1945 revealed extensive endobronchial disease about the left main stem bronchus which was completely obstructed with granulation tissue. The area was cauterized repeatedly with 30 per cent silver nitrate at four to six week intervals with slight improvement. (Fig. 3b shows status of lungs on April 9, 1945). In June 1945, she developed empyema in the left chest which proved to be tuberculous. This was treated semi-weekly by aspiration, irrigation, and instillation of Azo-chloramide with tetradecyl sulfate. The empyema cleared and became bacteriologically negative by October 1945. Left pneumonectomy was considered at this time but the active endobronchial disease in the main-stem bronchus at the level of the carina seemed to contraindicate operation. (Fig. 3c, taken November 9, 1945. Negative pressure was adjusted to —36 cm. of water after each aspiration with no further re-expansion of this lung. Note the massive atelectasis and mediastinal shift to the left).

Streptomycin therapy was started on April 27, 1947 consisting of one gram daily for one week then 0.5 grams daily, given in two divided doses. The treatment was continued for six months. Bronchoscopy on June 13, 1947 (seven weeks after institution of streptomycin therapy) disclosed complete clearing of the granulation tissue about the carina and the left main bronchus, but marked stenosis was observed just inside the left main stem bronchus. Left pneumonectomy was performed on June 18, 1947. (Fig. 3d, x-ray following left pneumonectomy and modified thoraycoplasty. The scattered markings in the right lung are due to residual oil.)
The pneumonectomy specimen revealed a greatly thickened pleura measuring up to 0.3 cm. The lung was firm and practically non-crepitant. A bronchial stricture which had been present was not included in the specimen. No harm apparently resulted in two cases in which strictures were left behind. On section of the lung there were large areas of caseation encapsulated by fibrous walls. These areas were extensive throughout the entire lung and the intervening pulmonary parenchyma was collapsed. These caseous areas impinged upon the bronchi and some of the smaller ones were filled with caseous material. Microscopic section demonstrated the encapsulated caseous foci with intervening collapsed lung. In addition, there was active tuberculosis within the thickened pleura. Hilar lymph nodes were negative. The microscopic diagnosis was: multiple caseous foci, tuberculosis of moderate sized bronchi, caseous tuberculosis of the pleura, atelectasis and fibrosis. The sputum immediately became negative and the patient was discharged as an arrested case one year later.

Comment: From these findings, it is obvious that this patient had extensive tuberculosis of the bronchi and that pneumothorax was contraindicated. There was ulceration of some of the bronchi with secondary destruction of the bronchial cartilages. As this lung was the main source of the tuberculosis, it was constantly seeding the opposite lung. The lung itself was non-functioning and tending to heal. The pathologic changes, together with the stricture, made this an ideal case for pneumonectomy.

The second case of this subgroup had extensive involvement of the left main bronchus with low grade stenosis, but in addition, had tuberculous granulations and ulcerations about the left upper lobe bronchus with moderate stenosis. Although resection of the left upper lobe was contemplated, pneumothorax was first tried cautiously, but resulted in massive atelectasis of the upper lobe. Streptomycin was not available at this time. The lobectomy specimen (left upper lobe) showed encapsulated caseous foci, bronchiectasis with extensive endobronchial tuberculosis, and tuberculosis of the hilar lymph nodes. This case presented involvement of both the bronchi and parenchyma. It is obvious that pneumothorax was contraindicated in the presence of extensive endobronchial disease and bronchostenosis.

II. Tuberculous Bronchiectasis

Tuberculous bronchiectasis as a clinical indication for resection has been applied quite loosely in our series; cases presenting bronchographic evidence of bronchiectasis with a positive sputum were placed in this category. In tuberculosis, most cases of bronchiectasis follow previous parenchymal and/or bronchial disease. If tuberculosis of any extent involves the parenchyma of the lung, the bronchi leading to this involved area invariably show some degree of tuberculosis. With healing of the parenchymal process,
some degree of residual bronchiectasis remains. Usually it is asymptomatic and is in the upper lobe. If bronchograms are done, they may reveal structural alterations which will usually directly vary with the severity of the previous process. These bronchiectatic areas may show an occasional tubercle but it is questionable whether such changes should be dignified by the name tuberculous bronchiectasis. Bronchiectasis (mainly non-specific, etiology tuberculosis) would seem to be a better diagnosis. In other instances (a much lower percentage) the degree of endobronchial tuberculosis may be prominent. In these cases the process can involve all sized bronchi. The pathology seen can be varied and bronchiectasis is an inevitable accompaniment. Our upper lobe bronchiectasis usually represented a burned out tuberculous process while the lower lobe bronchiectasis often showed active extensive endobronchial tuberculosis. Such changes could be designated as bronchiectasis with prominent endobronchial tuberculosis.

Rilance and Gerstl,26 from their studies of 47 tuberculous patients with bronchiectasis, attempted to differentiate tuberculous and non-tuberculous bronchiectasis. But they differentiated the two conditions from a morphologic and etiologic basis. On the other hand, Mitchell and Thornton27 stress the importance of positive sputum in establishing the diagnosis of tuberculous bronchiectasis.

From the surgeon's viewpoint, the diagnosis of tuberculous bronchiectasis should be made on a pathologic basis, difficult though this may be, as this condition is a surgical disease, amenable at this time only to resection. Through our studies, we feel that even though it is difficult to establish a diagnosis of tuberculous bronchiectasis, one can arrive at it in many cases with a reasonable degree of accuracy.

The endobronchial tuberculosis in an ectatic bronchus may range from an isolated tubercle (Fig. 4a), ulceration into a bronchus (Fig. 4b), to partial and complete destruction of the bronchial wall with obstruction and stenosis (Fig. 4c shows destruction of the bronchial wall). In diagnosing bronchiectasis with endobronchial tuberculosis the question arises as to where the dividing line may be between those cases with only rare submucosal tubercles and those with extensive involvement of the bronchi. From a practical point of view we now feel justified in making this diagnosis in the presence of persistently positive sputum, bronchographic evidence of bronchiectasis with absence of active parenchymal lesions, and with bronchoscopic evidence of disease. The location of the bronchiectasis may also furnish a clue. For example, of the 22 resection cases in the tuberculous bronchiectasis group (Group II), 11 had the bronchiectasis limited to the upper lobe.
Fig. 4a: Photomicrograph to demonstrate a submucosal tubercle. Note the overlying mucosa is intact.---Fig. 4b: Ulceration of a submucosal tubercle into a bronchus. Lining bronchial epithelium is intact.---Fig. 4c: Photomicrograph which demonstrates an ectatic bronchus partially destroyed by tuberculous granulation tissue.
Of these, only one had moderately extensive endobronchial disease, the remainder having predominantly non-specific bronchiectasis. On the other hand, in the 11 remaining cases that had pathology in the middle and/or lower lobes, six had moderate to extensive endobronchial tuberculosis. The old axiom "upper lobe bronchiectasis, tuberculosis; lower lobe bronchiectasis, non-tuberculosis" is founded upon an etiological classification and certainly does not hold true in our cases.

Pathogenesis: The discussion of the pathogenesis of tuberculous bronchiectasis resolves into a discussion of bronchiectasis and of endobronchial tuberculosis. The presence of some degree of bronchial block plus bronchial infection is generally accepted as being a common cause of bronchiectasis. Foreign bodies, endobronchial disease, tumors, enlarged peribronchial lymph nodes, and mechanical kinking of a bronchus as seen frequently following thoracoplasty or extensive fibrotic disease may all partially occlude a bronchus with stagnation of secretions and infection distal to the point of partial block. The importance of atelectasis of the lung exerting an external pull on the bronchus as an etiological factor has been emphasized by Andrus and Kent, Hedblom and others have also emphasized the effect of retracting parenchymal lesions with resultant fibrosis exerting a distorting effect on the bronchi, causing bronchiectasis. It is reasonable to assume that bronchiectasis can be caused by all these various factors and that different ones may cause bronchiectasis in various areas of the same tuberculous lung.

The pathogenesis of endobronchial tuberculosis has been the subject of considerable controversy in the literature. Theories have been advanced as to the mode of implantation of the tubercle bacillus in the bronchial submucosa. The lesions are in most cases secondary to a parenchymal focus and may take root in a bronchus by:
1) Direct implantation upon the mucosa;
2) Direct extension from neighboring structures, e.g. lymph nodes;
3) Spreading through the lymphatic system from the parenchymal focus;
4) Spreading through the blood stream.

Burgher, Littig and Culp and later Huang, from their study of 122 and 115 autopsy cases respectively, concluded that the predominant mode of infection was by direct implantation of tubercle bacilli upon the bronchial mucosa from the parenchymal focus. Silverman, from a study of 110 autopsy cases, also arrived at the same conclusion.
Reichie and Frost, from their study of 37 necropsies, concluded...
that the predominant mode of infection was from the lung parenchyma through the lymphatics to the adjacent bronchi, and also that the peribronchial tuberculous lymph nodes may play a part in infection of the mucous glands of the bronchi by contiguous infection. Meissner\textsuperscript{13} also believes that the lymphatics carry the bacteria from the parenchymal focus to the bronchial walls, this conclusion being drawn from his study of 60 surgical specimens. He found a high incidence of hilar lymph node involvement in these cases and stated, "Many of the lymphatics drain down the wall of the bronchus; the submucosa of the bronchus is also rich in lymphatics. Thus, the entire course of the bronchus...which leads from a parenchymal lesion is potentially subject to tuberculosis if tubercle bacilli will but lodge in its walls."

Miller,\textsuperscript{35} from his studies of the valves in the lymphatic system of the lung, concluded that the flow of lymph in the bronchial and arterial lymphatics was towards the interior of the lung: that is, from the hilum toward the periphery; whereas the flow of the lymphatics accompanying the pulmonary veins and its branches is from the periphery toward the hilum. The flow of lymph at the communications of the superficial (pleural) and deep (pulmonary) set of lymphatics is always toward the pleura. Thus, it is hard to conceive of an extensive tuberculous process in the bronchi occurring consistently in a retrograde fashion from a parenchymal lesion down to the main bronchi.

Ornstein and Epstein\textsuperscript{36} diagnosed tuberculous bronchitis clinically in eight cases with little or no manifest parenchymal disease. They believed that the infection was transmitted from the adjacent tuberculous lymph nodes by contiguity, and that reinfection of the parenchyma in some of these cases was caused by aspiration of the tubercle bacilli from the bronchial lesions. Silverman\textsuperscript{33} reports one case in her series of tuberculous autopsies that had miliary dissemination without cavity formation, in which extensive tuberculosis of the walls of the small bronchi were found.

The tubercle bacillus is notorious in spreading through the path of least resistance, so undoubtedly all of the various modes of spread can and do occur as reported by the different investigators above. However, the most common method by which tuberculosis infects the bronchi appears to be by direct implantation.

In addition to the study of the surgical specimens, we have had the opportunity of following the clinical course of our patients before resection. As result of this correlated study, we feel that the mode of causation of the endobronchial pathology in our series was predominantly if not entirely by direct implantation. The incidence of endobronchial tuberculous infection in lower lobe bronchiectasis (55 per cent) of 11 cases was considerably higher.
FIGURE 5: Photomicrograph which demonstrates (a, above) an open duct leading to (b, below) a tuberculous lesion associated with the mucous glands.
than in the upper lobe bronchiectasis (9 per cent) of 11 cases. Five of the cases in this group had previous thoracoplasties. In three with lower lobe bronchiectasis below thoracoplasties, there was rather extensive tuberculous involvement of the bronchi; whereas in the two cases of upper lobe involvement, the bronchiectasis was non-specific. Furthermore, the predominant pathology for which the thoracoplasty was performed was in the upper portion of the lung. In bronchiectasis, because of dependent drainage, cases with lower lobe pathology give rise to varying symptoms, whereas cases with upper lobe pathology are relatively symptom free. The dependency of the lower lobe bronchi in these cases might have favored more prolonged contact of the tubercle bacilli with the bronchial mucosa resulting in their implantation. In our studies, as were Meissner,13 Reichle and Frost,34 and Silverman,33 we were impressed by the frequency of the presence of submucosal tubercles near mucous glands and ducts (Fig. 5a). Mucous ducts are quite abundant and it is reasonable to assume that the tubercle bacilli gain entrance to the submucosal tissues by this route (Fig. 5b).

Group II — Tuberculous Bronchiectasis

A. Without Cavitation

There were four cases in this sub-group, all with positive sputa and evidence of bronchiectasis. There was no roentgenologic evidence of atelectasis.

Case 3: (17364-1) B.S. White female, age 21; duration of disease at time of resection was eight months. Onset was gradual with productive cough, fever, and chest pains in August 1945. In December, she raised some blood streaked sputa, and entered the sanatorium January 1, 1946 with minimal tuberculosis of the left lower lobe and positive sputum. Bronchoscopy on January 11 revealed extensive ulcero-granulomatous lesions below the left upper lobe bronchus which were cauterized with 30 per cent silver nitrate. By March 15, the lesions had cleared (Figs. 6a and 6b). Left lower lobectomy was performed on April 24, 1946. This failed to convert her sputum, and an x-ray film three months postoperatively revealed ipsilateral and contralateral infiltrations. Bronchoscopy on August 2 revealed an ulcero-granulomatous lesion about the upper lobe orifice.

The larger bronchi of the left lower lobectomy specimen showed no evidence of ulceration. In the smaller bronchi were prominent granulomatous tuberculous masses growing within their lumina, and in some instances the small bronchi were completely occluded. The lung draining these partially or completely occluded bronchi demonstrated variable degrees of atelectasis and emphysema. The microscopic findings showed striking changes in the moderate-sized and smaller bronchi. These granulomatous masses often eccentrically replaced the walls of the bronchi distorting their normal configuration, ulcerating through the mucosal surfaces and partially or completely blocking the lumina (Figs. 6c and
6d). The microscopic diagnosis was: Bronchiectasis with endobronchial tuberculosis (extensive, productive, and occlusive) of the major and minor bronchi; tuberculosis of the hilar lymph nodes.

The patient became discouraged and left the hospital against medical advice on September 24, 1946, five months postoperatively. An out-patient roentgenogram taken in July 1948 revealed complete clearing of the lesions seen three months postoperatively.

**Comment:** This patient had extensive tuberculosis of the moderate and small sized bronchi. It was difficult to see how this process could have healed without causing permanent destruction of the lung parenchyma. This case shows with clarity how futile it would be to think that tuberculosis of the bronchi could be cured.
with silver nitrate cauterization of the major bronchi when such extensive tuberculosis of the minor bronchi exists. It demonstrates that collapse therapy in treating such productive endobronchial lesions could not be expected to cause any appreciable improvement, and might exacerbate rather than diminish symptoms. From the findings listed above, we feel that removal of this lobe was justified.

At the other extreme, the left upper lobe was removed from a 52 year old female with tuberculosis for a period of 30 years. This patient had positive sputum demonstrable only by culture, and bilateral fibro-calcific infiltration throughout the upper portions of both lungs, with evidence of bronchiectasis in the left upper lobe. This specimen revealed a non-functioning lobe with well encapsulated caseous nodules and considerable secondary nontuberculous bronchiectasis. It is questionable whether this lobectomy was indicated, as the presence of predominantly nonspecific and symptomless bronchiectasis in an upper lobe in a patient with few signs and symptoms is not an indication for pulmonary resection.

1. With Atelectasis and Fibrosis:

There were three cases of tuberculous bronchiectasis without cavitation but with atelectasis and fibrosis. Two were lobectomies and one a pneumonectomy. This latter case and one of the lobectomies had negative sputa but the lungs presented the end result of extensive tuberculous processes with bronchiectasis and frequent small hemoptyes. The pneumonectomy case is presented below.

Case 4: (18005-46) A.W. White female, age 46; duration of disease over 13 years. She was a patient in the sanatorium from November 1934 to December 1937, at which time she was discharged as arrested. She developed a severe cold one month later and was re-admitted as a far-advanced case. She was again discharged as an arrested case in September 1939; the sputa all being negative during this period. In December 1944, she again developed positive sputum. She rested at home for a year, then returned to work. On regular check-up in October 1946, she was advised to re-enter for possible surgery, as there had been occasional small hemoptyes. She entered the Sanatorium in November 1946. She raised one to two ounces of purulent sputum in 24 hours, all specimens being negative for tubercle bacillus on smear, culture, and guinea pig inoculation. Vital capacity was 1800 cc. Electrocardiograms were within normal limits. (Fig. 7a is a bronchogram taken in June, 1938. Another bronchogram taken in December 1946 showed practically the same picture). Right pneumonectomy was performed on April 30, 1947.

The pneumonectomy specimen showed numerous fibrous adhesions over the surface of the lung. The hilar lymph nodes contained prominent calcification and caseation. Sections through the lung showed no evidence of cavitation but considerable bronchiectasis which was predominantly non-specific with occasional submucosal tubercles. There were
numerous calcified nodules throughout the lung and a few encapsulated caseous areas. Secondary emphysema was present (Fig. 7b). The microscopic diagnosis was: encapsulated caseous foci and fibrosis of the right lung; bronchiectasis, predominantly non-specific, with occasional submucosal tubercles; and caseous tuberculosis of the hilar lymph nodes.

The patient had a somewhat stormy postoperative course, but felt considerably better after the fluid was aspirated and the mediastinum shifted to the right as in the preoperative film. Unfortunately, postpneumonectomy thoracoplasty was performed on this case. When the mediastinum was again replaced to a normal position, a marked cardiorespiratory insufficiency developed and the patient expired 16 days later.

At autopsy, the contralateral lung disclosed no evidence of emphysema. There was considerable fibrosis of the pleura and lung, with edema, interstitial fibrosis, and encapsulated caseous foci. The heart was markedly enlarged (410 grams) and the walls of the hypertrophied right ventricle measured 1 cm. in thickness.

Comment: This patient had considerable impairment of pulmonary reserve before operation and was up in the age group in which pneumonectomy may be dangerous. There was no evidence of bronchial obstruction. In spite of the extensive bronchiectasis, the right lung had functioning pulmonary parenchyma. Death following operation was due to cardio-respiratory insufficiency. Although the contralateral lung was considerably enlarged in

FIGURE 7a

Fig. 7a: Extensive bronchiectasis and atelectasis of right lung with shifting of the mediastinum to the right.—Fig. 7b: Gross specimen with prominent mainly non-specific bronchiectasis.
Fig. 8a, 10-20-44: Note multilobular cavities with complete destruction of left lung.—Fig. 8b, 5-23-46: Roentgenogram after seven rib thoracoplasty.—Fig. 8c, 11-1-46: Extensive cylindrical bronchiectasis of left lower lobe.—Fig. 8d, 9-2-48: Post-lobectomy film (17 months).
volume due to the marked shifting of the mediastinum to the affected side, there was no evidence of emphysema. Ornstein has stated that in cases of pulmonary resection, the contralateral lung does not become emphysematous but actually hypertrophies; and for this reason, he does not advocate post-pneumonectomy thoracoplasty to obliterate the empty pleural space. Post-pneumonectomy thoracoplasties are performed primarily to prevent rapid overdistention of the contralateral lung, thus preventing reactivation of healing or healed tuberculous lesions; and secondarily to minimize potential empyema by obliterating the pleural space. However, in certain cases (as case 4 above) where there is marked shifting of the mediastinum to the involved side prior to the resection, we now feel that post-resection thoracoplasty is not necessary and may at times be harmful.

Of the two lobectomy patients, one had negative sputum and was on exercise preparatory to discharge when she developed frequent hemoptyses which gradually grew in severity. Changes of non-specific bronchiectasis dominated the picture in the specimen and the tuberculous infection was minimal and well controlled. The second lobectomy case had positive sputum, and the bronchiectasis was borderline: that is, although only rare submucosal tubercles were seen, in one section the endobronchial tuberculosis was quite prominent with granulation tissue protruding into the lumen. The parenchyma showed caseous, lobular, tuberculous pneumonia which was tending to fibrose. We feel that in both of these cases the resection was justified, the indications being hemoptyses in one and bronchiectasis with endobronchial tuberculosis in the other.

2. Previous Thoracoplasties

a) Without Empyema or Broncho-cutaneous Fistula: The five patients in this group had bronchographic evidence of bronchiectasis with positive sputa following thoracoplasty. The lesions for which the thoracoplasties were performed were apparently controlled. The bronchiectasis in all cases was present on the side of the thoracoplasty, being in the upper lobe in two and in the lower lobe in three.

Case 5: (16489-36) E.J.S. White female, age 15; duration of disease over three years. Onset was acute with symptoms of a severe cold and hemoptysis in February 1944. She was admitted to the sanatorium on July 23, 1944 as a far-advanced case with severe symptoms and positive sputa. She was placed on strict bed rest, and left phrenemphraxis was performed in September 1944 (Fig. 8a, taken after left phrenemphraxis). Pneumoperitoneums were attempted but were unsuccessful due to discomfort. The left phrenemphraxis was repeated in September 1946. A seven rib thoracoplasty in two stages was performed the following February under
epidural anesthesia (Fig. 8b). Sputum was not converted, and bronchoscopy revealed considerable purulent sputum in the left lower lobe bronchus. Bronchograms disclosed an extensive cylindrical bronchiectasis of the left lower lobe (Fig. 8c). Left lower lobectomy was performed on April 2, 1947 (Fig. 8d).

The left lower lobe was practically non-crepitant. The hilar region was not remarkable. On section the bronchi were all moderately dilated. There were numerous caseous nodules throughout the lung measuring from 0.4 to 0.7 cm. Near the periphery, there were numerous small cavities which communicated with the bronchial tree. Microscopically, they were seen to be dilated bronchi. There were tubercles on the pleural surface and also tuberculous granulation tissue ulcerating into the walls of the small bronchi. Numerous single and conglomerate caseous foci were present (Fig. 8e). The microscopic diagnosis was: chronic tuberculosis with encapsulated caseous foci of the left lower lobe, bronchiectasis with endobronchial tuberculosis of the medium sized bronchi, and tuberculosis of the pleura.

Comment: It is doubtful whether collapse therapy would have improved this situation. The lobe was non-functioning and the process was tending to heal. There was extensive endobronchial tuberculosis. These factors seemed sufficient to justify lobectomy.

The two other cases of lower lobe bronchiectasis beneath thora
coplasties were similar to the case presented above clinically, radiologically, and pathologically. On the other hand, the remaining two cases who had upper lobe bronchiectasis proved pathologically to be predominantly non-specific. In both of them sputum was not converted following resection, and in one, an occult cavity was demonstrated by laminagraphs in the contralateral lung. In the second case, sputum was converted after further compression of the contralateral pneumothorax. These two cases indicate the importance of carefully checking for presence of occult cavities and infiltrations in the opposite lung.

FIGURE 8e: Completely destroyed lobe with extensive bronchiectasis and encapsulated caseous foci.
b) With Empyema and Broncho-cutaneous Fistula: There were two cases in this group, both similar in that they had insufflated cavities when pneumothorax was instituted. Pneumothorax was abandoned and thoracoplasty performed, followed by tuberculous empyema and broncho-pleuro-cutaneous fistula. Both cases had bronchographic evidence of bronchlectasis with sputa and pleural drainage positive for tubercle bacilli, and showed predominantly non-specific bronchlectasis with only rare submucosal tubercles.

**Case 6:** (18131-77) C.S.R. White female, age 26; duration of disease over 5½ years. Onset was gradual in March 1942. She entered another sanatorium where right pneumothorax was instituted. She entered the Missouri State Sanatorium first in August 1942 for right pneumonolysis (Fig. 9a), which was followed by acute effusion. She was returned to her sanatorium in October 1942, where the pneumothorax was continued. However, because she developed empyema, bronchopleural fistula, and empyema necessitas, she was returned to our sanatorium in January 1945 for thoracoplasty (Fig. 9b). Bronchoscopy on February 10, was not remarkable except for slight narrowing of the right main bronchus. A three stage nine rib thoracoplasty was performed between February 14 and April 18. A subscapular abscess was incised and packed in June. Sputa were not converted however, and she was returned to her sanatorium six months later.

She returned for further surgery on January 26, 1947 with a broncho-pleuro-cutaneous fistula, small empyema on the side of the thoracoplasty, and a four months pregnancy. Sputum was positive for tubercle bacilli. Bronchograms revealed moderate cylindrical bronchlectasis of the right lower and middle lobes, with some puddling in a small empyema pocket (Fig. 9c). A live baby was delivered normally in June 1947. Right pneumonectomy was performed on August 27, 1947. Streptomycin was administered for six weeks preoperatively and three months postoperatively, giving one gram daily for one week followed by 0.5 gram daily in two divided doses.

The right pneumonectomy specimen showed a nodular thickened pleura with a questionable bronchopleural fistula demonstrated in the upper lobe. Hilif lymph nodes showed areas of tuberculosis. On section the parenchyma was collapsed, containing numerous encapsulated caseous and calcified nodules. The bronchi were dilated with thickened walls. Microscopic examination demonstrated the fistulous tract lined by tuberculous granulation tissue. The surrounding lung parenchyma showed extensive fibrosis, encapsulated caseous foci, and collapse. There were rare tubercles in the bronchial mucosa. The microscopic diagnosis was: encapsulated caseous foci, bronchopleural fistula, fibrosis, and bronchlectasis, predominantly non-specific. Following resection, the cutaneous fistula closed and the sputa became negative (Fig. 9d).

**Comment:** This patient originally had a tension cavity. The pneumothorax followed by pneumonolysis was ineffective because tuberculous empyema complicated by a broncho-pleuro-cutaneous fistula developed. The thoracoplasty slightly improved the condition but the sputum remained positive. Pneumonectomy resulted in conversion of the sputa to negative and obliteration of the
Fig. 9a, 8-9-42: Right pneumothorax with persistent tension cavity.—Fig. 9b, 1-30-43: Complete collapse of the right lung with bronchial pleura fistula and empyema.—Fig. 9c, 2-15-47: Bronchogram with cylindrical bronchiectasis of the right lower and middle lobe with puddling in an empyema pocket.—Fig. 9d, 2-27-48: X-ray taken six months post-pneumonectomy.
fistulous tract. The removed lung was non-functioning. Pneumonectomy was the only surgical procedure which could have brought about a cure.

The second patient of this subgroup had a much larger empyema pocket with empyema of over 3½ years' duration at the time of resection. She had large hemoptyses, and resection was attempted as a life-saving procedure. She had evidence of amyloid degeneration and did poorly following resection, dying six months postoperatively of cardiac failure.

These two patients were classified under tuberculous bronchiectasis, as the sputa were positive and bronchiectasis was demonstrated by bronchograms. Had the bronchiectasis not been demonstrated, further thoracoplasty and perhaps Schede thoracoplasty might have been considered, particularly in case 6 presented above. In cases with bronchopleural and broncho-cutaneous fistula with empyema, however, we now feel that pulmonary resection is the procedure of choice and hereafter these complications will be considered as primary indications for resection. Sarot and Gilbert,37 Davidson and Bailey38 have developed a technic of operation whereby they perform extrapleural type of pneumonectomy and attempt a total extrapleural enucleation of the empyema pocket. Theoretically, this approach seems to be based on sound surgical principles.

Of the three cases of tuberculous and mixed empyemas in our series, the empyema pocket was entered in all and partial decortication was performed with satisfactory results in two and a late death in the third.

3. Pneumothorax Failure:

There was one patient in the series in whom pneumothorax resulted in effusion, and the collapse was insufficient to control the disease or convert the sputum. Thoracoplasty was contemplated, but a routine bronchogram revealed bronchiectasis.

Case 7: (17775-8) E.W. White male, age 25; duration of disease over three years. Onset with left pleurisy in 1943. His local physician advised him to go to the Southwest, but the pains continued, so an x-ray film was finally taken in 1945 revealing an infiltration in the left upper lobe. The patient entered another sanatorium in April 1945, where left pneumothorax was instituted with resultant fluid. The pneumothorax was re-expanded, and the patient was referred to us in July 1946 for further treatment. He had hemoptysis of approximately one pint the preceding month. Bronchograms (Fig. 10a) in August 1946 revealed saccular dilatations of the anterior and apico-posterior segments of the left upper lobe. A diagnosis of tuberculous bronchiectasis was made and left pneumonectomy was performed on October 15, 1946, followed by a modified thoracoplasty six weeks later.

The left pneumonectomy specimen had a markedly thickened pleural surface. The hilar region was not remarkable except for questionable
tuberculosis of the hilar lymph nodes. On section, the bronchi to the upper lobe were dilated. No cavities of the upper lobe were identified. There were numerous well defined prominent caseous nodules throughout the lung and fibrosis of the intervening lung parenchyma was pronounced. The microscopic diagnosis was: encapsulated tuberculosis, and bronchiectasis with endobronchial tuberculosis. Postoperative course was smooth and the sputum was converted.

Comment: This patient had unsatisfactory collapse therapy by pneumothorax. Sputum was positive and the bronchograms showed bronchiectasis. Microscopic sections further demonstrated that there was considerable tuberculosis of all bronchi and that the lung was non-functioning. There was pronounced bronchiectasis with endobronchial tuberculosis in the upper lobe and extensive acinous-nodose infiltration of the lower lobe. Figure 10b shows a section through the lower lobe.

B. With Cavitation

1. Without Atelectasis:

There were four cases in this subgroup; three pneumonectomies and one lobectomy. All had demonstrable cavitation, positive sputa, and bronchiectasis of the lobe in which the cavity was located. A representative case is presented.

**FIGURE 10a**

*Fig. 10a, 8-16-46:* Bronchogram demonstrates saccular dilatation of the anterior and apical posterior segments of the left upper lobe. — *Fig. 10b:* Gross photograph of the right lower lobe which demonstrates confluent caseous lobular active tuberculous process.
Case 8: (18219-94) J.A. White female, age 30; duration of disease seven years. Onset with right pleurisy in January 1940, followed by a small hemoptysis the following month. She gradually became worse and tuberculosis was diagnosed in August. She first entered the sanatorium in October as a far advanced case with positive sputa. A right pneumothorax was instituted in November, and although a contra-selective collapse was obtained, it resulted in sputum conversion and so was maintained until fluid developed in July 1941. The lung was gradually re-expanded by repeated aspirations and right phrenemphraxis was performed in March 1943. She was discharged as an apparently arrested case in July.

Following discharge, she resumed her occupation as a beautician and was apparently in good health until August 1946, when she had an hemoptysis of three ounces. She began resting at home, but in January 1947, her sputum became positive, so she was re-admitted on March 16, 1947 as a moderately advanced case. At this time she had a moderate-sized cavity in the right apex, fibrosis and moderate retraction of the right upper lobe which was the site of disease 6½ years previously. Bronchograms revealed saccular and cylindrical bronchiectasis involving all segments of the upper lobe (Fig. 11). Right upper lobectomy was performed on October 13, 1947, followed by a modified thoracoplasty with removal of the upper four ribs; the fifth having been removed at the time of the resection.

The right upper lobectomy specimen showed fibrous pleural thickening at the apex. There was a cavity two centimeters in its greatest diameter at the extreme apex communicating with a bronchus. A confluent

FIGURE 11, 4-5-47: Cylindrical and saccular bronchiectasis involving all segments of the right upper lobe.
**FIGURE 12a**

Extensive infiltration upper two-thirds, right lung, moderate infiltration, left mid lung field.

**FIGURE 12b**

Collapsed lung, right, with multiple fluid levels.

**FIGURE 12c**

Prominent shifting of the mediastinum to the right with pooling of oil posterior superior portion of the chest.

**FIGURE 12d**

Five months post-pneumonectomy.
grayish-white firm tuberculous process surrounded the cavity. The sections demonstrated considerable secondary bronchiectasis in the regions of the cavity with only rare submucosal tubercles. The surrounding parenchyma showed considerable fibrous tissue and encapsulated caseous foci. The microscopic diagnosis was: chronic tuberculosis with cavitation and bronchiectasis, predominantly non-specific. She has been consistently negative since surgery.

Comment: This patient had a residual open chronic cavity with secondary bronchiectasis, mainly non-specific. Although the lobe was non-functioning, it is debatable whether lobectomy was indicated. The source of the positive sputum was from the open cavity. This case might have been better treated by thoracoplasty, or at least the thoracoplasty might have been tried first.

Of the remaining four cases in this subgroup, three had similar findings and resections were probably not indicated. The fourth case was a 47 year old white female who had been ill for over 17 years, had extensive bronchiectasis throughout the entire lung, and a five centimeter cavity in the apex of the lower lobe. She had a great deal of bronchial thickening, bronchiectasis, and many of these dilated bronchi revealed numerous submucosal tubercles.

2. With Atelectasis and Fibrosis:

There were three cases comprising this subgroup, all having positive sputa, cavitation, atelectasis with mediastinal retraction to the affected side, and bronchographic evidence of advanced bronchiectasis. Pathologically, they were similar in that the bronchiectasis was predominantly non-specific.

Case 9: (16691-68) O.H. White female, age 39; duration of disease 5½ years. The onset was in March, 1942, with hemoptysis of one cupful, followed by cough and expectoration. However, tuberculosis was not diagnosed until a second hemoptysis in November 1944, at which time a roentgenogram was taken. She entered the sanatorium on November 21, 1944 as a far advanced case with a positive sputum and tuberculous laryngitis (Fig. 12a). Treatment consisted of a right phrenemphraxis and pneumoptonéums. Five months after the institution of this therapy, she developed hydropneumothorax on the right (Fig. 12b). This was treated by aspiration and re-expansion. Laryngeal lesions were treated between December 1946 and April 1947 by cauterization with 30 per cent silver nitrate, but the patient remained quite hoarse. Bronchograms demonstrated a marked deviation of the trachea to the right and extensive pooling of oil in the postero-superior portion of the chest (Fig. 12c). As the contralateral lung appeared fairly stable, right pneumonectomy was performed on July 23, 1947, followed in six weeks by a modified thoracoplasty (Fig. 12d). The hoarseness disappeared after correcting the tracheal deviation.

The specimen consisted of a markedly contracted right lung showing numerous adhesions and dense fibrous thickening of the pleural surface. There was moderate narrowing of the main bronchus within a few centimeters of its origin. The entire parenchyma was infiltrated with con-
fluently fibro-caseous areas. The markedly dilated bronchi contained only rare submucosal tubercles. A cavity measuring 3 x 2 x 1.4 centimeters was present in the apex; no direct bronchial communication could be established. Hilary lymph nodes contained fibrocaseous tubercles. The microscopic diagnosis was: chronic tuberculosis with cavitation, encapsulated caseous foci, bronchiectasis (predominantly non-specific), and tubercles of hilary lymph nodes. The patient had had a negative sputum since the resection and was discharged as an arrested case in September 1948.

Comment: The bronchiectasis in this case and in the two others of this subgroup was predominantly non-specific, but because it was advanced and because of the extensive involvement of the parenchyma, removal of these lungs was probably justified. The bronchograms of one of the other cases of this group are presented (Figs. 13a and 13b).

III. Destroyed Lung with Cavitation

One case was classified in this group as we were unable to introduce iodized oil because of a markedly distorted main bronchus. Clinically, it was felt that this patient, a white female, age 21, had extensive tuberculous bronchiectasis with cavitation, atelectasis, and fibrosis. The x-ray film of the chest was quite similar to those of the three patients in the previous group. This patient had been treated for an extensive endobronchial tuberculosis which improved under silver nitrate cauterization. Streptomycin was not administered preoperatively. The pathologic sections demonstrated rather extensive endobronchial tuberculosis and bronchiectasis of the large, medium, and small bronchi; a persistent cavity, encapsulated caseous foci, atelectasis, and fibrosis. In view of the pathologic findings, we feel that this resection was justified.
IV. Lower Lobe Cavity

There were two cases in this group, both with slight endobronchial involvement demonstrated bronchoscopically. In the first there was some submucosal infiltration and edema, and in the second superficial granulation tissue was present. Bronchograms on one demonstrated bronchiectasis and a primary resection was done. The second case was a phrenemphraxis and pneumoperitoneum failure, and is here presented.

Case 10: (16887-52) E.A. White female, age 22, duration of disease over two years. The onset was acute in the spring of 1944 with a cold, pleurisy and cough. Diagnosis was made in January 1945 and she was admitted to the sanatorium on March 13 as a far advanced case with positive sputa. There was no apparent improvement after six months of strict bed rest (Fig. 14a). Right phrenemphraxis was performed in September followed by pneumoperitoneums. Bronchoscopy in October revealed some superficial granulation tissue about the left main bronchus which was cauterized with 30 per cent silver nitrate. In August 1946, there was no evidence of endobronchial disease or stenosis; however, considerable purulent sputum was seen coming from the right lower and middle lobes. Right pneumonectomy was performed on August 21, 1946, followed by a modified thoracoplasty one month later (Fig. 14b).

The right pneumonectomy specimen showed hilar nodes with tuberculous involvement. On section, the upper lobe demonstrated scattered tubercles. The middle lobe was collapsed and revealed extensive bronchiectasis and endobronchial tuberculosis. In the lower lobe there was a huge cavity 7 x 5 centimeters (Fig. 14c). Microscopic sections of the bronchus leading from this cavity showed ulceration of its surface and metaplasia of its epithelium, together with tubercles in its submu cosa. The microscopic diagnosis was: cavitation, bronchietasis with endobronchial tuberculosis and encapsulated caseous foci of the right lower lobe; bronchiectasis and advanced endobronchial tuberculosis of the right and middle lobe bronchi, and acinous and acinous nodose foci in the right upper lobe. The sputa were converted to negative following resection. A temporary broncho-pleurale fistula without empyema was present for a short time. The patient was discharged as an arrested case in December 1947.

Comment: The huge cavity of the lower lobe failed to close following the phrenemphraxis and pneumoperitoneums. The changes in the middle lobe were probably secondary to the pathology in the lower lobe. From the pathologic findings, it appears that pneumonectomy was indicated. The pathologic findings of the other case in this group were similar to the one presented above.

V. Thoracoplasty Failure

There were two patients in this group, both having residual cavitation and bronchiectasis. They were poor operative risks and both died of cardio-respiratory failure.
Fig. 14a, 8-21-45: Lateral view to demonstrate huge cavity posteriorly at the apex of the lower lobe.—Fig. 14b, 5-12-47: Nine months post-pneumonectomy and thoracoplasty.—Fig. 14c: Gross specimen to demonstrate huge cavity of the lower lobe.
Case 11: (18374-63) B.W. White female, age 65; duration of disease 16½ years. Onset was in January 1931 with an acute cold. First admission was in July 1931 as a far advanced case with positive sputa. In March 1932, right pneumothorax was attempted but was unsuccessful. Right phrenemphraxis was performed the following November and the patient was discharged to another sanatorium in October 1933 as unimproved.

The patient subsequently underwent three stages of right thoracoplasty at a third institution. She then worked until January 1946, when she developed productive cough, dyspnea and positive sputum. She was re-admitted to our sanatorium in July 1946 with a diagnosis of far advanced tuberculosis and hypertension for either a revision of the thoracoplasty or resection. This was not done as she developed congestive heart failure and symptoms of toxic nephritis. She was orthopneic with dependent edema and was returned to her sanatorium but insisted on resection because of severe, exhaustive cough and expectoration (Fig. 15). She was re-admitted here on June 11, 1947 with a moderately enlarged and tender liver, and engorged neck veins. Electrocardiograms showed left axis deviation with possible coronary insufficiency. Right pneumonectomy under the thoracoplasty was performed on July 2, 1947 as a last measure. The patient expired a few hours post-operatively of cardiorespiratory failure.

The specimen consisted of the entire right lung in which a large cavity in the upper lobe measuring 7 centimeters in its greatest diameter was demonstrated. The lung surrounding this cavity showed extensive fibrosis. The middle lobe was fibrotic and the bronchi to this lobe showed peribronchial fibrosis. The lumen of the bronchus to the lower lobe was narrow, and throughout this lobe were encapsulated caseous and fibrotic nodules. The sections demonstrated rather prominent bronchiectasis with minimal submucosal tubercles. The microscopic diagnosis was chronic tuberculosis with cavitation, encapsulated caseous foci, fibrosis, and bronchiectasis with minimal endobronchial tuberculosis.

**FIGURE 15**

*Fig. 15: Residual cavity under right thoracoplasty.*

**FIGURE 16**

*Fig. 16: Extensive caseous pneumonic process entire right lung.*

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Comment: Failure of collapse therapy is a generally accepted indication for resection. In cases of residual cavities following thoracoplasty, several procedures may be considered; namely, (1) revisional operation, (2) extrapleural packing, (3) some form of cavernostomy such as the flap drainage advocated by Eloesser, Rogers and Shipman, or (4) resection. When the thoracoplasty collapse is not adequate, either the first or second procedures may be sufficient to control the disease. The flap drainage operation was performed successfully in 18 of 24 cases by Eloesser and his co-workers in dealing with insufflated cavities. However, this operation is followed by a prolonged period of convalescence. Resection is the most formidable of these procedures, but it is the most gratifying when successful.

The patient presented above was in the upper age group and died of cardio-respiratory insufficiency following operation. It appears obvious that when a patient of this age has so much damage, it is not worthwhile to undertake the risk of pneumonec- tomy.

The other case in this group was a 42 year old white male who also had a residual cavity and bronchiectasis. He developed symptoms and signs of cardiac failure in the third postoperative month and bronchopleural fistula with empyema in the fifth postoperative month; death occurred two months later. The surgical specimen was similar to the one previously mentioned, however, the bronchiectasis and endobronchial tuberculosis in the lower lobe was considerably more prominent than in the previous case.

Error in Diagnosis: There were two cases in this series in which the preoperative diagnosis was in error. The first was a 10 year old colored boy who was thought to have non-tuberculous bronchiectasis with pulmonary suppuration. All sputum studies were negative for tubercle bacilli. Only after the chest had been opened and the caseous hilar nodes found was the correct diagnosis realized. The entire lung was of liver-like consistency. As there was no radiologic evidence of disease in the contralateral side, the decision to resect was made at that time (Fig. 16). The microscopic diagnosis was: caseous, lobular tuberculous pneumonia of the right lung and caseous tuberculosis of the hilar lymph nodes. This patient developed empyema of the right pleural cavity which was apparently controlled by aspirations and instillation of 50,000 units of Dridalol twice weekly. Because of his physical underdevelopment, thoracoplasty was not performed. In the eighth postoperative month, he developed a bronchopleural fistula and a spread of the disease to the contralateral lung, and died the following month.

Young patients with little resistance to tuberculosis frequently present progressive caseous-pneumonic disease. Although this pa-
tient was apparently doing well following resection until the bronchopleural fistula developed, it is doubtful whether resections are indicated in cases showing this type of pathology.

The second case in this group was a 64 year old white female who was thought to have malignancy in the left upper lobe. She was the wife of a physician, and an x-ray film taken in 1942 (when she was 60 years old) was negative for any infiltration. She gave a history of frequent colds, and five weeks before admission, raised about one-half ounce of rusty sputum (Fig. 17a). Sputum and bronchoscopic examinations were negative. Laminographs revealed what was thought to be a circumscribed mass in the upper mediastinum and upper lobe (Fig. 17b). Pneumonectomy was performed, followed by thoracoplasty (Fig. 17c). The surgical specimen showed a conglomerate, encapsulated caseous foci (tuberculoma-like mass) (Fig. 17d). Following the resection, she had a moderate degree of

*Figure 17a (above, left), 7-1-46: Poorly delineated shadow left upper lobe.—Figure 17b (above, right), 8-24-46: Laminagraph shows a fairly well delineated mass at left apex.—Figure 17c (below, left), 3-10-47: Post-pneumonectomy film.—Figure 17d (below, right): Gross specimen to show conglomerate productive tubercles simulating neoplasm roentgenologically.*
respiratory embarrassment, and died one year later of bronchopneumonia without evidence of reactivation of the tuberculous process (proved by autopsy). She was in the upper age group where pneumonectomy is hazardous.

SUMMARY AND CONCLUSION

Thirty-four surgical specimens of tuberculous lobes and lungs were studied in order to correlate the clinical indications for resection with the pathology. Although the indications for resection are not clear cut, certain statements can now be made that may aid the surgeon in the selection of suitable cases.

The patient with tuberculosis has often been a chronic invalid with irreparable damage to his cardio-respiratory system. The advantages to be gained from the surgical procedure should be carefully weighed against the operative risk. With advancing age there is increasing morbidity and mortality, particularly from cardio-respiratory embarrassment. In addition to electrocardiograms and other clinical tests for evaluating cardiac reserve, estimations of ventilatory function and oxygen and carbon dioxide diffusion in the alveoli would be ideal particularly in those cases presenting contralateral pleural fixation, collapse, fibrosis or emphysema.

With the increasing availability of streptomycin, it should be administered preoperatively as well as postoperatively to all patients undergoing tuberculous pulmonary surgery. Its use apparently decreases the incidence of spreads by reducing the total volume of sputum and the number of bacteria. In certain types of cases, particularly those with tension cavities, the use of streptomycin may release the check-valve mechanism by healing the endobronchial tuberculosis, thus making the cavities amenable to the various collapse measures. In this way, streptomycin may decrease some of the indications for resection. At the same time, the drug often converts poor risk cases into cases suitable for surgery. Two patients in this series with severe endobronchial tuberculosis of the stem bronchus were resected without complications after streptomycin therapy. Most of our cases in whom resection was justified presented varying degrees of endobronchial tuberculosis.

The incidence of early postoperative spreads was 6.2 per cent (two cases out of 32). Of the 30 patients who were operated under epidural anesthesia, there was only one spread (3.3 per cent). We feel that the use of this anesthesia was also an important factor in reducing the incidence of spreads, as the patients were conscious and co-operative, being able to cough and expectorate throughout the operative procedure.
The clinical indications for resection in this series were:

1. Bronchostenosis.
2. Tuberculous bronchiectasis.
3. Destroyed lung with cavitation.
4. Lower lobe cavities.
5. Thoracoplasty failures.

**Bronchostenosis**, the end result of endobronchial tuberculosis, is a justifiable indication for resection. Bronchiectasis is almost always present distal to the stricture, usually with varying degrees of endobronchial tuberculosis. The healing of parenchymal tuberculous lesions usually results in bronchiectasis, varying in proportion to the extent of the parenchymal lesion. The resultant *upper lobe bronchiectasis* is usually non-specific and its mere presence without symptoms should not be an indication for surgery. When this pathology is present with positive sputum, careful search should be made for occult cavities or active infiltration. With upper lobe bronchiectasis plus cavitation, thoracoplasty probably should be tried first. *Bronchiectasis in the lower lung fields* is more apt to be complicated by endobronchial tuberculosis. In the absence of an active parenchymal focus but with positive sputum and evidence of bronchiectasis (condition frequently seen following adequate thoracoplasties) one may be justified in making a diagnosis of bronchiectasis with endobronchial tuberculosis. In cases presenting cavitation, massive atelectasis, fibrosis, and bronchiectasis with positive sputum (the so-called “destroyed lung”) resection is the method of choice. Resection is also the procedure of choice in chronic *bronchopleural fistula with empyema*. The bronchus leading to the fistula is usually ectatic with endobronchial tuberculosis. In one of our cases, thoracoplasty alone was not successful in closing the fistula. In two, the resection was performed for hemoptyses. As the source of bleeding was from ectatic bronchi, they were classified in the “tuberculous bronchiectasis” group.

**Lower lobe cavities** are frequently complicated by endobronchial tuberculosis. With the introduction of streptomycin they may respond satisfactorily to collapse therapy. The two cases in this series did not receive streptomycin but the presenting pathology justified their removal. In *residual cavities following thoracoplasties*, there are several operative procedures that may be utilized, depending somewhat on the general condition and age of the patient. Resection is the most formidable of these procedures, but gives the most gratifying results. It is doubtful whether surgical resection even as a heroic measure is indicated in *caseous-pneumonic disease*. Although there were no *tuberculomas* in this series, these lesions should be resected as they often contain caseous
material and are always a potential source of spread. Radiographically, they oftentimes cannot be distinguished from neoplasms.

Future reports should state specifically the type of pathology found, particularly in those cases presenting bronchiectasis with or without endobronchial tuberculosis. Further studies may produce a uniform basis of classifying the indications and contraindications for resection in pulmonary tuberculosis, which may be further clarified by long and careful follow-up periods.

(All of the resections presented in this series were performed by Dr. W. W. Buckingham, Visiting Thoracic Surgeon. We are indebted to Dr. Charles A. Braisher, Superintendent of the Missouri State Sanatorium for his co-operation in the preparation of this paper).

RESUMEN Y CONCLUSIONES

Con el fin de correlacionar las indicaciones clínicas para resección con la anatomía patológica, se estudiaron treinta y cuatro especímenes de lóbulos o pulmones. Aunque las indicaciones no fueron muy precisas, ahora se pueden hacer algunos asertos que pueden ayudar a los cirujanos para la selección de los casos adecuados.

El enfermo tuberculoso ha sido frecuentemente un inválido crónico con daño irreparable cardio-respiratorio. Las ventajas que pueden obtenerse de un procedimiento quirúrgico deben ser cuidadosamente estimadas frente al riesgo operatorio. Al aumentar la edad hay un aumento considerable de la morbilidad y la mortalidad, principalmente debido a los trastornos cardio-respiratorios. Además del electrocardiograma para estimar la reserva cardíaca, serían ideales las estimaciones de la ventilación y la difusión del oxígeno y de anhídrido carbónico en los alveolos, especialmente en aquellos casos que tienen fijación contralateral, colapso, fibrosis o enfisema.

Con la creciente facilidad de obtener estreptomicina, se deberá emplear tanto antes como después de las operaciones en todos los enfermos sujetos a cirugía pulmonar. Aparentemente su uso disminuye la frecuencia de diseminaciones al reducir el volumen, los esputos y el número de las bacterias en ellos. En algunos tipos de afeción, especialmente en los que tienen cavidades hipertensivas, el uso de la estreptomicina puede contrarrestar el mecanismo de válvula al curar la tuberculosis endobronquial y de ese modo se pueden hacer estas cavidades susceptibles de responder al tratamiento por otras medidas de colapso. En cierto modo la estreptomicina puede reducir las indicaciones de la resección. Al mismo tiempo la droga a menudo convierte casos que son considerados como malos riesgos, en casos adecuados para la cirugía. Dos enfermos en esta serie, con grave tuberculosis endobronquial afectando el
La mayoría de los casos en los que la resección fué justificada presentaban grados diversos de tuberculosis endobronquial.

La frecuencia de las diseminaciones postoperatorias tempranas fué de 6.2 por ciento (dos casos entre 32). De los 30 enfermos que fueron operados bajo anestesia epidural, solo hubo una diseminación (3.3 por ciento).

Creemos que el uso de esta anestesia fué también importante factor para reducir la frecuencia de las diseminaciones, pues los enfermos estaban conscientes y cooperaban, capacitados para toser y expectorar durante toda la operación.

Las indicaciones clínicas para resección en estas series fueron:

1. Broncoestenosis.
2. Bronquiectasia tuberculosa.
3. Destrucción pulmonar con excavación.
4. Cavidades de lóbulo inferior.

Broncoestenosis, el resultado final de la tuberculosis endobronquial, es una indicación justificada de resección. Siempre hay bronquiectasia distal a la estenosis generalmente con grados variados de tuberculosis endobronquial. La curación de las lesiones parenquimatosas generalmente trae consecuentemente la bronquiectasia que varía en proporción a la extensión de la lesión parenquimatosa. La consecuente bronquiectasia de lóbulo superior generalmente no es específica y su sola presencia sin síntomas generalmente no es una indicación para resección.

Cuando este estado patológico se presenta, debe buscarse con cuidado si hay esputo positivo, para encontrar el foco activo o una excavación.

En la bronquiectasia asociada a excavación en lóbulo superior la toracoplastía debe ser intentada primeramente. La bronquiectasia de los campos pulmonares inferiores es más posible que se complique con tuberculosis endobronquial. En ausencia de foco activo parenquimatoso pero con esputo positivo y evidencia de bronquiectasia (cosa frecuentemente vista después de toracoplastias adecuadas) uno puede estar justificado para hacer el diagnóstico de bronquiectasia con tuberculosis endobronquial. En los casos que presentan excavación, atelectasia masiva, fibrosis y bronquiectasia con esputo positivo, (el llamado “Pulmón destruido”), la resección es el procedimiento de elección.

La resección es también el método de elección en la fistula broncopleural con empiema. El bronquio que conduce a la fistula es habitualmente ectásico con tuberculosis endobronquial. En uno de nuestros casos la toracoplastia sola no logró clausurar la fistula. En dos, la resección se realizó por hemoptisis. Como la fuente de
la hemorragia fueron los bronquios ectásicos, se clasificaron como "bronquiectasia tuberculosa."

Las cavidades de lóbulo inferior frecuentemente están complicadas o con tuberculosis endobronquial. Con la introducción de la estreptomicina pueden responder satisfactoriamente al colapso. Los dos casos en esta serie no usaron estreptomicina, pero la patología encontrada justificaba la extirpación. En las cavidades residuales después de toracoplastía, varios procedimientos pueden usarse dependiendo de las condiciones generales del sujeto y de su edad. La resección es el procedimiento más formidable pero da los más satisfactorios resultados.

Es dudoso que la resección esté indicada aún como medida heroica en la afección caseoneumónica.

Aunque en nuestra serie no hay tuberculomas, estas lesiones deben sujetarse a resección puesto que a menudo contienen material caseoso que siempre es una fuente potencial de diseminación. Radiológicamente no pueden frecuentemente distinguirse de las neoplasias.

Informaciones en el futuro podrán especificar el tipo de patología encontrado particularmente en aquellos casos que presentaron bronquiectasis con o sin tuberculosis endobronquial. Estudios ulteriores podrán proporcionar una base uniforme para la clasificación de las indicaciones y contraindicaciones para la resección en la tuberculosis pulmonar, lo que se aclarará mucho más por el estudio de los enfermos seguidos largo tiempo.

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