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SEGMENTAL PNEUMONECTOMY IN BRONCHIECTASIS

THE LINGULA SEGMENT OF THE LEFT UPPER LOBE

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A NEW chapter in surgical anatomy dedicated to the detailed structure of the lung has been opened by the operative surgery of bronchiectasis and a more precise study of the pathology of that disease. Solely as a concession to operative technics, the lobe has been considered the surgical unit of the lung. The very name of the operation of lobectomy indicates the general acceptance of this concept.

A lobe is merely a segment of lung bounded by more or less constant and complete external fissures. It has been the convenience of these fissures rather than the underlying pathology that has defined the areas for pulmonary resection. A lobe of the lung, however, is in reality made up of a cluster of bronchopulmonary segments.

Greater precision in diagnosis and operative technic now indicates that the bronchopulmonary segment may replace the lobe as the surgical unit of the lung. This concept is developed in presenting the diagnostic and surgical aspects of the lingula segment of the left upper lobe. The basic principles of the concept, however, transcend the importance of this one bronchopulmonary segment and their wider application will be referred to briefly.

Bronchiectasis is frequently limited to one or more bronchopulmonary segments within a lobe, the remainder of the lobe being normal. It also tends to be primarily multilobar in its distribution. In a series of 86 cases of bronchiectasis operated upon by one of the authors (E. D. C.) at the Massachusetts General Hospital, the disease was limited to the confines of a single lobe in only 20 per cent. This characteristic of the disease provides a rational basis for proposing the resection of diseased bronchopulmonary segments from several lobes, if necessary, with the conservation of normal lung segments, rather than continuing with the removal of entire lobes as unit structures. This principle finds particular application in early cases of bronchiectasis and those with a bilateral distribution.

An accurate appraisal of the extent and distribution of bronchiectatic

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areas requires precision in the technic and interpretation of lipiodol bronchography and insistence upon complete visualization of not only the main bronchi but of every secondary and tertiary branch bronchus as far as its finer ramifications. Such detailed study is essential in nearly every case if a practical working basis is to be established for eradication of the disease by surgical methods.

Satisfactory surgical results in bronchiectasis can be achieved by the removal of all diseased segments of lung tissue, but the removal of a single lobe in a case of multilobar disease can lead only to disappointment unless the operation is undertaken as a palliative rather than a curative measure. A failure to delineate the complete pattern of the disease before the operation is the first step toward unsatisfactory operative results.

In our experience, bronchiectasis usually has reached its full extent and distribution at the time the diagnosis is made. The concept that bronchiectasis spreads insidiously from lobe to lobe has received undeserved support from the fortuitous demonstration of dilated bronchi by incomplete bronchograms in varying portions of the lung at different examinations. In rare instances a spread of bronchiectasis has been observed, usually as a sequel to an acute pneumonitic episode. In general, however, the anatomic pattern of the disease remains static over long periods of time although the symptoms are notoriously subject to variation. Any attempt to explain an unsatisfactory surgical result on the basis of postoperative extension of the disease appears contrary to the observed facts of preoperative pathology.

A recent survey of the Massachusetts General Hospital cases revealed that the lingula is also involved sufficiently to demand resection in at least 80 per cent of the cases of bronchiectasis of the left lower lobe, the most common site of the disease. The disappointing clinical results of some lobectomies can be explained by the failure to appreciate this high incidence and the perpetuation of cough and sputum attributed to residual disease in an unresected lingula. The lingula process of the left upper lobe stands, therefore, as an anatomic entity of great practical significance.

The Surface Anatomy of the Lingula.—It has been suggested by Nelson[8] that each lung is normally composed of four lobes: Upper, middle, lower and dorsal.* The evidence presented in support of this suggestion depends upon:

* The "dorsal lobe" is the synonym for the apical portion of the lower lobe. It is supplied by the first dorsal branch of the lower lobe stem bronchus, arising opposite the middle lobe bronchus on the right, and 1 to 2 cm. below the upper lobe bronchus on the left. The artery to the dorsal lobe arises from the inferior of the two main divisions of the pulmonary artery, close to its origin, and passes downward and medially, posterior to the main stem bronchus. The vein from the dorsal lobe drains into the inferior pulmonary vein (Fig. 5). Well developed fissures between the dorsal lobe and lower lobe proper are seen occasionally, and not infrequently the plane of cleavage is indicated by an incomplete horizontal fissure at the level of, or below, the fissure between the middle lobe and the upper lobe. This fissure is seen more commonly on the right side than on the left, especially in the lungs of children. Dévé[3] records a well defined fissure in 20 out of 180 lungs examined. Levitin and Brunn[7] have also described the two major bronchovascular segments that make up the lower lobe, with particular emphasis on the embryology and roentgenologic appearance.

(1) The demonstration by dissection of four major bronchovascular segments in each lung; and (2) the not infrequent occurrence of rudimentary fissures, constant in position but not in degree of development, subdividing the lung into four lobes. Each lobe possesses an independent bronchus and blood supply and is separated from the adjacent lobes by either a complete or partial fissure, or by an avascular plane of cleavage across which no vascular communications are encountered until the hilum is approached.

For descriptive purposes, the lingula process may be considered as the homologue of the right middle lobe, although embryologists are not unanimous in accepting this designation. It occupies a corresponding position; but, whereas, the fissure between the right upper and middle lobes is usually well developed, this is uncommon on the left side.

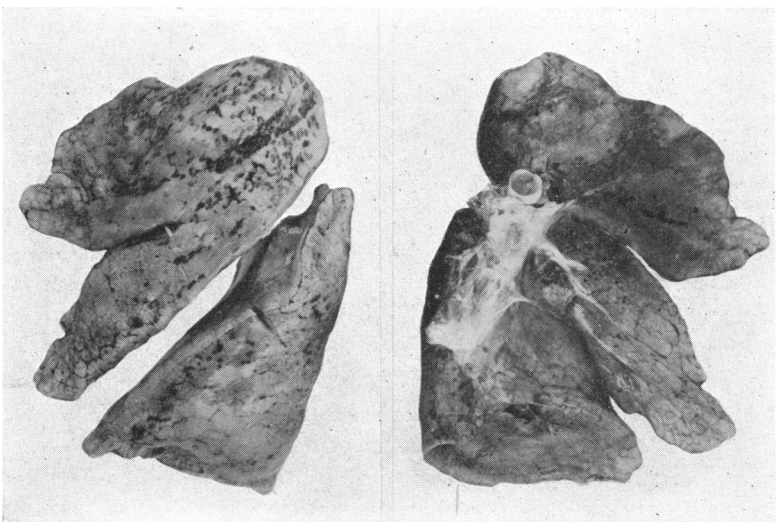

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FIG. 1.—Normal human left lung showing well developed fissure between the upper lobe and the lingula.

Figure 1 demonstrates a left lung in which the fissure between the upper lobe and lingula is well developed except posteriorly; a rudimentary dorsal lobe fissure is also present in this specimen. When the fissure between the left upper lobe and lingula is not well developed, its position is indicated by a notch on the anterior margin of the lung. The fissure is commonly more pronounced on the mediastinal than on the costal surface of the lung (Fig. 2).

The lingula, when well developed, resembles the right middle lobe in shape and exhibits a quadrilateral mediastinal surface, a semielliptical inferior or interlobar surface, and a triangular anterolateral or costal surface. A prominent ridge or "frenum" separates the mediastinal and inferior surfaces and extends upward and backward to the hilum. In the posterior end of this ridge are situated the bronchus and blood vessels supplying the lingula.

Hovelacque *et al.*[6] have reported two cases of trilobar left lungs, and Chiari[2] another, in which the extrapulmonary course of the lingula bronchus

resembled that of the right middle lobe bronchus, having an independent origin from the left lower lobe stem bronchus.

The Lingula Bronchus.—The anatomy of the lingula bronchus was described by Ewart,[5] in 1889, in his monograph on the bronchi and pulmonary blood vessels. Ewart referred to the lingula as the "cardiac lobe," and on the evidence of dissections and bronchial casts described a "cardiac stem bronchus" arising from the inferior aspect of the upper lobe bronchus about 1 cm. from its origin, dividing after a 2 to 3 cm. course into anterior and posterior cardiac branches, the anterior again dividing into medial or sternocardiac, and lateral or mammary cardiac branches. Further subdivisions were described in detail.

The lingula bronchus arises from the inferior aspect of the left upper lobe

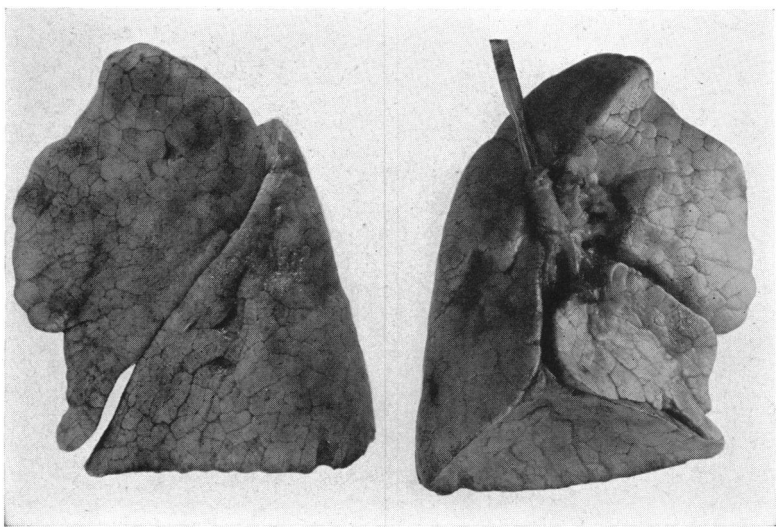

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FIG. 2.—Normal human left lung showing the lingula fissure well developed on the mediastinal surface, and the characteristic notch on the anterior border of the lung. The lingula bronchus has been dissected to demonstrate its origin from the upper lobe bronchus and its bifurcation.

bronchus 1 to 2 cm. from its origin and runs downward and forward. It terminates by division into two branches, an anterolateral and a posteromedial (Fig. 3).

In our own material, consisting of dissections of the human lung and lipiodol bronchograms, certain minor variations in the mode of origin of the lingula bronchus and the axillary branch of the upper lobe bronchus were encountered. Figure 4A represents the more common arrangement. Occasionally the lingula bronchus and the axillary branch of the upper lobe bronchus arise by a common stem from the main upper lobe bronchus as demonstrated in Figure 4B. Variations are also encountered in the distance of the orifice of the lingula bronchus from the orifice of the upper lobe

bronchus, and in the length of the lingula bronchus proximal to its first division.

The Blood Supply to the Lingula.—The branch of the pulmonary artery supplying the lingula arises from the main arterial trunk above the level of

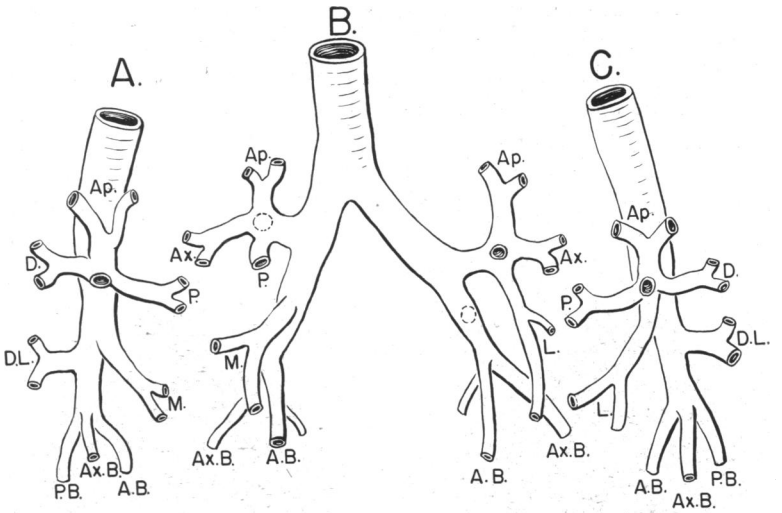

FIG. 3.—Diagrammatic representation of the normal bronchial tree. (A) Right lateral view. (B) Anteroposterior view. (C) Left lateral view. (Ap.) Apical division of the upper lobe. (Ax.) Axillary division of upper lobe. (P) Pectoral division of upper lobe. (D) Dorsal division of upper lobe. (L) Lingula bronchus. (M) Right middle lobe bronchus. (D.L.) Dorsal lobe bronchus. (A.B.) Anterior basic division of the lower lobe. (Ax.B.) Axillary basic division of the lower lobe. (P.B.) Posterior basic division of lower lobe.

the origin of the upper lobe bronchus, behind which it runs downward and laterally, continuing its course lateral and slightly posterior to the lingula bronchus (Fig. 5). The main artery divides into two branches which follow closely the two primary divisions of the lingula bronchus, the artery accom-

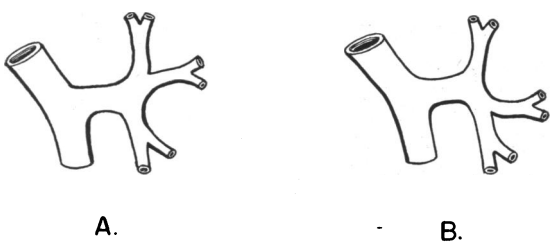

FIG. 4.—Diagrammatic representation of variations in the mode of origin of the lingula bronchus and the axillary division of the upper lobe bronchus. The arrangement shown in A is the more common.

panying the posteromedial division descending anterior to the anterolateral branch bronchus. The lingula veins run in a plane anterior to the bronchi and arteries, and drain into a main vessel running medial and slightly anterior to the lingula bronchus to join the inferior pulmonary vein. At the hilum of the lingula the vein, the bronchus and artery are encountered, in that order, dissecting laterally from the mediastinum.

Experimental Delineations of the Lingula Segment.—Injection experiments were undertaken to determine the projection areas on the surface of the lung of the bronchopulmonary segment supplied by the branches of the lingula bronchus. In the first series of normal human lungs, the main lingula bronchus, and in the second series, one of the two primary divisions were injected under pressure with a viscid solution of old roentgen films in acetone, colored with aniline-black dye. The advantage of this solution as an injection material lay in its tendency to harden into a solid mass, allowing the injected bronchopulmonary segment to be dissected from the remaining lung tissue, and its shape and relations to be determined. Figure 6 demonstrates the typical appearance of a normal lung following injection of the main lingula bronchus and inflation of the remainder of the lung, and shows the area of lung

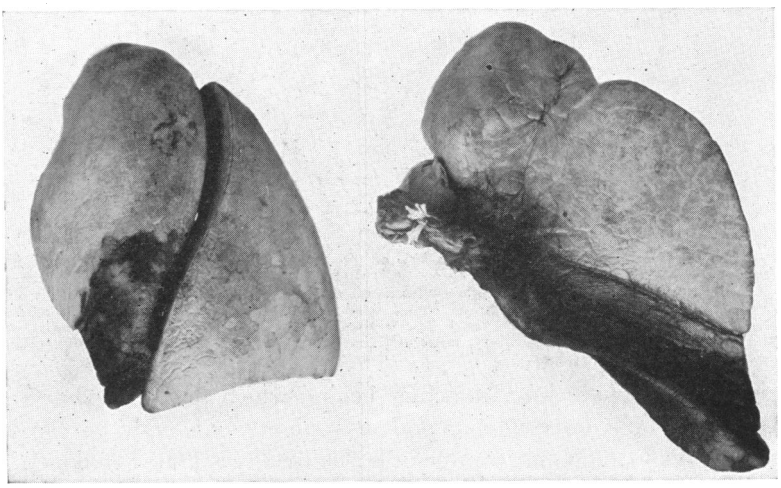

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FIG. 6.—(A) Injection of the main lingula bronchus of a normal left lung to demonstrate the whole lingula segment. (B) Left upper lobe, mediastinal aspect.

surface in relation to that of the lingula segment. Injection of the posteromedial branch of the lingula bronchus filled the mediastinal segment of the lobe; when the anterolateral branch was injected the mass was confined to the costal segment. In a series of 20 injection experiments the bronchopulmonary segments supplied by the lingula bronchus were found to be constant in size, position and configuration.

Clinical Visualization of the Lingula Bronchus by Lipiodol Bronchography.—A modification of the bronchography technic, evolved by Erwin,[4] was employed in obtaining the bronchograms reproduced in this article. The patient receives sodium pentobarbital Gr. 1½ one-half hour before the injection. The preliminary use of this drug appears to diminish the incidence of cocaine reaction. The pharynx and one nostril are sprayed with 4 per cent cocaine solution containing adrenalin; cotton pledgets soaked in the same solution are held in each pyriform fossa on Negus laryngeal forceps for two minutes to anesthetize the superior laryngeal nerves. A fine, rubber urethral

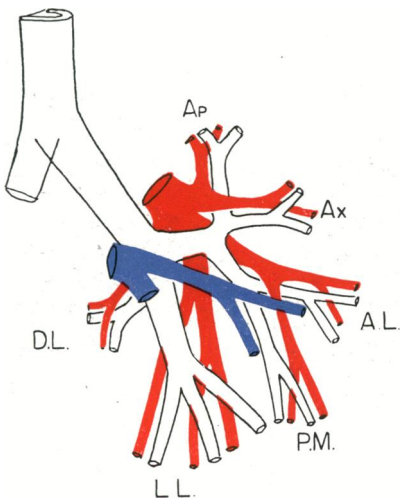

Fig. 5.—Diagrammatic representation of the blood supply to the lingula. Branches of the pulmonary artery shown in red and the veins in blue. (Ap.) Apical division of upper lobe. (Ax.) Axillary division of upper lobe. (A.L.) Anterolateral division of the lingula. (P.M.) Posteromedial division of the lingula. (D.L.) Dorsal lobe branches. (L.L.) Lower lobe branches.

catheter is passed through the cocainized nostril while the patient forcibly draws his tongue forward; the tip of the catheter shows a natural tendency to enter the larynx and passes easily between the cords. Having entered the trachea, 2 cc. of cocaine solution are injected through the catheter to anesthetize the tracheal and bronchial mucosa and suppress the cough reflex. The tip of the catheter lies in the lower third of the trachea and no attempt is made to pass it into the bronchi.

Certain general principles are observed during the injection. The lipiodol is used cold; when warmed the viscosity is diminished and the oil tends to run out into the alveoli. The oil is injected slowly and the cough reflex held completely in abeyance. Twenty cubic centimeters of oil are sufficient to outline both bronchial trees in an adult, less being required in a child. More information concerning bronchial pathology can be obtained by outlining the bronchial lumen with a thin, evenly distributed film of oil than by complete filling of the lumen. The side, or the suspected side, of the disease is filled first. Ideally, each lung should be filled and examined independently at three-week intervals in order that a true lateral as well as an anteroposterior film of each bronchogram may be obtained. It is not always practicable to do this and, when both lungs are to be examined at the same time, it is usual first to fill the suspected side and make the anteroposterior and lateral exposures; the other lung is then filled and further anteroposterior and oblique exposures are made. Lateral films taken with both lungs filled are dangerously misleading, owing to the superimposition and confusion of the two bronchial patterns.

With the catheter in position, the patient is placed horizontally upon the table with his shoulders supported on two pillows and the body half turned toward the left side; 6 cc. of oil are slowly injected into the dorsal lobe and dorsal branches of the lower lobe bronchus. The patient is then instructed to sit up, to bend forward, and lean toward the left side; 3 cc. of oil are then injected into the middle lobe or lingula bronchus and into the anterior branches of the lower lobe bronchus. The pillows are then removed and the patient lies down and is completely turned onto his left side; 3 cc. of oil are then injected into the upper lobe bronchus and lateral branches of the lower lobe bronchus. A left lateral exposure is then made with the patient lying on his left side; an anteroposterior picture with the patient lying flat on his back; and, if the left lung alone is being examined, a right oblique exposure is made in the standing position. If both lungs are being examined, the patient is turned toward the right side after lateral and anterioposterior exposures of the left side have been made, and the remaining lipiodol distributed between the three positions corresponding to those used for the left lung. Less lipiodol is required to fill the second side as some tends to run over from the bronchi previously filled. Anteroposterior and right oblique exposures are then made with the patient in the erect position. The position which best demonstrates the anatomic relations of the lingula bronchus is the right oblique with the patient in the erect position (Fig. 7). The advantage

of using a rubber intratracheal catheter, through which to inject the oil, lies in the ease with which the posture of the patient can be changed during the injection.

Interpretation of the Bronchogram.—No opinion can be based upon a single anteroposterior view; lateral and oblique views are essential for the interpretation of the bronchogram. The anatomy of the normal or diseased lingula can be determined only if its bronchus is completely outlined throughout its entire course, and its origin from the upper lobe bronchus clearly traceable, conditions which presuppose adequate filling of the upper lobe bronchus. Its first descending branch will be recognized as the lingula bronchus. Figures 8 to 11 demonstrate variations in the appearance of the bronchograms of the normal lingula bronchus in the three positions: anteroposterior, left lateral and right oblique. The lingula bronchus is apt to be confused with the lower lobe bronchi in the anteroposterior position, but their differentiation presents no difficulties in the left lateral and right oblique positions. Reference to the diagrams in Figures 3, 4 and 7 will assist in the interpretation of these bronchograms, and the identification of the various branch bronchi. The position of the lingula as visualized on the bronchogram varies with the condition of the lower lobe. In general it is situated more laterally when the lower lobe is normally aerated than when it is collapsed. After left lower lobe lobectomy the lingula swings downwards and posteriorly.

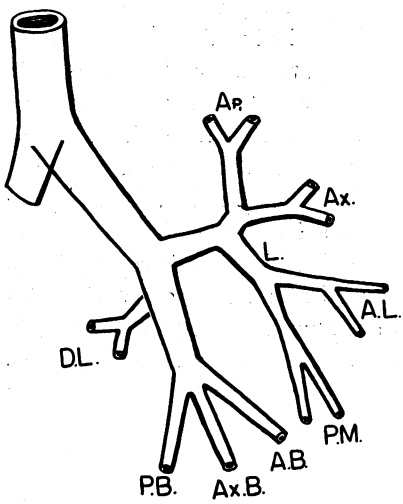

FIG. 7.—Diagrammatic representation of the normal left bronchogram, as visualized in the right oblique view. The distance between the orifice of the lingula bronchus and the orifice of the upper lobe bronchus has been slightly exaggerated. (Ap.) Apical division of upper lobe. (Ax.) Axillary division of upper lobe. (L.) Lingula. (A.L.) Anterolateral division of the lingula. (P.M.) Posteromedial division of the lingula. (D.L.) Dorsal lobe. (A.B.) Anterior basic division of lower lobe. (Ax.B.) Axillary basic division of lower lobe. (P.B.) Posterior basic division of lower lobe.

Bronchiectasis of the Lingula Process.—In the present series of 86 cases of bronchiectasis operated upon at the Massachusetts General Hospital (by E. D. C.), there were 55 cases in which the left lower lobe was removed as the major focus of the disease. In 44, or 80 per cent, of these 55 cases the lingula was also resected because of demonstrable bronchiectasis. In 108 cases of bronchiectasis of the left lower lobe operated upon at the Brompton Chest Hospital, London, the lingula was involved in 81, or 75 per cent.[1] These statistics demonstrate the great frequency with which resection of the lingula in addition to the removal of the left lower lobe is necessary to eradicate bronchiectasis of the left lung. Figures 12 and 13 demonstrate the bronchograms of two typical cases of bronchiectasis of the lingula and left lower lobe.

It has been observed that commonly the posteromedial branch of the lingula bronchus alone is diseased and only rarely are both branches involved.

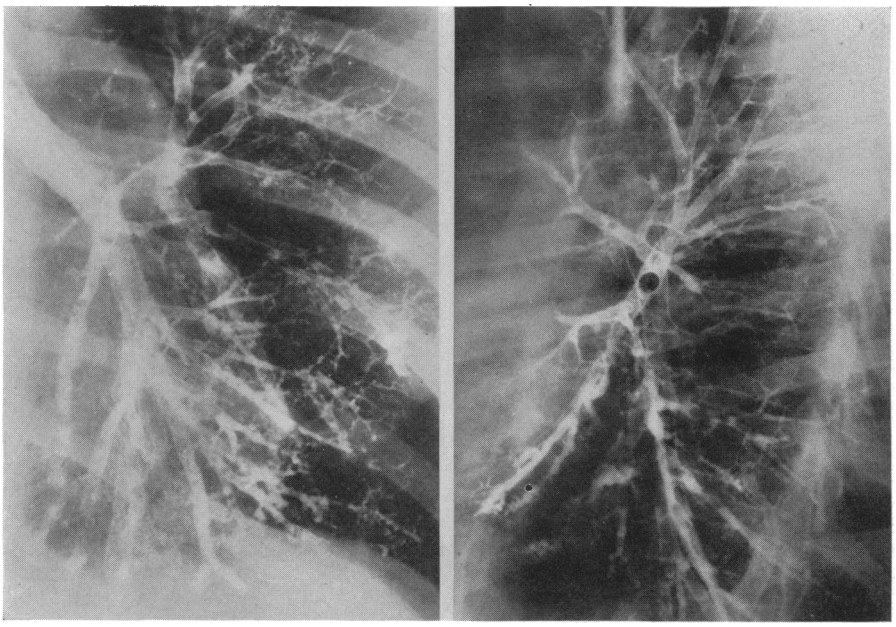

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FIG. 8.—Normal left bronchogram. (A) Anterolateral view. (B) Left lateral view. In the lateral view, the lumen of the axillary branch of the upper lobe bronchus is seen end-on as a dark circle.

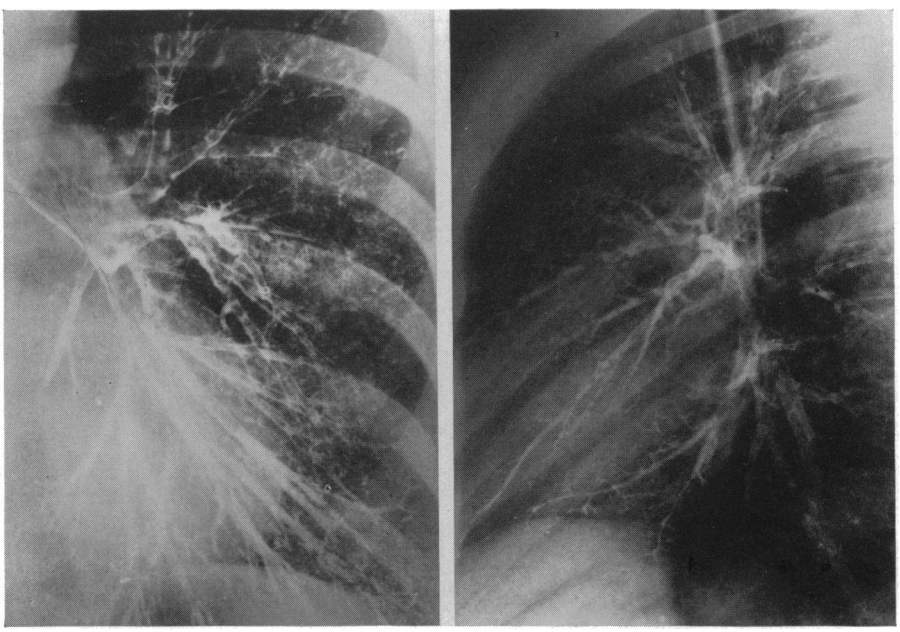

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FIG. 9.—Normal left bronchogram. (A) Anteroposterior view. The pectoral branch of the upper lobe bronchus is seen descending anterior to the anterolateral branch of the lingula bronchus, with which it should not be confused. (B) Left lateral view. Pectoral bronchus well shown just above lingula bronchus.

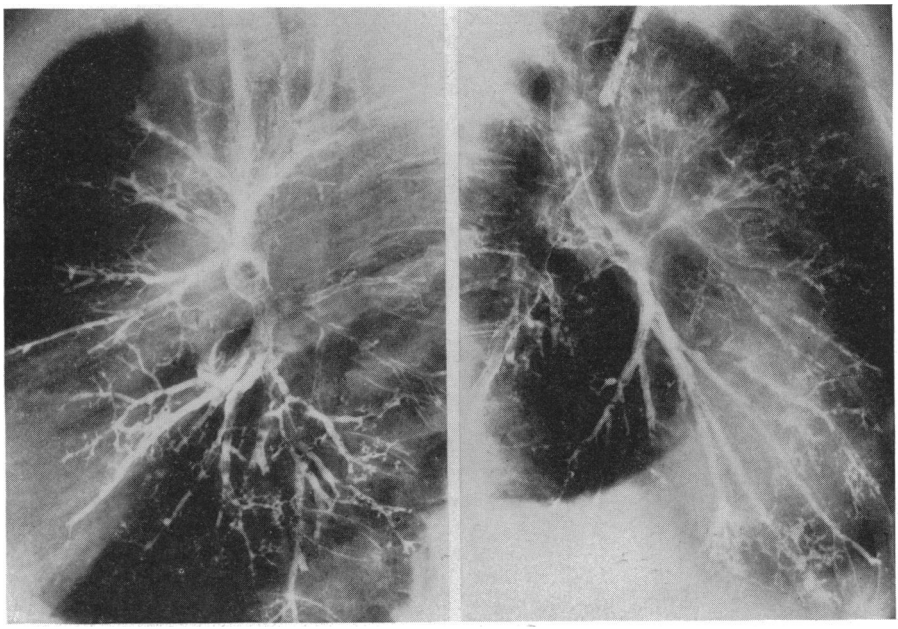

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FIG. 10.—Normal left bronchogram. (A) Left lateral view. (B) Right oblique view. Owing to the upward obliquity of the left upper lobe bronchus, the lingula bronchus appears to arise abnormally high in the left lateral view. Origin with axillary branch as shown in Figure 4B.

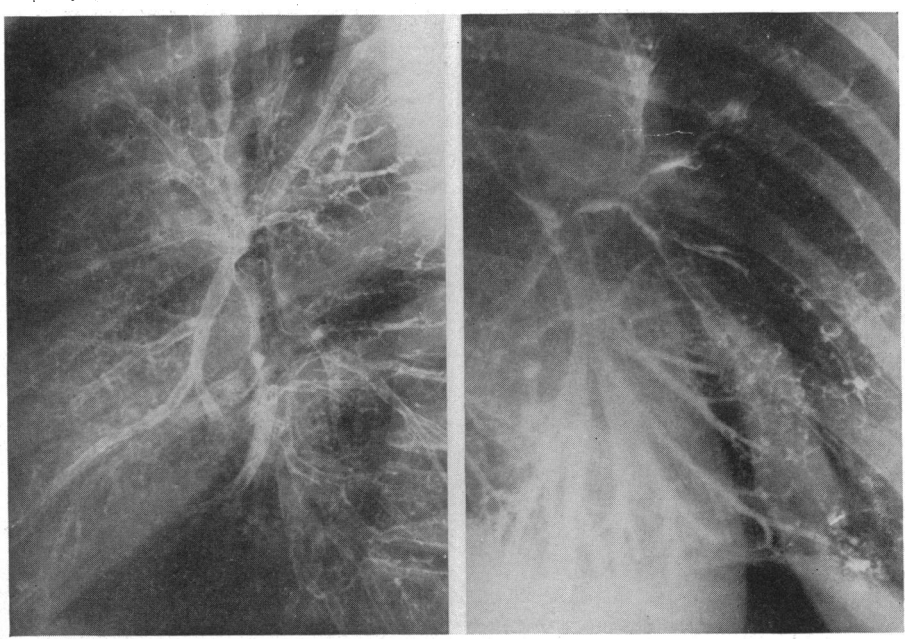

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FIG. 11.—Normal left bronchogram demonstrating the lingula bronchus and its primary divisions. (A) Left lateral view. (B) Right oblique view (see Fig. 7).

Bronchiectasis may be confined to, or predominant in the lingula process, but this distribution is not common, and was encountered only four times in a series of 50 cases of bronchiectasis studied by complete bronchograms. Figure 14 demonstrates a case of bronchiectasis confined to the lingula process and of sufficient severity to cause disabling symptoms. Figure 15 demonstrates a case of bronchiectasis predominant in the lingula process but with minimal involvement of a single bronchus in the left lower lobe. In Figure 16 is shown bronchiectasis of the anterolateral segment of the lingula and the right middle lobe, an unusual combination.

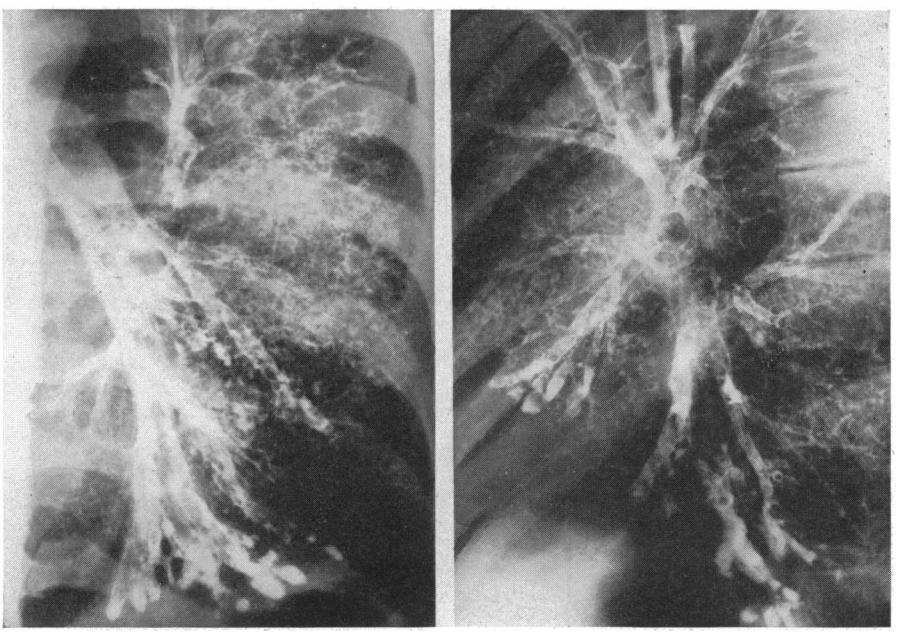

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FIG. 12.—Cylindric bronchiectasis of the left lower lobe and posteromedial divisions of the lingula bronchus. (A) Anteroposterior view. (B) Left lateral view.

Residual Lingula Bronchiectasis.—Despite the fact that the lingula has been resected with the left lower lobe in 80 per cent of the Massachusetts General Hospital series, at least two patients have been observed with residual symptoms due to failure to recognize disease in this area or resect it at the time of operation. Before the perfection of bronchographic technic, the gross appearance of the lingula at the time of operation was taken as indication for or against resection. These unsatisfactory results demonstrate that this procedure, while usually adequate, is not wholly reliable.

Patients have also been seen following lobectomy in other clinics, who complain that after removal of the left lower lobe a considerable quantity of sputum has remained. Bronchography has revealed the presence of residual bronchiectasis in the lingula process. Review of the original bronchograms, on the basis of which the lobectomy was performed, revealed either an inadequate filling of the lingula bronchus, which rendered it impossible to

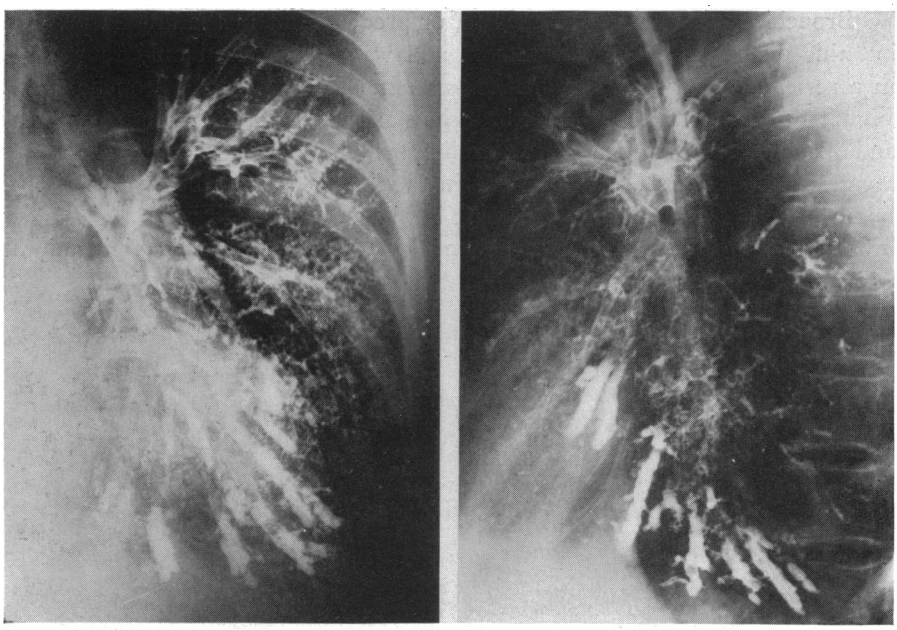

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FIG. 13.—Cylindric bronchiectasis of the left lower lobe and posteromedial divisions of the lingula. (A) Anteroposterior view. (B) Left lateral view. In the anteroposterior view, the diseased posteromedial branch of the lingula overlies dilated branches of the lower lobe bronchus, but is clearly differentiated from them in the lateral view. The anterolateral branch of the lingula is normal.

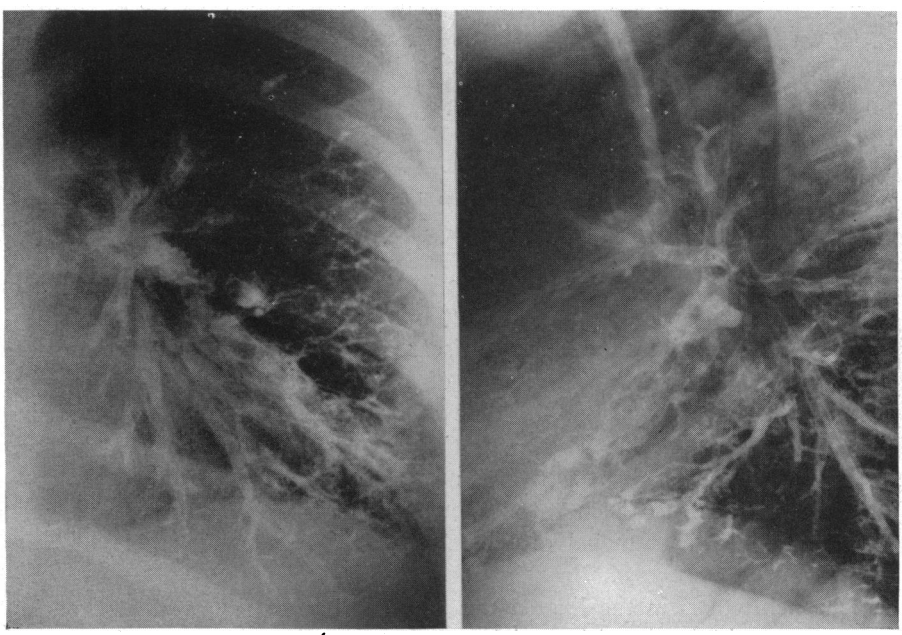

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FIG. 14.—Cylindric bronchiectasis of both divisions of the lingula bronchus. The left lower lobe is normal. (A) Anterolateral view. (B) Left lateral view.

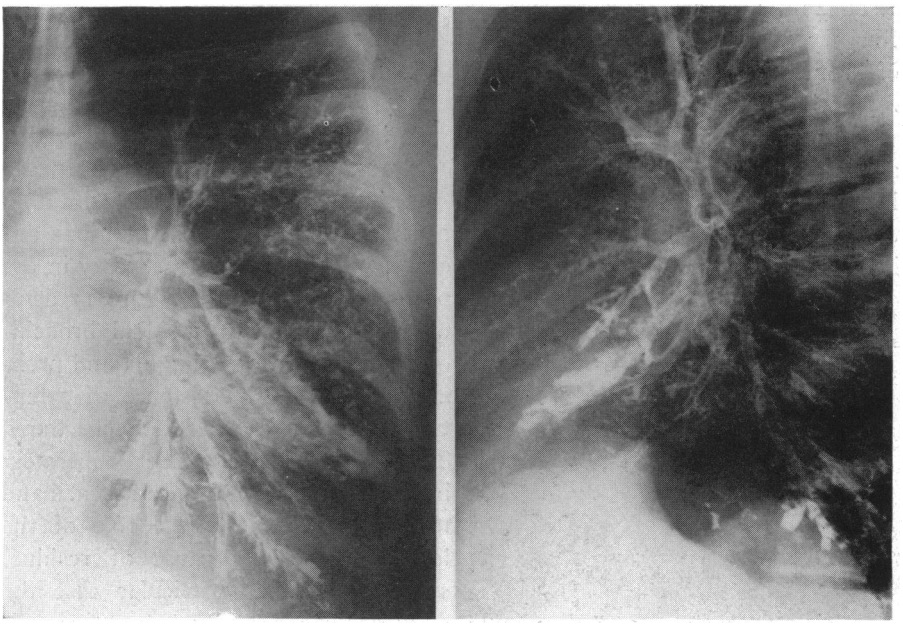

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FIG. 15.—Cylindric bronchiectasis of both divisions of the lingula bronchus, associated with minimal disease in a single lobule of the lower lobe. (A) Anteroposterior view. (B) Left lateral view. In the lateral view, note that the pectoral branch of the upper lobe bronchus has been drawn downward toward the lingula bronchus, and that one of its terminal branches is dilated.

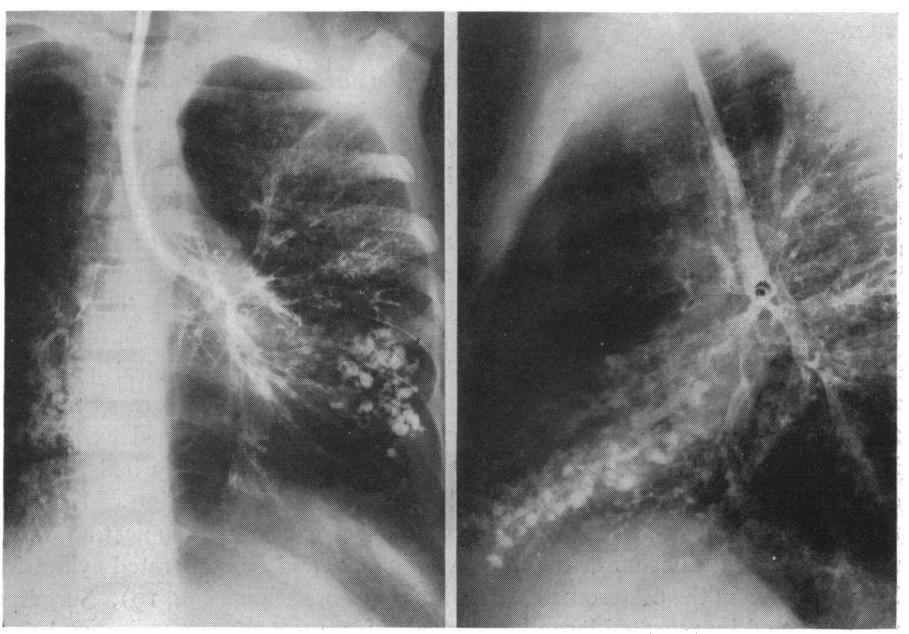

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FIG. 16.—Saccular bronchiectasis of the lingula; disease is also present in the right middle lobe. (A) Anteroposterior view. (B) Left lateral view. In the anteroposterior view, the saccular dilatations appear to communicate with the branches of the axillary basic division of the left lower lobe bronchus, but the left lateral view localizes the bronchiectasis to the lingula, and demonstrates the lower lobe to be normal.

visualize the disease present therein, or failure to interpret the film correctly. Surgery of this type will quickly cast disrepute upon the surgical treatment of bronchiectasis just as it is beginning to live down a somewhat unsavory reputation.

Persistence of symptoms due to lingula bronchiectasis is to be differentiated from the production of secretion by granulation tissue in an abnormally large lower lobe "stump," or a small persistent empyema pocket draining through the stump of the lower lobe bronchus. Both of these conditions are known to be associated with persistent cough and sputum, at least early in the postoperative period. Figure 17 demonstrates a case of residual bronchiectasis present in the lingula and probably causing the persistence of symptoms following a lower lobe lobectomy. The qualification is made deliberately because sufficient data are not at hand to evaluate properly the rôle of the lobar stump as a cause of residual sputum. In this particular case the stump is short and presumptive evidence incriminates the lingula.

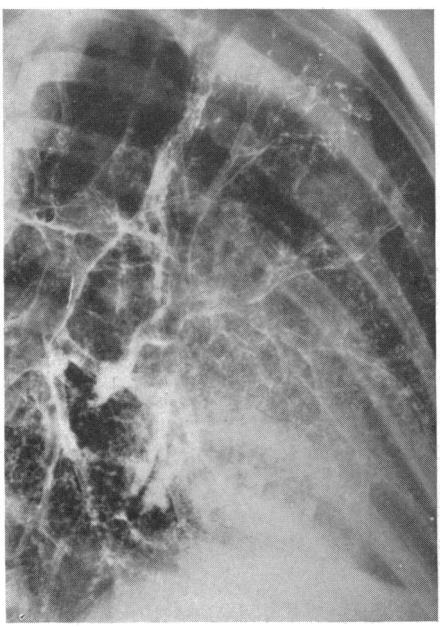


FIG. 17.—Postlobectomy bronchogram demonstrating the stump of the lower lobe bronchus, and residual bronchiectasis in the lingula, which has been displaced downward and backward. Right oblique view.

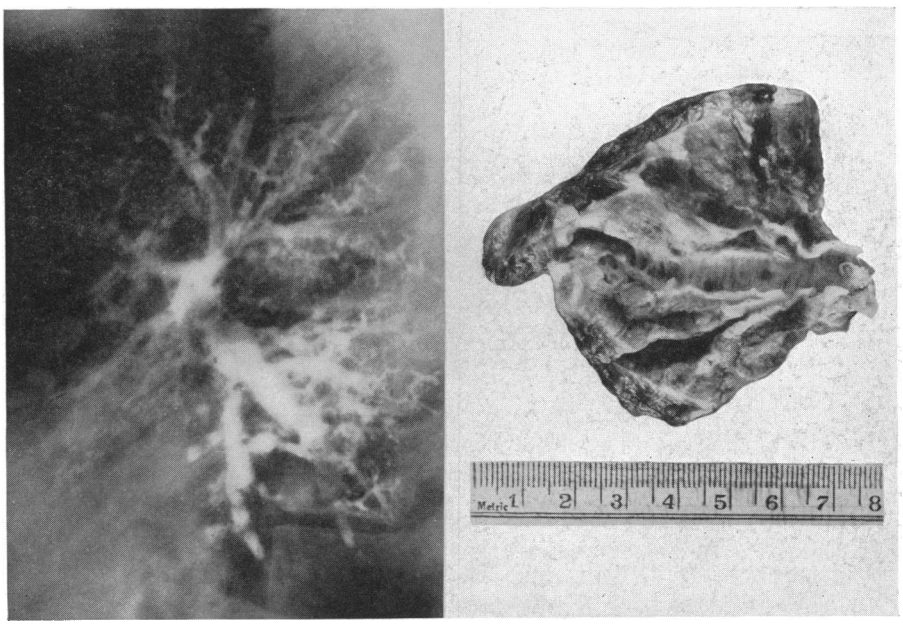
Figure 18 shows the postlobectomy bronchogram of a patient who complained that the removal of the lower lobe had only slightly diminished the volume of sputum. Bronchography revealed the presence of a residual lingula bronchiectasis. The stump of the lower lobe was also well filled by lipiodol but the operative note indicated a higher amputation than usual. Bronchoscopy disclosed a dry stump completely epithelialized and an inflamed lingula bronchus full of pus. The lingula was resected in this case with complete relief of symptoms.

Chronic Pulmonary Abscess of the Lingula.—In the clinical material forming the basis of this paper, there has occurred one case of abscess confined to the lingula, in a male, age 19. The abscess had been drained externally in the acute stage seven years previously; the wall of the cavity had become epithelialized and an external bronchial fistula persisted. Injection of lipiodol through the bronchocutaneous fistula outlined a cavity communicating with the anterolateral division of the lingula bronchus, and demonstrated cylindric bronchiectasis in the posteromedial division of the bronchus (Fig. 19). Surgery was indicated by repeated large hemorrhages from the abscess cavity, and the lingula process was excised through an anterolateral approach.

OPERATIVE TECHNIC.—The lingula is usually resected at the time the lower

lobe is removed and is readily accessible through the usual posterior incision. In the few instances in which the lingula alone has been resected, an anterolateral approach, similar to that employed for a middle lobe lobectomy, has been found satisfactory.

It has been considered advisable to complete the lower lobe lobectomy, including closure of the hilar stump, before dealing with the lingula. Then the tip of the lingula is grasped with lung forceps and as adhesions that may be present are severed, it is drawn sharply upward and laterally, throwing the "frenum" into prominence. Adhesions to the pericardium in the line of the pericardiophrenic vessels may be troublesome, and at times the phrenic



A B

FIG. 18.—Postlobectomy bronchogram revealing residual bronchiectasis in the lingula, two years after left lower lobectomy for bronchiectasis. (A) Left lateral view. Note how the lingula has been displaced downward and backward. Some of the shadow cast by the lipiodol is undoubtedly cast by the stump which was carefully surveyed at the secondary operation and found to be a contracted nodule of scar tissue at the hilum. (B) Resected lingula.

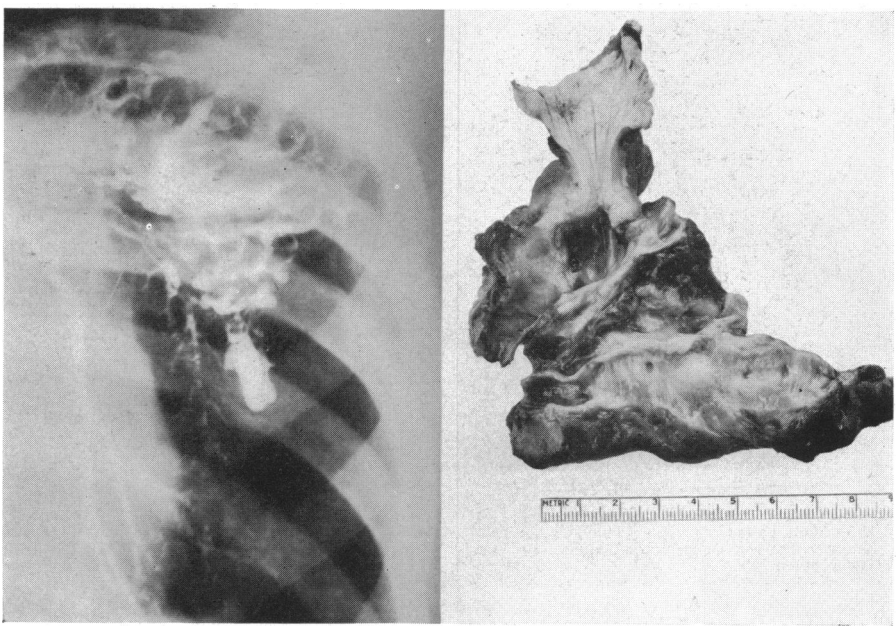
nerve is jeopardized as it tends to separate from the pericardium by traction on the adhesions.

Dissection into the hilar region is started at the base of the frenum, separating the lung parenchyma from the mediastinal pleura until the bronchus and its related blood vessels are exposed (Fig. 20). The vessels are divided between ligatures, taking pains to avoid injuring the artery to the lower lobe in case the lower lobe has not been removed.

The anesthetist is then instructed to release the positive intratracheal pressure, allowing the upper lobe to deflate. A light clamp is applied to the bronchus with sufficient pressure to occlude its lumen but not crush the walls. The lobe is now reinflated by restoring the positive intratracheal pres-

sure. The lingula bronchopulmonary segment remains atelectatic (Fig. 21). This maneuver not only positively identifies the bronchus but delineates the relatively avascular cleavage plane for section of the lung parenchyma.

Division of the lung is now made with the aid of curved clamps placed in the form of a T, the vertical line parallelling the course of the "frenum" and stopping at the bronchus which is now amputated. The plane between inflated and deflated alveoli is always discernible and the clamps are placed just on the atelectatic side to allow greater freedom in suturing. Running stitch ligatures are then placed on the lung substance held by the clamps. The bronchus is closed by a circular ligature, or simple plastic procedure, and adjacent lung tissue is drawn over the stump. Finally, a running suture



A B

FIG. 19.—Chronic lung abscess of the anterolateral segment of the lingula, and secondary bronchiectasis in the posteromedial segment. (A) Anterolateral view after injection of lipiodol through the chronic chest wall sinus. (B) The lingula after removal, showing the abscess cavity, and the cylindric bronchiectasis in the adjacent bronchi.

on an atraumatic needle buries the hemostatic sutures and brings visceral pleurae together in a neat T-shaped line. Lobules closely adjacent to the suture line may become filled with blood, but on the whole the procedure is attended by very little hemorrhage if the segmental vessels have been properly secured and the avascular cleavage plane followed. If the ligature has been placed only on the posteromedial division of the artery, as may be done by mistake, brisk hemorrhage will be encountered from the anterolateral division as the hilum is approached.

The anesthetist should now vary the intratracheal pressure allowing the

remaining portion of the upper lobe to deflate and inflate, thus demonstrating the integrity of the remaining bronchial divisions.

If preoperative bronchograms have clearly demonstrated a normal anterolateral division of the lingula bronchus, only the posteromedial segment need be resected. To this purpose the lung parenchyma is divided between clamps at the base of the "frenum" without exposing the structures at the hilum. The bronchus may be identified by palpation and a stitch ligature thrown about it. Adjacent vessels are clamped and ligated and bleeding from the lung parenchyma controlled with curved clamps as described above. As this dissection does not follow an avascular cleavage plane, it is attended by more

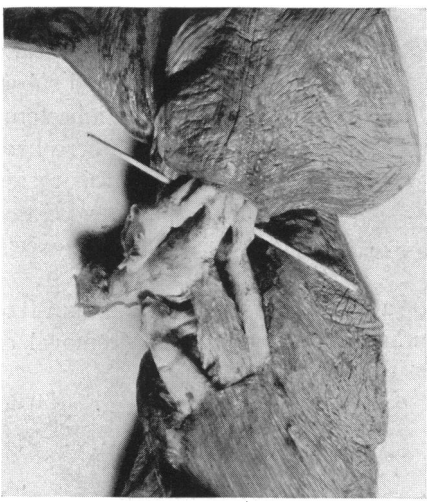


FIG. 20.—Dissection of the hilum of the lingula, as approached anteriorly with the tip of the lingula elevated. The bronchus lies in the center with the vein at its medial aspect and the artery situated laterally.

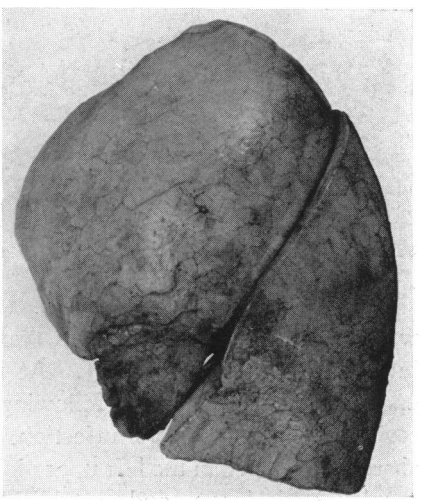


FIG. 21.—Appearance of normal lung, inflated after obstruction of the lingula bronchus. The line of demarcation between the atelectatic lingula and the aerated upper lobe is clearly discernible.

bleeding, but if the dissection is carried from the hilum outward, it may be reduced to a minimum. Figure 22 demonstrates a posteromedial segment of the lingula bronchus removed by this method. Figure 23 is worthy of note in this connection. It has already been stated that involvement of the posteromedial division alone appears to be the commonest lesion of the lingula.

Discussion.—Anyone with much experience in the surgery of bronchiectasis will realize that in many cases dense adhesions and active infection producing the so-called "frozen hilum" will make the dissection of hilum structures exceedingly hazardous or impossible. Interlobar fissures may be so fused that they cannot be identified. However, as less severe cases of the disease present themselves for surgical treatment, refinements of technic may be directed toward the conservation of normal lung tissue. This is particularly important if involvement of the contralateral lung indicates a program of bilateral operations.

The dorsal segment of the lower lobe is found free of disease in a con-

siderable number of cases of lower lobe bronchiectasis. Employing the principles described above for resection of the lingula, the lower lobe has been divided in two cases, preserving the large dorsal segment with its bronchus and vascular supply intact. In both of these patients the lingula was resected at the same time. The same deflation technic was employed to delineate the avascular plane for section of the lower lobe.

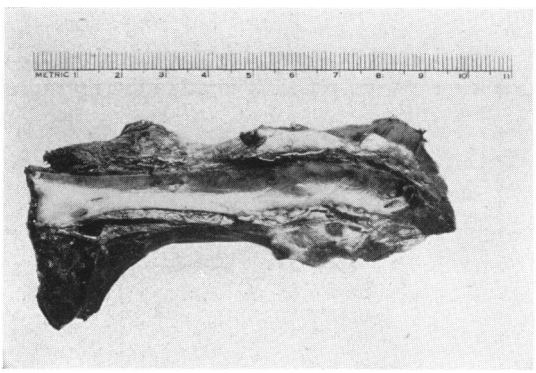


FIG. 22.—Posteromedial segment of the lingula process following excision for bronchiectasis.

Postoperative Complications.—It has already been stated that the lingula has been resected with the left lower lobe in 44 cases. It has also been resected without removal of the lower lobe in one instance, and at a period subsequent to lower lobe lobectomy in one instance. There have been no deaths in this series. Bronchial fistulae have closed spontaneously with the exception noted below.

In one instance (Hosp. No. 18196) a patient was found sputum-free with healed fistula and incision two months after the operation (removal of left lower lobe and lingula). At the end of the third month, following a severe upper respiratory infection, an abscess developed in the left upper lobe, requiring drainage and establishing large bronchial fistulae that will require plastic closure. This complication may or may not be attributable to the lingula resection, or may be due to the fact that only the posteromedial division was removed, leaving residual bronchiectasis in the anterolateral segment.

One very definite complication appears to attend the removal of a single bronchial segment that is not as frequent when an entire lobe is removed by the tourniquet technic. It has appeared in a high percentage of middle lobe lobectomies. The amputation of a large bronchus close to the main stem of the bronchial tree appears to favor obstructive atelectasis in closely adjacent areas of lung. After a middle

FIG. 23.—Lipiodol injection through the chest wall sinus, after removal of the left lower lobe and the posteromedial segment of the lingula, demonstrating a residual empyema pocket communicating through a bronchial fistula with the posteromedial division of the lingula bronchus. The anterolateral division of the bronchus is normal.

lobe lobectomy, complete or partial atelectasis of the lower lobe may persist for a period of three to four weeks. It is attended by cough and mucoid sputum that subsides as the lobe reexpands. The same happening has been observed in the upper lobe following complete resection of the lingula but does not often appear if the posteromedial division alone is resected. It has also occurred in the dorsal segment of the lower lobe after resection of the inferior segment.

This is not a surprising event and is readily explained by the inflammatory edema that must surround the focus of secondary healing in the bronchial tree. To minimize this complication, trauma is to be avoided in closing the bronchus and fine absorbable suture material employed. In a one stage operation in a free pleural cavity particular attention is to be paid to postoperative expansion of the lung.

Just how important this complication will be as a hazard of segmental resection of the lung remains to be seen. The advantage of a smaller residual empyema pocket when healthy lung is conserved is to be balanced against it.

SUMMARY

The anatomy of the lingula segment of the left upper lobe is considered. The lingula bronchus and blood vessels are described.

The bronchogram of this particular segment is illustrated.

Indications for surgical removal of the lingula are discussed and operative technics described.

More general applications of the principle of segmental pneumonectomy are indicated, particularly with reference to the lower lobes.

It is suggested that the bronchopulmonary segment may replace the lobe as the surgical unit of the lung.

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