

CONSERVATION OF LUNG TISSUE BY PARTIAL LOBECTOMY

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THE TRANSITION of pulmonary anatomy from an academic to an applied subject became complete when the mortality and morbidity of thoracic operations were lowered to about the same order as encountered in operative procedures elsewhere in the body. The lungs, the pulmonary lobes and the various divisions and segments of the lobes have been the objects of intensive and systematic studies by various investigators. The surgical possibilities are becoming more and more apparent as this knowledge increases.

Before anesthetic technics were perfected, assuring the safety of un-hurried and precise operating in the open chest, surgeons were forced to place a premium on speed. Pulmonary resections in most cases were accomplished as rapidly as possible by mass ligation of the hilum of the lobe with the aid of a tourniquet. It was necessary, therefore, to sacrifice the entire lobe regardless of the extent of the disease. Even before researches in the surgical anatomy of the lungs eliminated the necessity of mass ligation methods in many cases, it was recognized that the five pulmonary lobes distinguished by more or less constant fissures could not be regarded as the structural units of the lungs based on the distribution of the bronchi and blood vessels. The importance of the lingula of the left upper lobe has been appreciated for many years. And the dorsal divisions of the lower lobes were considered as separate units of the lung by Ewart¹ as early as 1889. In 1934, Nelson² suggested that the lungs were made up of eight lobes. Two upper lobes, two middle lobes (the lingula of the left upper lobe was considered the left middle lobe) the dorsal divisions of the lower lobes and the basal divisions of the lower lobes (Fig. 1).

An anatomic approach to pneumonectomy by separate ligation of the structures at the pulmonary hilum was first practiced by Rienhoff,³ Mason,⁴ and Crafoord.⁵ The technic was soon adopted widely because the incidence of successful closure of the bronchus was greatly increased. The success of the method stimulated several investigators⁶ to study the surgical anatomy of the pulmonary lobes in an effort to determine the feasibility of separate ligation of each anatomic structure when lobectomy is performed. These studies have demonstrated that in many instances, and probably in the great majority of cases, individual ligation of the structures at the roots of the lobes is a feasible procedure. The technic is preferable because the incidence of severe putrid empyemas following mass ligation methods is greatly reduced.

An important contribution by Churchill and Belsey,⁷ in 1938, suggested that despite the lack of uniform and well-defined surface markings the bronchopulmonary segments might replace the lobes as the surgical units

of the lungs. They applied the principle of segmental pneumonectomy in resection of the lingula of the left upper lobe (left middle lobe) by removing the posteromedial segment of the lingula and also employed the technic in operations on the dorsal divisions of the lower lobes. Subsequent experiences have demonstrated that it may be possible to conserve important amounts of lung tissue in selected cases by the extirpation of the diseased pulmonary lobules of a diseased segment rather than an entire lobe. The successful application of the principle of partial lobectomy depends upon an intimate knowledge of the structural anatomy of the lung. It is desirable, therefore, to review briefly the various lobes, divisions and segments of the lungs and establish the surgical and pathologic significance of each. In the following discussion of the surgical units of the lung, the nomenclature proposed by Adams and Davenport⁸ will be employed.

FOUR MAJOR SURGICAL UNITS OF LUNG

MEDIAL VIEW

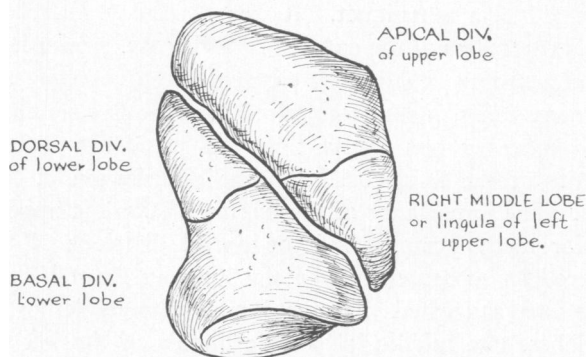


FIG. 1.—Diagrammatic representations of the surgical lobes of the lung. Each unit has a separate bronchus and arterial and venous channels accessible for individual ligation technic.

THE STRUCTURE OF THE LOWER LOBE

Both lower lobes are composed of two divisions, namely, the dorsal and basal divisions.

The dorsal division of the lower lobe is such a well-defined and constant structure that it is generally considered as a separate lobe. This division of the lower lobe possesses a definite arterial and venous channel and a separate bronchus. Not infrequently it is separated from the basal portion of the lower lobe by a distinct fissure, and of all the pulmonary segments it is most adaptable to separate removal. Precise localization of the dorsal division segment at operation, even when the superficial markings are absent or incomplete, is not difficult because its bronchus is easily accessible and, by occluding it, a delineating atelectasis of the division can be produced. The dorsal divisions of the lower lobes have special significance both surgically and pathologically since these segments are by far the most

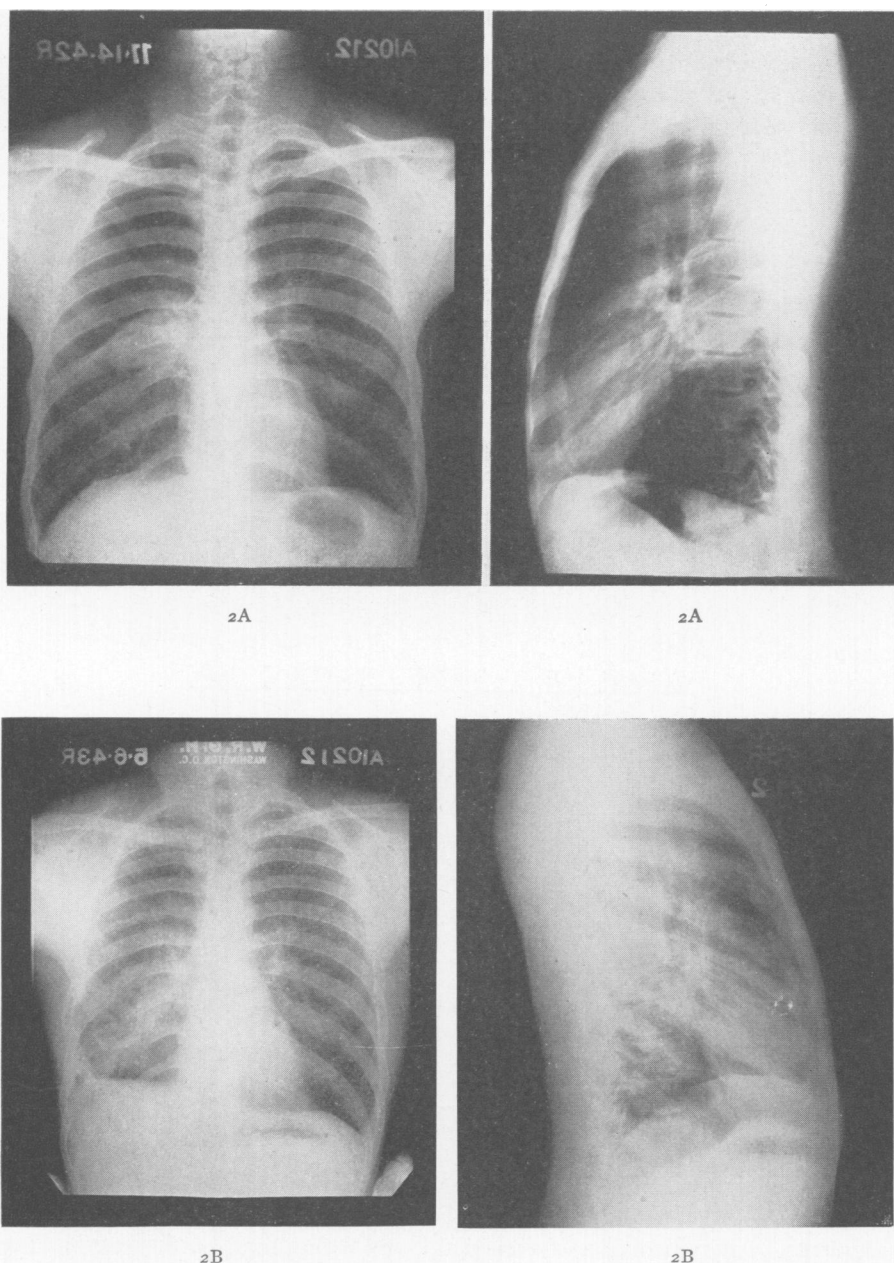


FIG. 2.—A. Roentgenograms of the chest demonstrating a sharply localized lesion of the dorsal division of the right lower lobe.
B. Appearance of the chest after resection of the dorsal division of the lower lobe. The dorsal division which contained a chronic pulmonary abscess was removed alone and the entire basal division of the lower lobe saved.

frequent sites of pulmonary abscess. Involvement of these divisions by bronchiectasis is rare, however, despite the predominance of bronchiectatic lesions in the basal segments of the same lobe. It becomes apparent, therefore, that if the disease is sharply localized to either division of the lower lobe the affected portion of the lobe may be removed separately (Fig. 2 A and B).

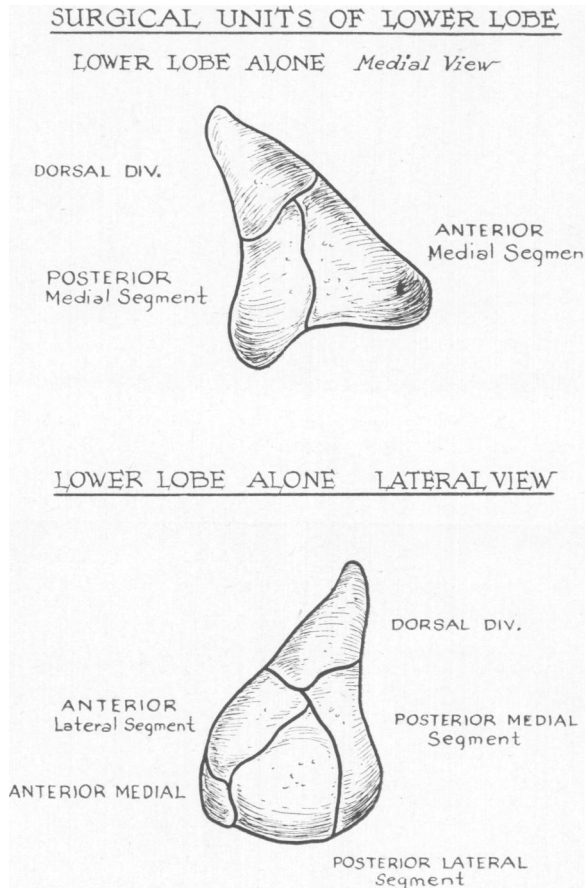


FIG. 3.—Schematic drawings of the lower lobe demonstrating the four segments of the basal divisions.

BASAL DIVISION OF THE LOWER LOBE

The basal division of a lower lobe is divided into four fairly constant segments—anteromedial, posteromedial, anterolateral and posterolateral (Fig. 3). In some cases an attempt to resect any one of the four segments in the basalar division would be impractical and dangerous. The superficial markings on the surface of the lungs are rarely sufficiently clear-cut to distinguish clearly each of the four segments, and inaccurate localization might result, in some instances, in incomplete extirpation of the diseased lung tissue. However, when both of the anterior segments or the posterior segments are

removed there is a sufficient margin of safety to insure complete eradication of a lesion confined to the periphery in an anterior or posterior position. Visualization of the lower lobe bronchus with a bronchoscope will reveal two segmental bronchi, and sometimes all four segmental bronchi can be seen. Adequate bronchography and bronchoscopic examination will establish the anterior or posterior location of the lesion. Not infrequently, one or more of the segments of the basal division will be sharply defined by rudimentary fissures. If preoperative localization places the lesion, usually bronchiectasis, in the well delineated segment, excision of the single segment is safe and advantageous (Figs. 4 and 5).

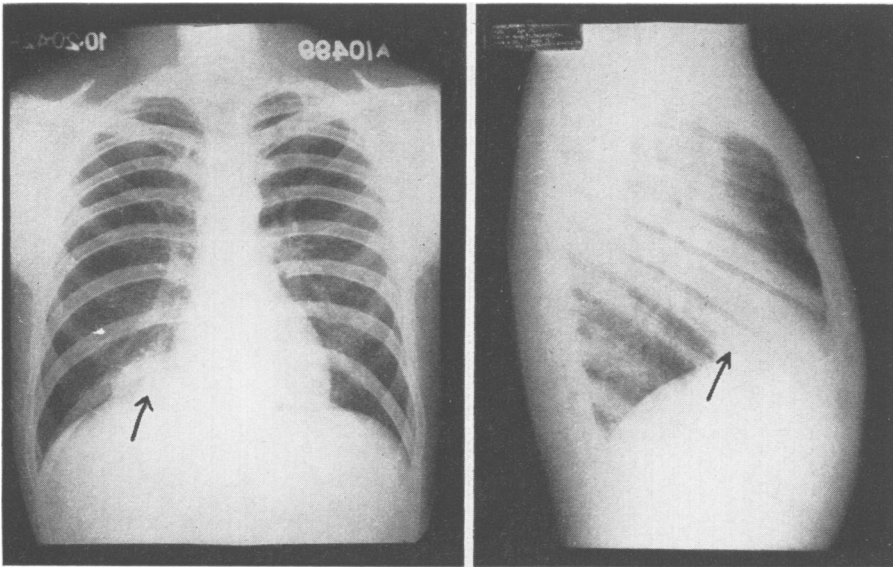


FIG. 4A.—Roentgenograms of the chest showing a sharply localized peripheral lesion of the antero-medial segment of the right lower lobe.

THE MIDDLE LOBES

For surgical purposes, the lingula of the left upper lobe may be regarded as the left middle lobe. Except for minor anatomic variations, and perhaps embryonic differences, the lingula is comparable in every respect to the right middle lobe. Both pathologically and surgically they are of the same significance. For example, the lingula is involved in more than 60 per cent of cases of bronchiectasis of the left lower lobe. The same condition is true for the right middle lobe when the right lower lobe is bronchiectatic. The boundaries of the lingula and the right middle lobe are easily identified and their bronchi are of sufficient lengths to allow individual management. They both are composed of two segments, the anterolateral and posteromedial.

Segmental pneumonectomy on the lingula division has been performed successfully by Churchill,⁷ with removal of the posteromedial segment alone. It is questionable, however, that individual resection of either of the segments of the right middle lobe would be advisable. The segments on the right are

difficult to identify and little lung tissue would be saved. Lesions localized in the right middle lobe should, therefore, be removed by complete lobectomy. In this connection it should be stated that if there is any question concerning the amount of lung tissue to be excised the surgeon is obligated to error on the radical side. Inadequate extirpation of the diseased tissue will cast disrepute on a principle that is sound when employed properly.

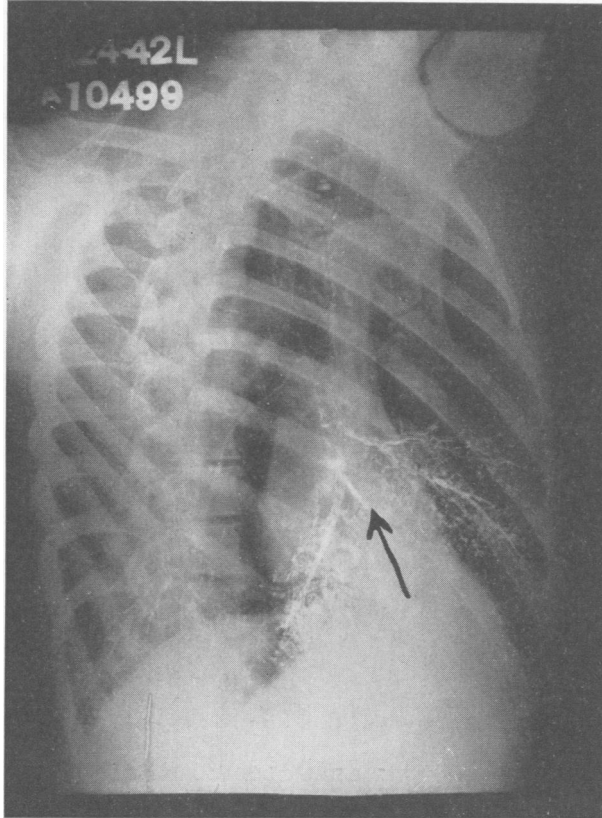


FIG. 4B.—Bronchogram demonstrating amputated bronchus to the anteromedial segment. The patient was suffering from intractable hemoptysis originating from localized bronchiectasis of the anteromedial segment of the lobe. The remainder of the lobe was conserved by partial lobectomy. The patient is cured, and is now on active military duty.

THE SURGICAL UNITS OF THE APICAL DIVISION OF THE UPPER LOBES

The apical divisions of the upper lobes are divided into four segments—anterosuperior, posterosuperior, anterolateral and anteroinferior.

Since tuberculosis is the predominant disease of the upper lobes, local excision of lung tissue of the anterosuperior or posterosuperior segments will not be indicated in many cases. There are, however, occasional instances when partial lobectomy of the upper lobe will obviate the necessity for total pneumonectomy. For example, bronchiectasis of the anteroinferior or lateral segments of the upper lobes may be found in association with middle lobe disease on the same side. The remainder of the upper lobe can be

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saved by resection of the involved segment. Another important indication for the excision of a diseased segment in the upper lobe will sometimes be encountered in suspected bronchiogenic tumor cases. In sharply localized peripheral masses from which tissue cannot be obtained through the bronchoscope for microscopic study, excision of the local lesion should be performed before a radical operation is undertaken. Gross examination and rapid microscopic studies of the tissue may prevent the calamity of unnecessary pneumonectomy. Inspection of the surface of the lungs and palpation through intact lung tissue while usually adequate, is not wholly reliable. In



FIG. 4C.—Photograph of operative incision two weeks after the partial lobectomy.

our own experience, a case which presented all of the characteristic clinical features of peripheral bronchiogenic carcinoma, except a visible tumor on examination with the bronchoscope, was subjected to exploratory thoracotomy with the intention of performing a pneumonectomy. Inspection and palpation of the lung in the operating room strengthened the opinion that the lesion was a carcinoma. Local resection of the involved lung tissue and rapid histologic study, however, revealed that the lesion was inflammatory.

The hazards of exploratory thoracotomy are so insignificant that there should be no hesitation in recommending it if other diagnostic procedures have failed to establish the nature of an intrathoracic mass. The application of this principle will undoubtedly lead to earlier diagnosis and increasing numbers of successful operations for peripheral lung tumors. If, however, there is any question concerning the nature of the disease, failure to resect the local lesion before a radical operation is undertaken will constitute a grave error in judgment (Fig. 6 A and B).

REQUIREMENTS FOR PARTIAL LOBECTOMY

Certain requirements must be fulfilled if the principle of lung conservation by partial lobectomy is to be successful: First, all of the diseased pulmonary lobules must be identified and extirpated; second, the major bronchi and vessels of adjacent segments must be left intact; and third, the satisfactory repair of the raw surface of incised lung tissue must be accomplished.

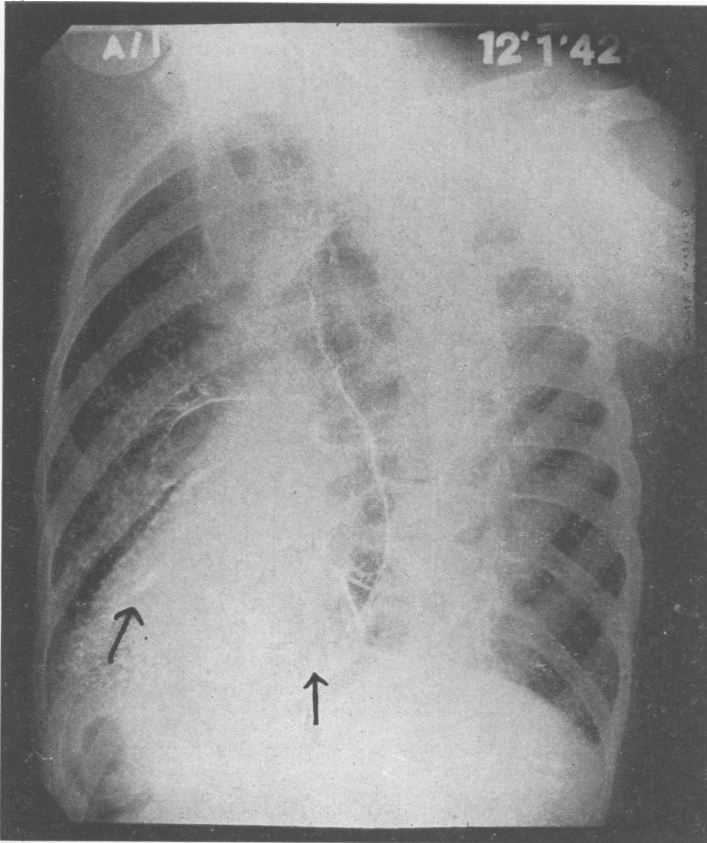


FIG. 5A.--Bronchogram showing sharply localized bronchiectasis of the lingula of the left upper lobe and the posteromedial segment of the left lower lobe.

Precise preoperative localization of the disease with an accurate appraisal of its boundaries in terms of bronchopulmonary segments, can be accomplished by conventional roentgenograms, properly prepared bronchograms, and examinations with the bronchoscope. This information, combined with actual inspection and palpation of the lungs when the operation is undertaken, will usually localize the diseased lobules in a satisfactory manner. When the dorsal divisions of the lower lobes or the lingula of the left upper lobe are the objects of surgical attack, temporary occlusion of the bronchus to the division will positively identify its boundaries. If the bronchus to a segment is not easily accessible, and it is impractical to produce atelectasis

to delineate the segment, rapid variations in the intratracheal pressure will often aid in outlining the various segments (Fig. 7 A, B and C). Careful inspection of the lung surface not infrequently will reveal rudimentary fissures which become more apparent during inflation and deflation of the lung. It is our impression that often the diseased segments fail to inflate as rapidly as adjoining normal segments.

Transillumination of the inflated lung tissue at the operating table will, we believe, furnish another valuable aid in localizing small sharply localized lesions. Further experience with this method will be necessary before its accuracy can be evaluated.

When a palpable mass is encountered the simple expedient of excising it with a margin of healthy tissue is permissible. This practice will not, however, eliminate the necessity of careful and complete preoperative localization of the disease.

There is little danger of injuring the bronchi and blood supply of adjacent lung tissue when a diseased segment of a lobe is extirpated. The rich pulmonary blood supply limits the possibilities of producing gangrene of lung tissue to ligation of major vessels or to the injudicious use of encircling ties which will occlude the blood supply to distal lobules. A comparable margin of safety is also present in the bronchial tree. Many of the limbs of the tree can be destroyed so long as the trunk is preserved. Excision of the periphery of a contiguous segment will, therefore, cause no permanent damage.

If the principle of partial lobectomy for the conservation of healthy lung tissue is generally adopted, it is safe to assume that various refinements in operative technic will develop. The method I shall describe is offered as one which has proved satisfactory in a series of eight cases (removal of the lingula not included). There were no deaths and only one case was complicated by postoperative empyema. Assessment of any influence on the immediate mortality of the procedure compared to total lobectomy, however, must await further experience.

Morbidity and empyema become almost synonymous in a consideration of lung operations and infections of the pleura, and usually result from bronchial fistula. Thoroughly satisfactory results in partial lobectomy will depend, therefore, upon the ability of lung tissue to heal after incision and suture. Experimental observations, by Olch and Ballou,⁹ indicate that healing and scar tissue formation in the lungs is similar to that elsewhere in the body. There is, in addition to laboratory observations, ample clinical evidence to prove that the pulmonary parenchyma heals readily provided the

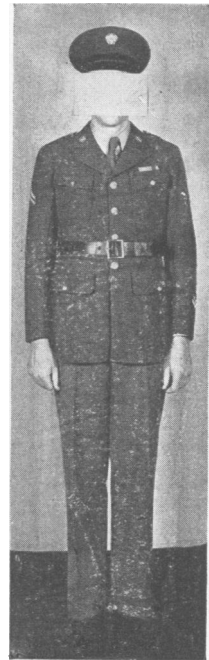


FIG. 5B. — Photograph of patient 18 days after lingulectomy and partial lower lobe lobectomy. Despite the rather minimal amount of bronchiectatic dilations the patient was incapacitated by a chronic productive cough before the operation. The soldier has returned to duty.

blood supply is not destroyed and the incision is made through healthy tissue. The bronchi in the peripheral portion of the lungs are of small caliber and, unless they become fixed to the chest wall, permanent closure of the divided bronchi can be anticipated in most cases. It is in this connection that the use of a pleural graft, which will be described, is probably of great value.

OPERATIVE TECHNIC

No comment is necessary on the technic of lingulectomy. The method described by Churchill and Belsey⁷ is entirely satisfactory and generally accepted. Excision of the dorsal division of a lower lobe can usually be

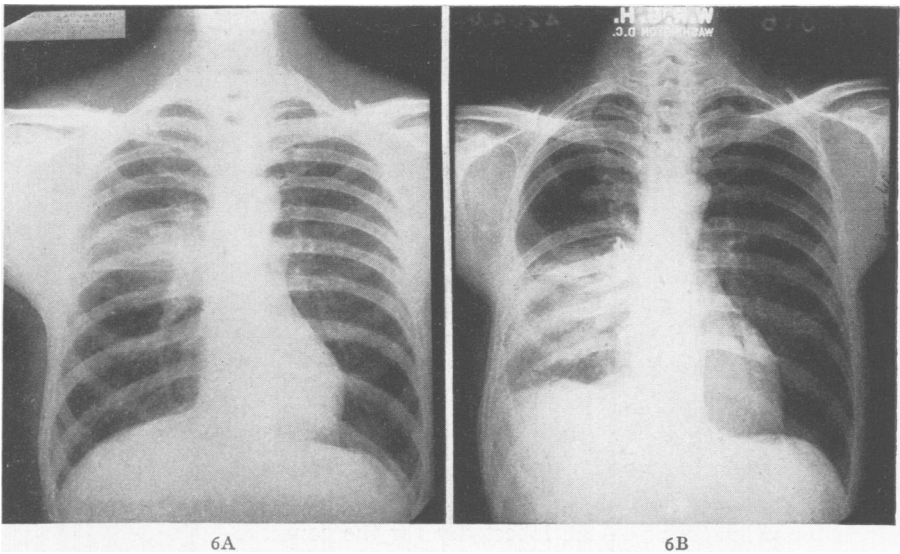


FIG. 6A.—Preoperative roentgenogram of a case which was considered to be bronchiogenic carcinoma.

B. Roentgenogram of chest ten days after local resection of an inflammatory lesion. Total pneumonectomy was avoided by partial lobectomy. The haziness in the lower right chest represents a small amount of fluid and thickened pleura; the result of the thoracotomy.

effected through relatively avascular lines of cleavage after the bronchus and blood vessels are identified and secured. When the bronchus is occluded the line of demarcation between the basal and dorsal divisions will be sharply defined and the incision through the lung tissue made at this proper level. Partial excision of the basal division of a lower lobe, however, necessitates incisions through rather thick, vascular lung tissue. Extirpation of the diseased lobules in this location may be accomplished by placing one small hemostat at the desired position and incising the tissue below the level of the instrument. The bleeding vessels in the unclamped cut-surface of the tissue to be removed are seized separately to mark their exact positions. After the division of approximately one inch of lung tissue the line of incision is approximated and the positions of the vessels held by the proximal clamp are determined. These vessels are controlled by suture ligatures before the clamp is removed. By repeating this maneuver, the

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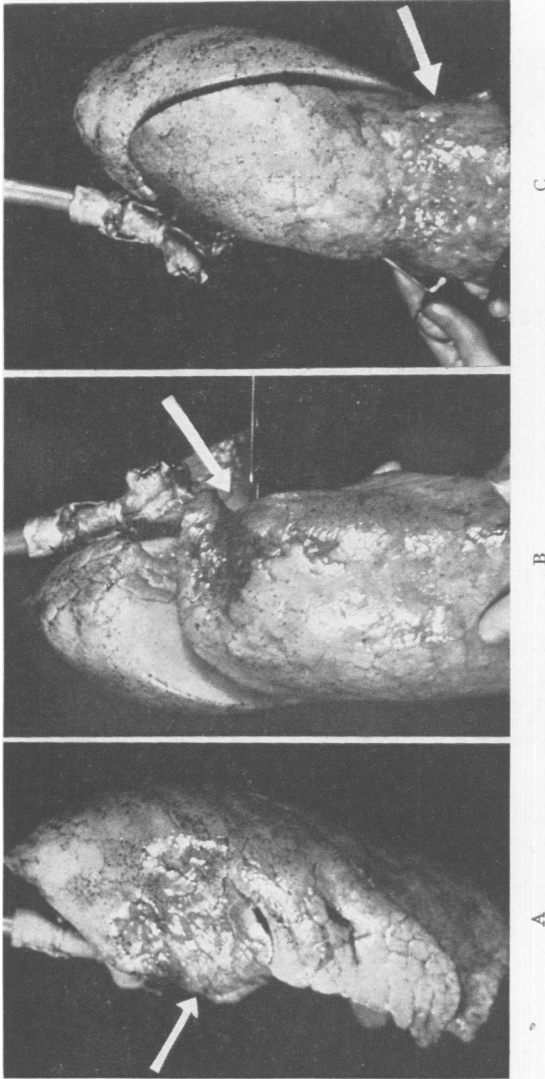


Fig. 7.—A. Photograph of delineating atelectasis of antero-inferior segment of the upper lobe produced by rapid inflation and deflation of the lobe.
B. Atelectasis of the dorsal division of the lower lobe produced by occluding the bronchus to the division.
C. The basal division of the lower lobe after occlusion of the basal division bronchus. Note the enormous difference in the size of the divisions when they are inflated and when they are atelectatic.

segment or desired amount of lung tissue is excised. When the hemostat is removed, oozing from the cut-surface, or a vessel which has not been secured by the suture ligatures, is controlled by a few interrupted sutures of fine absorbable material. The raw cut-surface of lung parenchyma is then covered with a large graft of parietal pleura, which is obtained from the chest wall (Fig. 8).

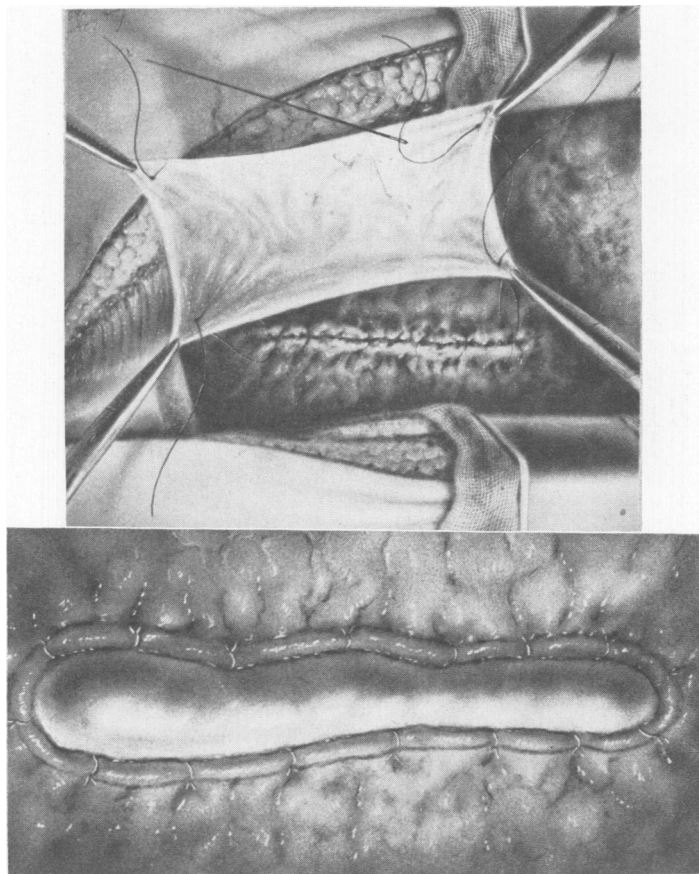


FIG. 8.—Drawings of pleural graft covering the line of incision through the lung tissue. Parietal pleura from the chest wall can be removed easily for this purpose.

Incision of the lung tissue by electrosurgical methods might be advantageous. This technic, however, must wait for an entirely satisfactory non-explosive anesthetic agent. The application of clamps across the lung tissue is admittedly crude, but if the instruments are removed quickly the rich blood supply of the lung apparently prevents permanent damage to adjacent lobules.

It must be emphasized that partial lobectomy should be reserved for suitable cases. The lesion must be peripheral and preoperative localization must coincide precisely with the location of the diseased lobules when the

lung is exposed at the operating table. Finally, if there is any question concerning adequate extirpation of the lesion by partial lobectomy, complete lobectomy should be undertaken. If these precautions are observed important amounts of lung tissue may be conserved successfully in selected cases.

REFERENCES

- ¹ Ewart, William: *The Bronchi and Pulmonary Blood Vessels*. London, 1889, J. A. Churchill.
- ² Nelson, H. P.: Postural Drainage of Lungs. *Brit. M. J.*, **2**, 251, 1934.
- ³ Rienhoff, W. F., Jr.: Pneumonectomy: A Preliminary Report of the Operative Technique in Two Successful Cases, *Bull. Johns Hopkins Hosp.*, **53**, 390, 1933.
- ⁴ Mason, G. A.: Extirpation of Lung (Hunterian Lecture Abridged). *Lancet*, **1**, 1047, 1936.
- ⁵ Crafoord, Clarence: On the Technique of Pneumonectomy in Man. *Acta Chir. Scandinav.*, **81**, Suppl. 54, Stockholm, 1937.
- ⁶ Blades, B., and Kent, E. M.: Individual Ligation Technique for Lower Lobe Lobectomy. *The Jour. of Thoracic Surg.*, **10**, 84, 1940.
- ⁷ Churchill, E. D., and Belsey, R.: Segmental Pneumonectomy in Bronchiectasis. *ANNALS OF SURGERY*, **109**, 481, 1939.
- ⁸ Adams, Ralph, and Davenport, Lourey T.: Bronchography. *J. A. M. A.*, **118**, 106, 1942.
- ⁹ Olch, I. Y., and Ballou, H. C.: Experimental Abscess of Lung Following Ligation of Pulmonary Artery and Incision and Suture of Pulmonary Parenchyma. *Arch. of Surg.*, **19**, 1586-1594, December, 1929.