Surgical Treatment in Pneumothorax

H. Morriston Davies, M.D., M.Ch., F.R.C.S., Medical Superintendent, Vale of Clwyd Sanatorium; Consulting Surgeon, University College Hospital, King Edward VII Memorial Hospital, General Hospital, and the City of London Hospital for Diseases of the Chest.

In considering the surgical treatment of pulmonary tuberculosis, that must be discussed is why and what extent the performances of the lungs should be treated by operative measures. There are three reasons why surgical treatment may succeed in arresting the disease or in prolonging life when other means have failed.

1. The condition of the patient is such that it failed him only when extremely run down in health, and possibly badly nourished or suffering from great mental strain, the alteration of these conditions by general treatment alone will suffice to make his resistance adequate to deal with the tubercle bacilli, as long as the former had circumstances do not recur. But if the resistance of the patient is sufficient only so long as the general health and fitness of the individual are really good, then each relapse from good health, every exposure to conditions not eminently suitable, will make a relapse of the disease in the lungs and a spread of the tuberculous lesion.

It is extremely difficult (if possible) to increase the specific resistance of the patient to tuberculosis; it is much more feasible to increase the power of resistance of the lungs to the bacilli and in this way rationally to increase the patient's resistance. The most efficient means we know of for reducing the virulence of these organisms is by rest—and in the lungs rest is obtained by immobilization by collapse.

2. The disease has progressed beyond the early granulation stage, where fibrosis sets in and a completely new set of complications arises. These alterations in the bronchial (the secondary bronchiectasis) are the most serious results of the fibrosis, since they in turn are responsible for the retention of sputum, for the exposure of the lung to infection. These are the mechanical factors which eventually prove more difficult to treat and a greater menace to life than the organisms which are the original cause of the trouble.

3. The formation of a cavity by the breaking down of a group of neighbouring caseating granulomata, aided probably by the action of organisms other than the tubercle bacillus, leads to a condition which is often disabling because of the retention of secretions, and is dangerous because of the risk of haemorrhage where these mechanical changes can be very little influenced by medical treatment; only the symptoms of the pathological conditions associated with them can be, for the time being, alleviated. By surgical treatment it is possible to collapse the lung, and whenever complete collapse is achieved the patient is put into a state of rest as regards ill effects of the excessive fibrosis are abolished; the shrinkage of this tissue can proceed without involving all the surrounding and adjacent tissues and structures; the dilated bronchial tubes are collapsed and the spaces which retained the secretions are abolished; cavities have their walls approximated and are no longer a source of danger and constant reinfection: they are no longer cesspools for organisms to flourish in and from which to pour out their toxins into the circulation. So far as the collapsed lung is responsible for the symptoms of the cough is abolished and sputum ceases, the fever due to the toxins disappears, and, if haemorrhage has been a symptom, the danger and fear of that too is done away with; this in itself is a great mental relief to some patients.

The collapse of the patient is now improve. That, together with the diminution in the virulence of the tubercle bacilli and the relative increase in the resisting powers of the patient, will place him in a most advantageous position for encapsulating the organisms and making him more secure against a possible renewal of the invasion.

When the collapse is incomplete it may be said that the advantages obtained are proportional to the degree of collapse. It comes to this, therefore, that once chronic pulmonary tuberculosis has progressed and has caused a degree of fibrosis beyond what can be compensated for by compensatory changes and by remaining healthy lung tissue, the disease may be said to have progressed beyond the early stages, and that from that time onwards, if some permanent improvement is to be looked for, surgical treatment must be considered as an aid to medicinal and to the ordinary system of conservative measures.

Such are the reasons why surgical treatment must be regarded as such an important asset. Now comes the consideration as to when a case is suitable. The chief postulate is that the disease must be unilateral, or that, if there is more than one area of disease, the opposite area is either extensive or acutely active; but there are certain exceptions to which I shall refer later. Surgical treatment is indicated—

1. For the treatment of the primary condition (a) when, although the resistance of the patient is moderate, he must return to work under unfavourable conditions; (b) when the resistance of the patient is insufficient to deal with the tubercle bacilli even under favourable conditions of environment, etc., as is shown either by inability to arrest the spread of the disease or by the fact that he is not impervious to the risks of infection, in the case of a mother returning to her home or her children, and in the case of patients (doctors and nurses) whose work brings them into contact with other people who are in indifferent health and who are infected with tubercle bacilli, the individual should return to work at the earliest possible moment.

2. When the secondary complications (the mechanical factors) are so advanced that it is impossible to control the process (secondary bronchiectasis, secondary emphysema, etc.).

3. When it is necessary to control haemorrhage.

4. When there is tuberculosis of the larynx, which organ is being continuously reinfected from the lung.

5. When there is pulmonary tuberculosis which against these indications for treatment by operation must be placed certain contraindications which are additional to those imposed by the extent of the disease in the lungs. The most important are albumin or sugar in the urine, tuberculosis of the intestinal tract, chronic intestinal stasis of an advanced degree, and (though mentioned last of considerable importance) the temperament of the individual. In an extremely nervous or highly strung person it is probably wiser not to attempt an artificial pneumothorax.

When I was discussing the extent of the disease with which operative treatment could be regarded as practicable under ordinary circumstances, I said there were exceptions. In some cases of fairly extensive pulmonary active infection and pneumothorax may be attempted.

1. When the disease is very active, with marked secondary change on one side, the prognosis is very grave, because of the hopelessness of producing any lasting improvement in the lung; then, as a desperate remedy, pneumothorax may still be attempted, even though there is acute active trouble in the other side, provided that lung has shown any signs of improvement with complete rest in bed, and is not extensively affected by secondary changes.

2. When the collapsed lung has responded to treatment but, later, activity develops, does not subside, or increases in the other lung, artificial pneumothorax may be attempted in this second lung also. In such cases a partial pneumothorax, equivalent to about one-third of each lung, is aimed at. The tendency is a brief account of what can be attempted.

When I first saw there was very extensive disease in the right lung, and there was some active trouble in the left also. Collapse of the right lung was undertaken in the first place because of the extent of the disease. At first there was improvement, but this was followed by a serious relapse due to a sudden exacerbation of the disease in the left lung. Last Christmas I decided of pneumothorax in the left but in December the patient had so much difficulty that pneumothorax could be done on the left side also. I allowed an incomplete re-expansion of the right lung, and a partial pneumothorax has been maintained ever since. She has since gained 21 lb. in weight, she runs a normal temperature, the last report of her sputum was negative, and she has been able to return home.

My experience is that bilateral partial pneumothorax is a quite justifiable procedure in such cases, as it is also in those in which one lung has been collapsed a year or more and then disease starts or recrudescence in the opposite lung. The lung first treated should be allowed to re-expand to about
two-thirds its bulk and then a similar degree of collapse of the second lung produced. Until I began to discuss the very serious type of case for which operative treatment may have to be considered as the last means of saving life I had not particularized as to the method whereby the collapse of the lung should be ended. For these severe cases I have, however, specifically referred to artificial pneumothorax, as that is the only method of intervention that can be attempted for them. Collapse can be brought about either by intercostal drainage or by intercostal incision, the cavity of the lung being filled by the intercostal space immediately below the band. The tissues which the tenotome will traverse are anaesthetized with 2 per cent. novocain. When this has been done and the cutting edge of the tenotome (which is of a special design) has been introduced, the tenotome is driven into the chest the X-rays are turned on and all other lights extinguished. The relationship of the point of the tenotome and of the adhesion can now be made out. The tenotome is pushed towards the adhesion and is moved up and down until it meets the band. The contact of these two can be both seen and felt. The edge of the knife is pressed on to the adhesion, which is then cut through by short sawing movements. If the band has not been made tight by a fairly high simulataneous pressure of the medicinal gas, too careful beforehand difficulty will be experienced in cutting through it, as the fibrous tissue is very tough and resisting, and pressure serves only to displace the band downwards and to pull the lung downwards and outwards. The moment the adhesion is cut through the lung will be seen to droop medially towards the mediastinum.

The opening made by the tenotome is so small that there is rarely more than a little surgical emphysema after the operation. Bleeding from the divided band is only rarely considered as a serious matter; it should occur as the result of the intrapleural pressure. As an illustration that in a simple straightforward case the operation is not a serious one I have had one patient, a woman, who having had her band divided returned home (a distance of twenty-six miles) two hours afterwards, and was seen again two days later.

If the adhesion is a tough one some pain will be felt whilst pressure is being applied to it, owing to the pull of the band at its point of attachment to the parietal pleura.

The most likely complications are surgical emphysema and a small pleural effusion or possibly a haemothorax. Of more serious character are those which may result from the lung being injured in the division. This is likely to happen only if a cone of lung has been drawn out by the band and simulates a pneumothorax, or if a traumatic pneumothorax or haemothorax or even a traumatic pyopneumothorax is produced. If any of this should happen the increase in intrapleur al pressure will force gas out through the incision in the pleura and produce a considerable increase in the surgical emphysema, whilst the possibility of infection may be very serious. Blowing with collapse of the lung may be injurious to the healthy lung.

Jacobaeus advocates the division of adhesions by the electric cautery. This necessitates two openings through the chest wall. Through the one is passed the thoracoscope—on the principle of the cystoscope—by which the adhesion is viewed, through the other the cautery. His results are extremely satisfactory. He is able to divide adhesions which might not be sufficiently visible to attempt by tenotomy, and he can work with a shorter interval of space between the lung and the chest wall. In the division, however, he is often forced to divide a sudden band by a sudden blow from the tenotome, and has frequently to change the air in the pleural cavity so as to be able to see what he is doing. There is also considerable difficulty in retaining the cautery at the correct heat, and in preventing the cautery from burning the lungs. The complications as those mentioned above may fall on this method of division.

An adhesion which is not accessible for division by tenotomy can be exposed by opening the chest and obtaining direct access to its parts. This is of course a more serious undertaking, but is justifiable when collapse of the lung is essential in the treatment, and is seriously interfered with by a band. It is the method also which may be required when the lung has become torn alongside an adhesion in the case of a large pneumothorax. If an opening is made in the chest wall that one side of it is held out by the adhesion and the other pushed away by the pressure in the pleural cavity. The opening even may be valve-like in character, giving rise
to an ingравescent pneumothorax. Such an accident may be further complicated by an effusion, at first simple but later infected by tubercle bacilli, by secondary organisms, or by an empyema.

The thorax is opened as near to the adhesion as possible by an incision along an intercostal space, the tissues having been anesthetized by novocain. The ribs on either side are strengthened, the muscles detached, and the adhesions exposed and divided.

The wound is then closed, care being taken to secure approximation of the parietal pleura. Should an effusion form after this it is advisable that the patient be placed so that the fluid does not come into contact with the wound. If the fluid is excessive it should be aspirated and replaced by oxygen.

There is one other matter in connexion with adhesions that requires mention. The base of the lung is not infrequently adherent either to the summit of the dome of the diaphragm or to the costal part of the corresponding half of the pleura. Occasionally it happens that before the intrapleural pressure has been raised sufficiently to collapse the non-adherent part of the lung, the pull on the diaphragm causes distress to the patient, who may suffer from pain and an irritable, coughing cough; also, if the collapse is on the left side, from vomiting as well. So persistent may these symptoms be, that either the pneumothorax must be abandoned or the diaphragm paralysed by dividing the phrenic nerve in the neck. This will, however, be painful and likely to lead to a further collapse of the base of the lung. It must be remembered, however, that the motor fibres to the diaphragm may enter the phrenic nerve through the subclavian muscle. In such cases section of the phrenic in the neck is followed by no changes of any consequence.

Extrapleural collapse of the lung is of value in certain types of cases only. When the disease is localized to one upper lobe and is resistant to treatment, or is advanced and is associated with secondary changes or a cavity, or is causing respiratory distress, the use of the pneumothorax has been abandoned and found to be impossible, local collapse of that lobe can be obtained by displacing the lung, together with the parietal pleura. Such displacement cannot satisfactorily be produced in tissue which is not incompressible, and it is too rapidly absorbed by or dispersed through the cellular tissues from which the pleura has been stripped. The displacement has therefore to be maintained by some solid substance, such as paraffin wax or fat.

If the patient has plenty of fat to spare, this is the most satisfactory substance to use, as it is non-irritating and is sufficiently fluid to accommodate itself to the shape of the space into which it is packed.† Falling this, paraffin can be used, but it has the great disadvantage of being in some cases very difficult to remove. It is essential that an extrapleural sequestrum be produced which, unless successfully tapped, will distend the wound, discharge through it, and in doing so carry away the paraffin with it. Moreover, when this happens there is the risk that the cavity may become infected.

The whole operation can be done under local and regional anaesthesia or under local anaesthesia with a little chloroform while the upper part of the parietal pleura is being stripped. An incision is made either over the anterior part of the second rib, part of which is removed, or through the anterior part of the second interpace when the ribs are not too closely approximated. The incision is carried down to the parietal pleura, which is carefully stripped away from the overlying tissues up to the apex, and in front and behind, until by this time the whole of the upper lobe is visible. If this has been done it will be found that there is a partial collapse of the upper lobe carrying the pleura with it, the collapse increasing during inspiration and decreasing during expiration, whi ch a cough will force the lung completely. The lung is then displaced by a coper retractor, and into the space thus formed is put either a mass of fat from the abdomen of the patient or the paraffin. This latter should have a melting point of about 112° F., and be just soft enough to be in a semi-liquid state. It is most important that the patient should not cough from the moment until the wound is firmly closed, as otherwise the paraffin will be forced out and an indifferent collapse obtained. In suturing the wound the closest approximation of the edges must be secured.

† The "Spannungspneumothorax" of the Germans, in which air enters the pleural cavity from the lung with each inspiration, but cannot escape during expiration.

‡ On the Continent omentum, lipomata, and fibrine are kept in cold storage, after removal from one patient, in readiness for another.

Collapse of the lung, together with the chest wall, is a more serious operation and the change obtained is permanent. It is not an operation to advise until all other means have failed, and then only if the conditions and change are found, and the class of case for which it is suitable is more limited, and the contraindications are more numerous and more rigid. It is an operation directed to the treatment not so much of the tuberculous disease as of the complication of that disease. It is of value not for the acute active case but for the patient with a long-standing chronic phthisis. Active disease must be, as far as is ascertainable, limited to the one lung, but the presence of a small amount of fibrosis in the other is not necessarily disqualification.

There are two methods by which the lung and chest wall can be collapsed. It can be done either by rib mobilization or by rib resection. Until lately I have been a strong advocate of the former in preference to the latter, as I thought that the resection method was excessively extensive. Recent experience has, however, now converted me to this one in preference to rib mobilization. Rib mobilization means two fairly big operations, and the patient is confined to bed usually for a couple of months. Rib resection means a severe operation only and a very much shorter time in bed. The results in both cases are equally good provided collapse of the apex is not essential.

In the operation of rib mobilization collapse is obtained by resecting portions of the posterior ends of the first nine or ten ribs at the first stage, and of the costal cartilages of the fixed ribs together with a wide section of the costal margin at the second stage. The resection of the portions of the first rib is extremely difficult, but unless this is done the disease will be disseminated. It is not, however, to be expected that the other ribs depends very largely on the freedom of the first. As the result of this detachment of the ribs from their posterior and anterior points of fixation and support they drop downwards, they fall inwards, and they tilt downwards and inwards. They must, therefore, be fixed at their costal margin. This is done by means of a myotomy, and the other ribs are fixed about the first, the second, and the third. This can only be done if the infection of the costal cartilage is complete. If the disease is in the apex and the chest wall it is necessary to paralyse the diaphragm, and to make an extrapleural sequestrum in the manner described above. By this operation, however, the other ribs depend very largely on the freedom of the first.

The operation of rib resection is done through a single vertical incision extending from the apex of the axilla to beyond the eighth or ninth rib. It is done under a general anaesthetic (chloroform), but immediately before this is started I try to inject each of the first nine intercostal nerves with 5 mins of absolute alcohol close to the angle of the ribs. Even if one does not strike every nerve the shock is considerably diminished and so also is the after-pain.

The ribs having been exposed the pericostium is stripped off each in turn, starting with the fourth or fifth and working up to the first rib, by division of the costal cartilages and the muscle, and then downwards to the eighth or ninth. The ribs are freed in front as far as the costo-chondral junction and behind to the angle. Each rib as it is freed is divided in the middle, the anterior half is bent forwards and will break off at its junction with the cartilage of the second rib, and the other half will drop back and may snap at the angle. If it will not break as desired, curved bone forceps must be used down the bone and the rib cut through as far back as possible. It is not feasible to reach the first rib through this incision, as it is impossible to fix the first rib. If the first rib is infected or a cavum in the first rib must be resected through a separate incision below the clavicle.

The wound is completely closed except for a drainage tube, which is left in for twenty-four hours. It must be remembered that the clavicle and costal margin of the pleura will secrete a serous effusion as well as the inner.

The deformity of the chest is considerable, the whole of the anterior and external aspect, and to a less extent the posterocranial aspect, sinking right in. This, however, is not visible because the clothes and not the pleura is grossed and there's been an effect on the shoulder, which has been in no way affected.

I have done two cases in the last six weeks and neither of these has had any shock sufficient to give the least anxiety. In the second case, from which I was operating, the amount of bone taken away was almost 3 ft. 6 in. in length when the ribs were placed end to end. Both were up within a fortnight—the second on the tenth day—and the temperature was normal after the third day.