SURGICAL TREATMENT IN CASES OF PULMONARY TUBERCULOSIS.*

BY

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
WELSH NATIONAL MEMORIAL ASSOCIATION, AND TO THE
CITY OF LONDON HOSPITAL FOR DISEASES OF
THE CHEST.

In considering the surgical treatment of pulmonary tuberculosis, the first point that must be discussed is why and when cases of tuberculosis 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. If the resistance of the individual 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 bad 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 mean 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 a much more feasible proposition to lower the virulence of the tubercle bacilli and in this way *relatively* 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. As soon as the disease has passed beyond the early granulation stage fibrosis sets in and a completely new set of complications arise.‡ The alterations in the bronchial tubes (the secondary bronchiectasis) are the most serious results of the fibrosis, since they in turn are responsible for the retention of secretions and so for the secondary infections. 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 bacilli, leads to a condition which is often disabling because of the retention of secretions, and is dangerous because of the risk of haemorrhage. 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 obtained then not only is that organ put at rest, but the 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, 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 general health of the patient can 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 for 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 in the 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 sanatorium 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 disease in the opposite side, it is neither extensive nor 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 activity of the disease or by repeated relapses; (c) when it is imperative to control the risks of infection, as 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 or in ill ventilated buildings; (d) when it is imperative that the individual should return to work at the earliest moment possible.

(2) When the secondary complications (the mechanical factors) are so advanced that it is impossible to control the symptoms (secondary bronchiectasis and cavity formation).

(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 pneumonic tuberculosis.

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 gastritis, gastroptosis, 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 bilateral active infection artificial pneumothorax can 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 this lung; then, as a desperate remedy, pneumothorax may 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 following is a brief account of a case so treated.

When first seen 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 extreme gravity of the case. 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 despaired of saving her life, but felt there might be a faint hope if a partial pneumothorax could be done on the left side also. I allowed incomplete re-expansion of the right lung, and then produced a partial collapse of the left. This bilateral pneumothorax has been maintained ever since. She has since gained 2½ st. 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 recrudesces in the opposite lung. The lung first treated should be allowed to re-expand to about

* Being part of a lecture delivered before the University College Hospital Medical Society, October 19th, 1921.

† To what extent chronic intestinal stasis and a partial failure of the endocrine glands may be responsible for weakening such resistance, or to what extent the remedying of these pathological states may increase it, I am not able to say, but there must be a great interdependence in the proper functioning of the various organs.

‡ In acute miliary tuberculosis, the fibrosis is insufficient to produce these secondary complications and death results from the acuteness of the tuberculous toxins.

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 obtained. 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 obtained either by intrapleural or by extrapleural separation of the lung from the chest wall, or by letting the chest wall fall in with the lung. Intrapleural collapse of the lung by artificial pneumothorax is the simplest of all these surgical procedures, and is therefore the one which must always be attempted before any other method is considered.

Of the technique, of the difficulties, of the complications, of the variations which are found, making each case almost a law unto itself, I am not going to talk to-night, as it is too vast a subject. I do, however, propose to discuss one complication—that is, adhesions—as I have had considerable personal experience in dealing with these, and it is a part of the subject which has been almost entirely neglected in this country except by myself. The type of adhesion under consideration is that which can be seen with the *x* rays stretching from the lung to the chest wall after partial collapse has been obtained. Such a band, by the pull it exerts on the lung, not only prevents that organ from collapsing to the required extent but tends to keep drawing it out again and to keep open the spaces, encouraging thereby the retention of secretions and the proliferation of the organisms of secondary infection.

These adhesions may be multiple or single, broad or fine; they may consist of fibrous tissue only or have fine blood vessels running along them. The lung at the point of their attachment to it may be drawn out into a cone, thus making the actual band look longer than it really is. The lung at this point may be apparently healthy, it may show tuberculous granulomata, or it may consist of a thin wall cavity. If either of the latter two pathological conditions exists, there is a considerable danger that the lung will rupture if too high a strain is put on it by producing too great a positive pressure in the pleural cavity. None of these details can be known without *x* rays, and it should be obvious therefore that attempts to collapse a lung without constant radiological control is risking disaster sooner or later. In nearly all the cases sent to me with complications to disentangle and treat, the trouble might never have developed had there been *x*-ray control.

Adhesions may be found between any part of the lung and the chest wall. By far the commonest position, however, is over the upper lobe, the parietal point of attachment being in the neighbourhood of the first, second, and third ribs. The second commonest site is between the mesial half of the base of the lung and the diaphragm.

Only the finest adhesions can be ruptured. If very fine bands are seen to be interfering with collapse and the lung at the point of their attachment is sound, it is justifiable to attempt breaking them by increasing the intrapleural pressure up to, but not beyond, 40 mm. of mercury. It may not be possible to raise the pressure so high—that depends entirely on the amount of pain and distress produced. One patient will complain of quite acute pain at a pressure equal to 10 mm. of mercury, and another tolerate one equal to 40 mm. of mercury or over, without even discomfort. The rupture will be felt by the patient, who will feel that "something has given way in his chest" and a sudden relief from discomfort or pain, if either were present immediately before. The operator will recognize the rupture by the sudden drop in the pressure and by the increase in the respiratory undulations.

If there is a single adhesion, too stout to rupture, and it can be seen that at its point of attachment to the lung that part of the organ is sound, then, unless rapid and complete collapse is imperative, an attempt can be made to stretch the adhesion by maintaining a steady high pressure in the pleural cavity. An adhesion which is more than about one-eighth of an inch in diameter will not stretch. If the band is too strong or there are more than one, the only treatment is by division. There are three ways of doing this: (1) by tenotomy without other opening through the chest wall than that made by the passage of the tenotome; (2) by the thoracoscope and electric cautery; (3) by thoracotomy and exposure of the adhesion. The first of these is my own method. It cannot be described

as a simple operation, yet in some cases it has proved extremely easy. Everything depends on the position of the adhesion and the possibility of being able to get the adhesion quite tight before attempting to cut it. It is essential for this method that a clear view of the band be obtained with the *x* rays.

The patient is placed with his back to the *x*-ray tube. The screen is swung so that it can be turned out of the way or brought in front of the chest and mechanically supported in any position desired. The line of approach to the adhesion is through 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 passed through the intercostal space 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 intrapleural pressure by an injection of gas a day or two 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 drop mesially 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 considerable; if it should occur, it will be checked by the increase in 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 after, and was at work 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 continuation of the mesial end. If a careful study has not been made beforehand, or if it is impossible to obtain a clear view of the whole length of the adhesion, then it may happen that this portion of lung tissue is cut and a traumatic pneumothorax or a haemopneumothorax or even a pyopneumothorax results. If any of these should happen, the increase in intrapleural 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 must not be lost sight of.

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 greatly hampered by the smoke from the burning of the adhesion, 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 to prevent it getting caught by the charring of the tissues. The same complications as those mentioned above may follow 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 it. This is of course a more serious undertaking, but is quite 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 spontaneous pneumothorax. The opening cannot close because 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 ingravescent 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 both.

The thorax is opened as near to the adhesion as possible by an incision along an intercostal space, the tissues having been anaesthetized by novocain. The ribs on either side are strongly retracted and the adhesion 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 mesial part of the corresponding half of the muscle. 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 incessant dry irritating 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 cause complete relief and allow of greater compression 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 nerve to the subclavius muscle. In such cases section of the phrenic in the neck is followed by no change in the diaphragm.

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 repeated haemorrhages, then if pneumothorax has been tried and been 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 by gas, as there is no sac into which to inject it, 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.† Failing this, paraffin can be used, but it has the great disadvantage of being in some cases very irritating and of causing an extrapleural serous effusion, 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 will 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 interspace 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 it is freed over the whole of the upper lobe. When 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, whilst a cough will force the lung completely out again. The lung is kept displaced by a copper 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 sufficiently hot to be in a fluid state. It is most important that the patient should not cough from this 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 "Spannungs-pneumothorax" 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 fibroids 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 chances are favourable. 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 lesion as of the secondary complications of that disease. It is of value not for the acute active case but for the patient with 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 lung is not necessarily a deterrent.

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 severe. 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 one 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 result will be disappointing, as the falling down and in of all 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 (bucket-handle action). By this change in position they diminish greatly the size of that half of the chest and collapse the lung to about one-third its original size in an adult, and even more so in a child.

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 minims 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 periosteum is stripped off each in turn, starting with the fourth or fifth and working first upwards, up to and including the second, 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. The posterior half is then bent back and may snap at the angle. If it will not break as desired, curved bone forceps must be slid 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, but the collapse of the lung and of the chest wall is not, in this operation, dependent on the freeing of it. In most cases sufficient collapse of the upper lobe will be obtained without it, but if it is necessary to get complete collapse of the apex (because, for instance, of a cavity) 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 external surface 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 postero-external aspect, sinking right in. This, however, is not visible when the clothes are on, as these hang from 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 whom I removed six ribs only, the total 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.