Open Thoracotomy in the Management of Spontaneous Pneumothorax

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A TOTAL OF 307 patients representing 376 spontaneous pneumothoraces seen at the Medical College of Virginia Hospitals were analyzed. Excluded from this study were all patients with known active pulmonary tuberculosis and pulmonary malignancy. The right lung was involved in 205 cases (54%) and the left lung in 165 cases (44%). Bilateral simultaneous spontaneous pneumothorax was recorded in six patients 2%),[1,23] (Fig. 1). There were 245 males and 62 females, a ratio of 4 to 1 males. There were 208 white patients and 99 black patients, a ratio of 2 to 1 white (Fig. 2). The age distribution ranged from immediately after birth to 84 years of age.[15,18,20] The greatest majority of patients were seen between the ages of 11 and 60 years (Fig. 3).

No significant seasonal differences in distribution of cases was noted. There were 86 patients seen during January, February and March, 84 during April, May and June; 100 during July, August, and September; and 106 during October, November and December.

Eighty per cent of the patients were at restful occupation when the spontaneous pneumothorax occurred. This varied from rest in bed shortly after awakening in the morning to non-strenuous employment. The remaining 20% were engaged in some type of physical effort (Table 1).

The percentage of pneumothorax present at the time of initial evaluation is always difficult to accurately record, but ranged from a minimal (5%), apical cap, to total collapse with tension. Twenty-three per cent had up to 25% collapse of the lung; 31% had between 25 and 50%; 13% had between 50 and 75%; and 33% had between 75 and 100% collapse of the lung.

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Medical attention was sought within 24 hours of onset of symptoms in 70% of the patients. Twenty per cent sought medical attention in less than 1 week; while 10% sought medical attention up to 2 years after the apparent onset of their symptoms.

The patients showed minimal systemic effects from the spontaneous pneumothorax. Seventy per cent of the patients had admission temperatures below 37.5 C.; 21% had temperatures between 37.5 C. and 37.9 C.; 6% had temperatures between 37.9 C. and 38.5 C. and only 3% had temperatures between 38.5 C. and 39 C. The admission pulse in 68% of the patients was below 90 per minute; 16% had a pulse between 90 and 100 per minute; 6% had a pulse between 100 and 110 per minute; and 6% had a pulse between 110 and 120 per minute; only 4% had a pulse above 120 per minute. Dyspnea as a subjective symptom was seen in only 58% of the patients.

Previous ipsilateral pneumothorax was recorded in 17% (52) of the cases. Thirty-four patients had previous single ipsilateral pneumothoraces; seven patients had two previous; seven patients had three previous; and four patients had four previous ipsilateral spontaneous pneumothoraces. Only 3% (9) of patients had single previous contralateral spontaneous pneumothoraces. Two of these patients had had thoracotomy for their previous contralateral pneumothorax (Table 2).

In this series of cases, only 14% (42) of patients had subsequent ipsilateral spontaneous pneumothoraces. Thirty-four had one; five had two; and three had three subsequent ipsilateral spontaneous pneumothoraces.

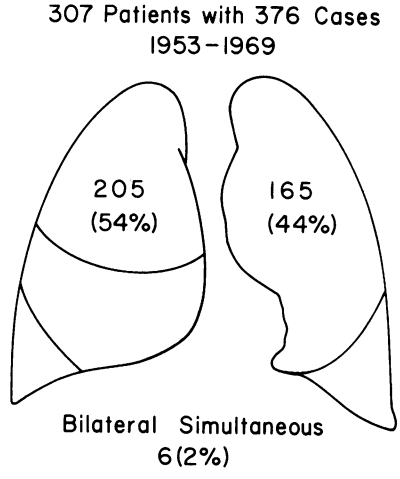

FIG. 1. Distribution of spontaneous pneumothorax cases according to side affected.

Subsequent contralateral pneumothoraces were seen in 4% (12) of the patients. Nine had one subsequent contralateral pneumothoraces (Table 3).

Analysis of the lung condition in those patients seen in the series revealed that 48% had emphysema[3,5,17] with or without bleb formation on chest X-ray. Forty per cent had no known lung disease; 5% had long histories of asthma; 5% had healed pulmonary tuberculosis; chronic bronchitis, mucovisicidosis, silicosis, hyaline membrane disease, post X-ray therapy to the neck collectively accounted for 2% of the cases involved in this study.[4,9,11]

A significant hydropneumothorax amounting to more than 500 cc. of fluid was seen in only 10% of this group of patients. A significant hemopneumothorax amounting to more than 500 cc. of blood was seen in only 3% of this group.[10,16] Tension pneumothorax was evident in only 7% of patients.

Treatment in this group of patients was divided into three approaches: (Table 4)

I. *Simple Observation* (32 patients). All of these patients had less than 10% pneumothorax, were without symptoms, and had no evidence of increase in size of the pneumothorax.[24] Usually the onset of symptoms had occurred 24 to 48 hours prior to observation in the emergency ward. They usually had X-rays made at the time or shortly after onset which, when compared with films made 24 to 48 hours later, showed no increase in size. Under these circumstances, observation was carried out for a period of 24 hours in the hospital and then the patient was followed as an out-patient. Activity was restricted only to eliminate hard labor or heavy sports during the time the penumothorax was resolving. No restriction of activity was imposed following complete re-expansion of the lung.

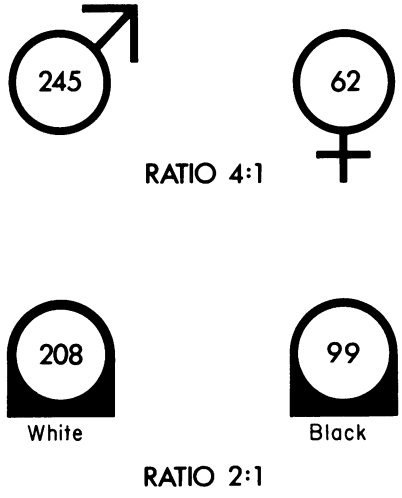

FIG. 2. Distribution of spontaneous pneumothorax cases by sex and race.

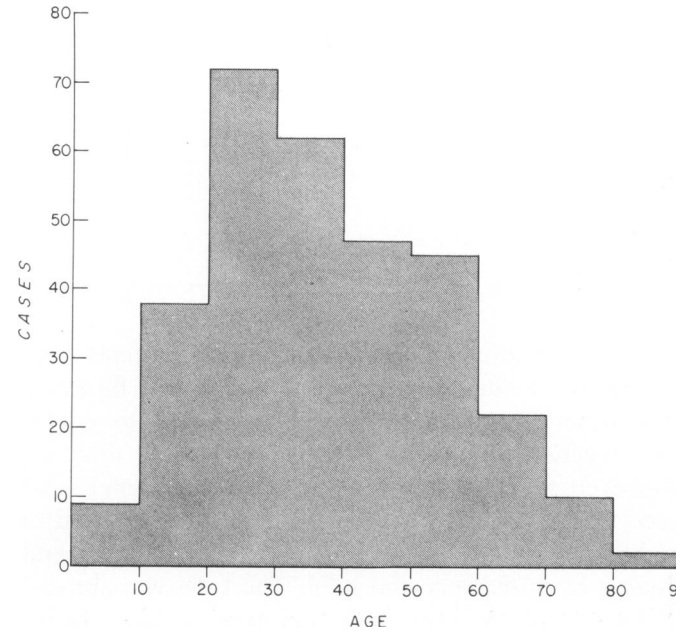

FIG. 3. Distribution of spontaneous pneumothorax cases by age.

II. *Aspiration by Needle* (19 patients). Patients who had less than 10% penumothorax, but were complaining of chest discomfort without dyspnea, had aspiration of the air. The aspiration was accomplished using a plastic needle and syringe. Following aspiration the plastic needle was removed. Although this approach was utilized in some 20 additional cases it failed and tube thoracostomy was necessary.

TABLE 1. *Activity of Patients at Moment of Onset of Spontaneous Pneumothorax.*

Rest	80%
Sports	20%
Labor	
Coughing	
Straining at stool	
Asthmatic Attack	
Yelling	
Singing	
Endotracheal Anesthesia	
Birth	

TABLE 2. *Summary of Previous Ipsilateral and Contralateral Pneumothoraces in This Series.*

Previous Ipsilateral Pneumothorax		
1 = 34		
2 = 7	17%	
3 = 7		20%
4 = 4		
Previous Contralateral Pneumothorax		
1 = 9 (2 surgical) 3%		

III. *Thoracostomy Tube Drainage* (225 patients). All patients not included in groups 1 and 2 had thoracostomy tubes inserted[19,22,26,27] and connected to underwater suction drainage. Initially intercostal drainage tubes were inserted into the anterior second intercostal space, mid-clavicular line, with enough tube inserted to reach the apex. Additional openings other than the end opening were made in the tube. The tube was sutured to the skin of the chest wall and kept in place for at least 3 days to increase inflammatory reaction and adhesion formation in hopes that this would help to reduce or prevent subsequent spontaneous pneumothoraces. During the latter part of the series the greatest majority of tubes have been placed in the 6th or 7th intercostal space, mid-axillary line, ascending from that point to the apex of the involved hemithorax. Cosmetically the lateral scar is better tolerated and from a therapeutic standpoint, more complete pleural involvement by adhesions from the chest tube are obtained. If any fluid is present in the pleural space, more adequate drainage is accomplished from this site of tube insertion (Fig. 4).

We have favored the insertion of a chest tube because this has resulted in immediate lung re-expansion; shortened morbidity; more rapid return to normal activity; and pleural adhesions resulting from tube irritation. Thoracostomy tubes are kept in place for 7 days or less in 78% of the patients. Table 5 outlines the percentage of patients in this series requiring intubation in terms of duration.

Thoracostomy tube complications were infrequent. Nineteen tubes were reinserted because of poor position. Massive subcutaneous emphysema occurred in three patients, probably caused by insertion of the chest tube into an area of lung adhesion adjacent to the chest wall insertion site. Excessive pleural fluid occurred in two patients which did not appear related to intrapleural or pulmonic disease. A small abscess occurred at the tube insertion site of one patient. Total paralysis of the left vocal cord occurred in one patient immediately after insertion of an anterior left intercostal drainage tube. Function of the left vocal cord never returned over a 3-year follow-up. Excessive bloody drainage amounting to 650 cc., but not requiring transfusion or thoracotomy, occurred in one patient. These were the only complications resulting from tube insertion for the management of this series of spontaneous pneumothoraces.

TABLE 3. *Summary of Subsequent Ipsilateral and Contralateral Pneumothoraces in This Series.*

Subsequent Ipsilateral Pneumothorax		
1 = 34		
2 = 5	14%	
3 = 3		18%
Subsequent Contralateral Pneumothorax		
1 = 9		
2 = 1	4%	
3 = 2		

TABLE 4. *Methods of Therapy Used in This Series of Spontaneous Pneumothorax.*

1.	Observation	32	(9%)
2.	Aspiration	19	(5%)
3.	Tube Thoracostomy	325	(86%)
	Pneumoperitoneum	42 (13%)	
	Thoracotomy	33 (10%)	

A. *Therapeutic Pneumoperitoneum* (42 patients). Any patient in whom there was not complete filling of a hemithorax after tube insertion and drainage was given a therapeutic pneumoperitoneum. (Fig. 5). If the patient has a persistent air leak beyond 36 to 48 hours after insertion of a chest tube, and even though the lung fills the hemithorax, a therapeutic pneumoperitoneum is used. Therapeutic penumoperitoneum was given by insertion of 1500 cc. of air into the left lower quadrant adacent to the umbilicus and far enough lateral so as not to injure the inferior epigastric artery. This resulted in elevation of the hemidiaphragms on

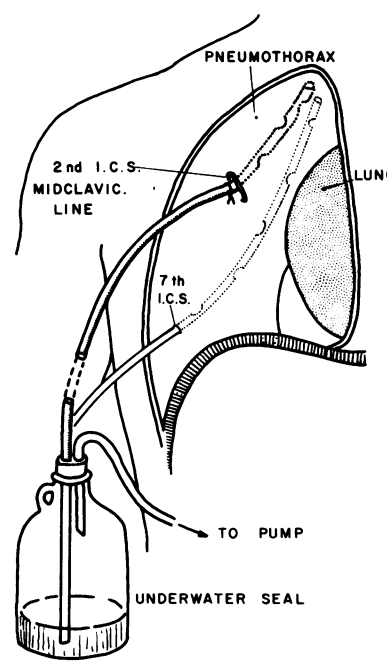

FIG. 4. Diagram of two different types of chest tube insertion for the management of spontaneous pneumothorax. The seventh intercostal space, mid-axillary line, is preferred.

TABLE 5. *Duration of Tube Placement Required in Treatment.*

1 Day	4%	
2 Days	20%	
3 Days	20%	
4 Days	14%	78%
5 Days	8%	
6 Days	5%	
7 Days	7%	
8–14 Days		14%
15–21 Days		5%
22–50 Days		3%

both sides. If the air leak continued beyond the next 24 hours, an additional 1500 cc. of air was given for further elevation of the diaphragms (Fig. 6).

It was our feeling that no patient should have open thoracotomy for spontaneous pneumothorax without the institition of a therapeutic pneumoperitoneum to aid in stopping the air leak. In many favorable instances, this procedure obviated the need for open thoracotomy for closure of a persistent air leak. No complications resulted from the use of a therapeutic pneumoperitoneum.

If a patient continued to leak air following insertion of the therapeutic pneumoperitoneum, open thoracotomy should be considered between the 7th and 10th post-tube insertion days. Prior to consideration of open thoracotomy the chest tube was always removed; the lung allowed to collapse; and a new tube was inserted into the area of lung collapse. This was done on the theory that certainly in some cases the tube itself may be responsible for a persistent leak due to its proximity to the actual leak. In actual practice leaks do stop after this maneuver.

Thoracostomy tubes which remained beyond 14 days were in patients in whom thoracotomy was contraindicated because of systemic manifestations. Only 24% of the patients with chest tubes in place had evidence of temperature elevation above 37.9 C during the entire time the tubes were in place.

B. *Open Thoracotomy* (33 patients).[2,8,13,14,21] Our indications for open thoractomy in the management of patients with spontaneous pneumothorax are:

1. Massive air leak which prevents the lung from completely expanding to fill the space of its appropriate hemithorax after tube insertion. Under the circumstances of such a massive air leak and incomplete re-expansion of the lung, a second chest tube is inserted to augment air removal, and bronchoscopy is performed to be certain that there are no major endobronchial mucous plugs or pathologic changes to explain incomplete re-expansion of the lung. If no remediable cause can be found for the incomplete expansion, immediate thoracotomy is recommended.

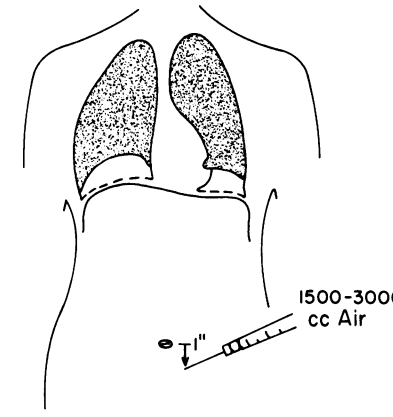

FIG. 5. Therapeutic pneumoperitoneum.

2. An air leak which persists beyond 7 to 10 days after initial insertion of a chest tube in a patient in whom the lung fills its proper hemithorax. These patients all have received therapeutic pneumoperitoneum and have had their chest tube position changed and a new tube inserted.
3. Those patients in whom a third ipsilateral pneumothorax has occurred and in whom the first two pneumothoraces were properly treated. In such a patient a total right spontaneous pneumothorax occurred for the first time in November 1, 1959. Response to tube thoracostomy was prompt and complete. A second total pneumothorax occurred on November 7, 1959. Complete re-expansion of the right lung continued with reaction of pleural irritation. The patient underwent a second right spontaneous pneumothorax and one day later had a third right spontaneous pneumothorax. A chest tube was inserted in this patient for complete re-expansion of the lung and he underwent open thoracotomy.
4. Those patients with a significant hemopneumothorax in which more than 1500 cc. of whole blood

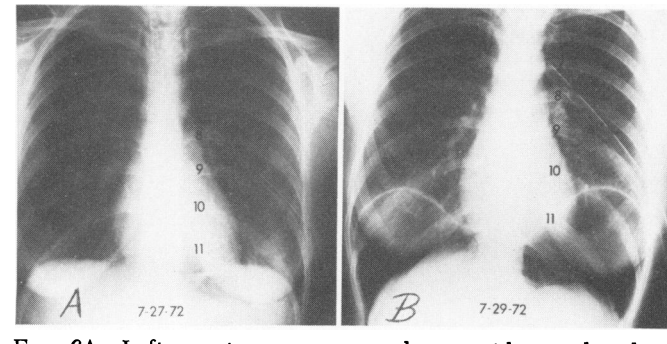

FIG. 6A. Left spontaneous pneumothorax with a tube thoracostomy in place and the lung completely filling pleural space. However, air has persisted beyond 48 hours. B. Same case 48 hours later with a 2500 cc therapeutic pneumoperitoneum. Note marked reduction in the size of both hemithoraces, thus compressing lung and making expiration more complete. Air leak stopped after additional 24 hours.

is lost or where the lung is trapped by pleural peel and will not expand properly after chest tube insertion. Forty per cent of the patients with spontaneous hemopneumothorax required thoracotomy because of excessive blood loss during the first 24 hours after admission to the hospital. The source of blood loss was found to be the chest-wall side of a torn adhesion. The adhesion undoubtedly was torn as the lung dropped with the developing pneumothorax.

At the time of thoracotomy for spontaneous pneumothorax we found that approximately one-third of the patients had tiny blebs at the apex of the upper lobe which were leaking and were the cause of the spontaneous pneumothorax. (Fig. 7). The remaining portion of these lungs appeared normal grossly and felt normal to palpation.

Approximately one-third of the patients had numerous tiny blebs throughout the entire lung on the surgically treated side and only one was leaking. Closure of multiple blebs was necessary and the lungs felt and appeared grossly to be over expanded with early changes of emphysema.

The remaining one-third of those operated upon had large and many tiny pulmonary bullae. The massive ones were resected, the smaller ones were closed with atraumatic silk sutures.

The age distribution in those patients requiring thoracotomy was rather evenly distributed between the young and the elderly. No age group predominated.

FIG. 7. About one-third of the surgically treated patients had tiny apical blebs with otherwise normal feeling and appearing lung.

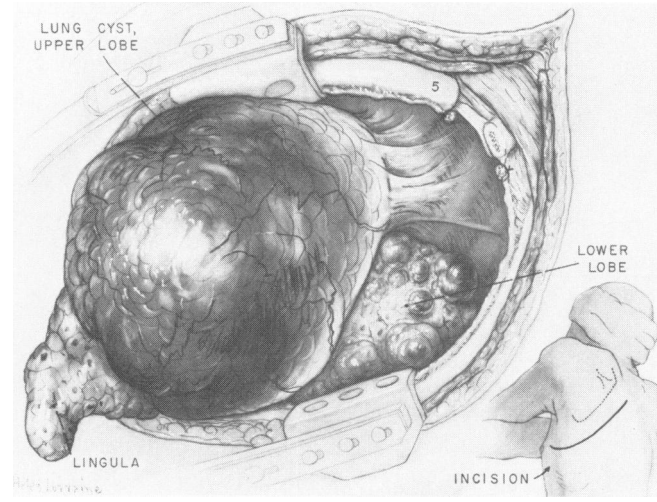

FIG. 8A. All patients were done through a postero-lateral approach using the fifth interspace and not removing a rib.

At the time of thoracotomy we excised all large bullae. (Fig. 8A & B). The multiple tiny blebs that were present were oversewn with interrupted atramumatic silk sutures; many had pedunculated bases and these were tied with silk. It was not necessary to carry out segmental resection lobectomy, or pneumonectomy in any of our operative cases. Following complete removal as possible of all significant bleb and bullae formation in the lung we removed the parietal pleura in order that the visceral pleura would adhere directly to the endothoracic fascia[7,12,25] (Fig. 9). This resulted in excellent adhesion formation over the entire lung surface. If the upper lung contained only tiny blebs as seen in

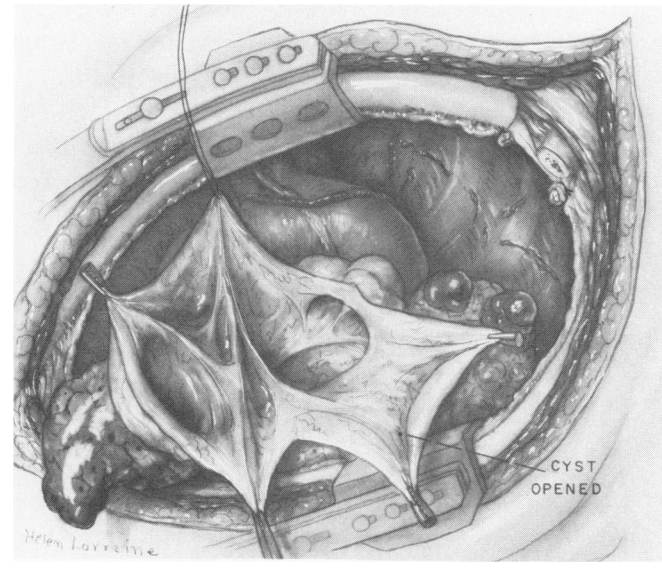

FIG. 8B. Larger blebs are opened, excised, and visceral pleura reapproximated. Smaller blebs tied at base or oversewn with atraumatic silk.

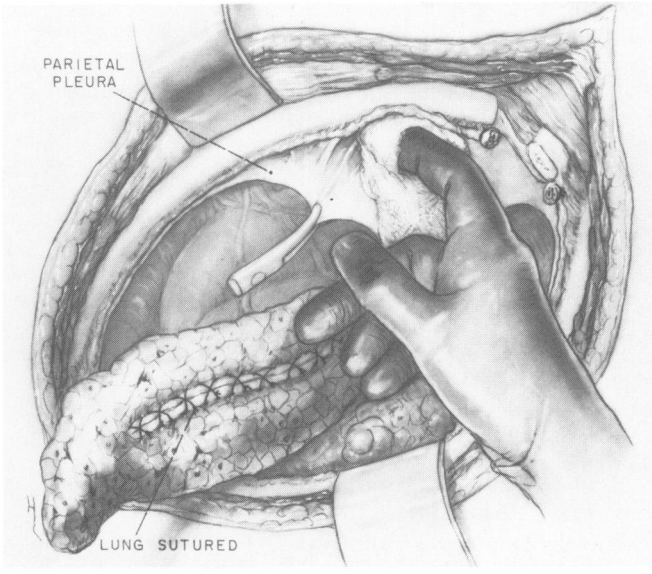

FIG. 9. Bulla removed and visceral pleura approximated. The operator is beginning removal of the parietal pleura.

Figure 7 then only the upper half of the parietal pleura was excised. If most of the lung was involved, then the entire parietal pleura, except that area over the pericardium and diaphragm, was removed. Dr. Clagett and others have raised an objection to this procedure in that subsequent thoracotomy would be most difficult because of the massive adhesions that are caused. Certainly this bears consideration in the young patient, but is probably not objectionable for the patient more advanced in years.

Eight of our surgically treated patients underwent partial hilar vagectomy. The vagus nerve was isolated above and below the hilum of the lung and all fibers going from it to the hilum of the lung were excised (Fig. 10). This does not result in a complete vagectomy of the lung because of the many fibers that cross in the adventitia of the vessels and in the structures around the bronchus. We saw no complications resulting from it. However, objective evaluation of benefit from it has been difficult to establish.

At the time of closure large drainage tubes are placed anteriorly and posteriorly from the bottom of the hemithorax to the top in order that all compartments are drained completely and continuously (Fig. 11).

Only four complications occurred after thoracotomy for spontaneous pneumothorax. One patient had an empyema which cleared with continued closed drainage and no other management was necessary. One patient had excessive bleeding because of the parietal pleurectomy and required re-exploration. One patient had a prolonged air leak lasting over 21 days before the chest tube could be removed. One patient had a cardiac arrest in the recovery room, was resuscitated, and survived without sequelae.

In those individuals who could not tolerate thoracotomy, pleural adhesions were stimulated by several

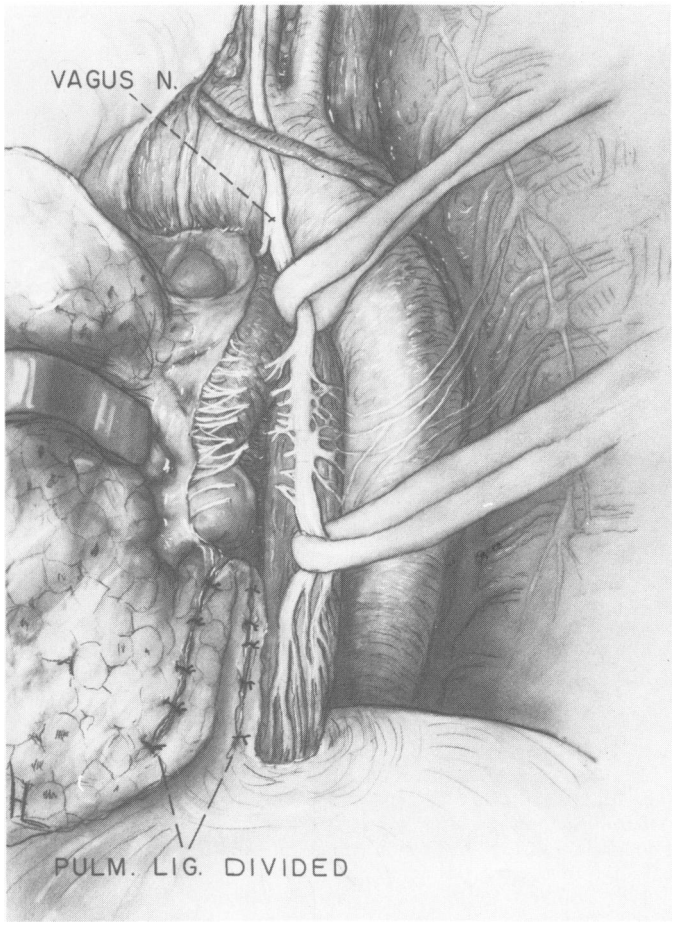

FIG. 10. Posterior hilar exposure for partial vagectomy of hilum.

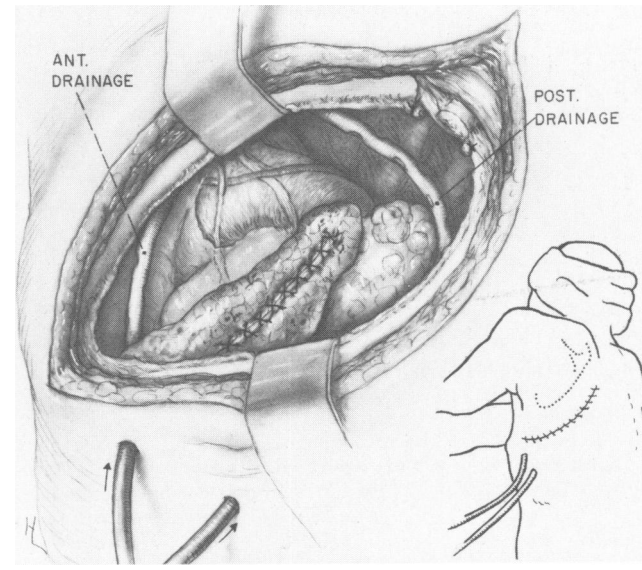

FIG. 11. View of open thoracotomy with bulla removed and chest drainage in place.

methods. We used varidase; blood; blood and varidase; 50% glucose; and diacetyl phosphate. No method appeared greatly superior over the other. However, diacetyl phosphate caused such severe pain that it is contraindicated. That method used most in our series has been 500 cc. of the patient's own blood followed in 24 hours by varidase and continued tube drainage.

Summary

Spontaneous pneumothorax is the sudden collapse of a lung usually caused by air leaking from a subvisceral pleural bleb. Response to tube thoracostomy, needle aspiration and simple observation is usually prompt and effective. Therapeutic pneumoperitoneum helps to stop air leaks in the more persistent cases. Open thoracotomy was necessary in the management of only 9% of the patients in this series.

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Discussion

Dr. Amistead M. Williams (Richmond): I have a couple of comments to bring up in disagreement with Dr. Brooks: The current location of inserting the tube at a lower level brings to mind the possibility of the tube keeping the lung from reexpanding completely. I have always preferred to use a soft rubber tube, because I feel that it will fold out against the chest wall; and I believe Dr. Brooks uses a plastic tube. I would like him to comment later.

One patient I had a few years ago brings up another question for Dr. Brooks. I had a patient in whom the lung did not completely reexpand and we had to operate on him. At the time when we decided to operate we discovered that he was a Jehovah's Witness. He signed the necessary papers to try to absolve us from any danger as far as blood loss, but it was a little harrowing.

Dr. Francis H. Cole (Memphis): I thoroughly enjoyed this beautiful discussion of Dr. Brooks. Our experience encompasses not quite so many patients, but approximateley the same distribution of necessary thoracotomy; about 10%, in our experience, have required open thoractomy.

I find almost nothing to disagree with in this paper, except that in our hands we operate on the second pneumothorax in the patient who has had one on the other side. We also have