E X T R A P L E U R A L
P N E U M O T H O R A X

T H E S I S

TO BE PRESENTED FOR THE DEGREE

of

M.Ch.

by

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INTRODUCTION

Extrapleural pneumothorax is a method of treating pulmonary tuberculosis. It is a form of apicolysis, or collapse therapy for apical disease.

The operation consists of stripping the parietal pleura off the deep surface of the ribs in the plane of the endothoracic fascia.

The extrapleural space so created is maintained by the repeated introduction of air.

It is well known that collapsing a tuberculous lung is of great therapeutic value. Until recently the main methods by which this was achieved were intrapleural pneumothorax, phrenicectomy, plombage, and thoracoplasty. Extrapleural pneumothorax had been tried as long ago as 1891, but for reasons to be explained was not successful.

Intrapleural pneumothorax is the ideal method of pulmonary collapse, but unfortunately it fails in many cases on account of pleural adhesions.

The introduction of wax - or plombage - has been given a very extensive trial in this country, and on the continent.

The foreign material may alter in position and give rise to grave complications. For the permanent collapse of chronic fibrous tuberculous disease thoracoplasty is the operation of choice.

This procedure, especially when the apex is collapsed by the Semb method, is too severe for many tuberculous patients. There is, therefore, a definite place for an operation of much less magnitude than thoracoplasty.

A number of patients object to the deformity caused by thoracoplasty: many of these cases can have their cavities collapsed by extrapleural pneumothorax.

HISTORY

Tuffier in 1891 showed that it was possible to separate the parietal pleura from the endothoracic fascia, and so to create a space between the chest wall and the lung. The difficulty at this time was to prevent the space from closing rapidly. Tuffier[73] tried air, but failed to maintain the space. He then tried omentum and fat from the buttock, but without much success.

Archibald[75] inserted the pectoral muscles in the space, while Lilienthal used rubber dam.

Baer,[76] in 1913, introduced a paste composed of paraffin, bismuth, and vioform. This he called plombage, and it proved an excellent method of collapsing the lung. The late results were, however, unfavourable, as the paste shifted its position, coming out of the wound or perforating the cavity of the lung. Infection was another trouble associated with this method, and it has almost completely been abandoned.

Refills of air were tried by Riviere and Romanis (1923)[59] Nissen (1932)[52] and Romanis and Sellors (1936).[60]

that their failure was due to cleavage in the wrong layer, but this has proved to be erroneous.

INDICATIONS

1. Unilateral Apical Disease

Tuberculous lesions in the lung vary according to the type of disease, and the duration of the infection.

Very early disease or tuberculous pneumonia is essentially a medical condition, and the thoracic surgeon is seldom consulted in this type of disease.

When cavitation is present collapse therapy is necessary in the majority of cases. There are two types of tuberculous cavitation:-

a. Early cavitation with thin walls and a surrounding area of comparatively recent tuberculous inflammation. Small cavities of this type may heal by rest and medical treatment, but larger ones require to be collapsed.

An intrapleural pneumothorax is possible in many of these cases but there are others in which one cannot be induced, or gives an unselective collapse. Extrapleural pneumothorax is the only other method of collapse of apical disease of this nature, as upper thoracoplasty is contra-indicated on account of the active nature of the infection.

Fairly recent disease can be collapsed with success by extrapleural pneumothorax as the operation is not a severe one, and the risk of the infection

spreading is slight as the patient can expectorate freely while under the local anaesthetic.

Fixation of the mediastinum which is essential for thoracoplasty is not necessary for extrapleural pneumothorax as there is no extensive rib resection causing paradoxical movement.

b. Cavitation with fibrous tissue formation. This more chronic type of disease is the most suitable for thoracic surgery. The cavities require collapsing and operation allows relaxation of fibrous tissue pull on the mediastinum.

Again an attempt is made to induce an intrapleural pneumothorax, and if this fails an extrapleural pneumothorax or thoracoplasty remain. The question arises - should an extrapleural pneumothorax be attempted if the patient can stand the more severe operation of thoracoplasty? A number of surgeons maintain that thoracoplasty gives such good results that there is no value in performing extrapleural pneumothorax in a fairly fit subject. In St.Mary Abbot's Hospital several patients suitable for thoracoplasty have had the less extensive operation of extrapleural pneumothorax. Whether a thoracoplasty or an extrapleural pneumothorax be performed should depend on the type of lung disease, and on the patient's physical condition.

The ideal case for extrapleural pneumothorax is one in which the disease is of comparatively recent duration and the cavities are thin-walled. The

longer the standing of the infection, with much fibrosis and thick-walled cavities, the better it is treated by thoracoplasty unless there is some contra-indication to that operation.

Cases of up to ten years' duration have had successful results from extrapleural pneumothorax but the risk of having to abandon the operation on account of dense adhesions is considerable.

If thoracoplasty is not possible in a patient with very chronic disease there is little harm done in attempting extrapleural pneumothorax, as a strip may be possible.

In growing children the operation of thoracoplasty, with its extensive rib resection is to be avoided, and an attempt should be made to perform extrapleural pneumothorax.

Patients with asthma would be safer with an extrapleural pneumothorax instead of an intrapleural pneumothorax as much less lung is put out of action.

Cardio-vascular disease and renal insufficiency should have an extrapleural pneumothorax in preference to the major operation of thoracoplasty.

The best guide as to whether extrapleural pneumothorax should be attempted or not is in the x-ray appearance. The following points have all to be examined in an x-ray film:-

a) the extent of the disease, as upon this is based the amount of stripping necessary;

b) the situation of the cavity, or cavities;

c) the thickness of the cavity wall;

d) the density of the affected lung;

e) the thickness of the pleura.

2. Unilateral Disease

The presence of an intrapleural pneumothorax is not a contra-indication to performing an extrapleural pneumothorax on the same side.

In extensive disease of one lung where only the lower and middle zones are controlled by an intrapleural pneumothorax, the extrapleural operation gives an excellent collapse of the apex. Many cases are seen where the apex is held out by adhesions indivisible by thoracoscopy and cauterisation. These are suitable for extrapleural pneumothorax in the majority of cases.

Some difficulty may be experienced in stripping the pleura in the neighbourhood of the adhesions, but as a rule it is possible with careful dissection.

A problem in this type of case is whether to divide the septum between the two cavities or not. In St. Mary Abbot's Hospital, the septum is practically always

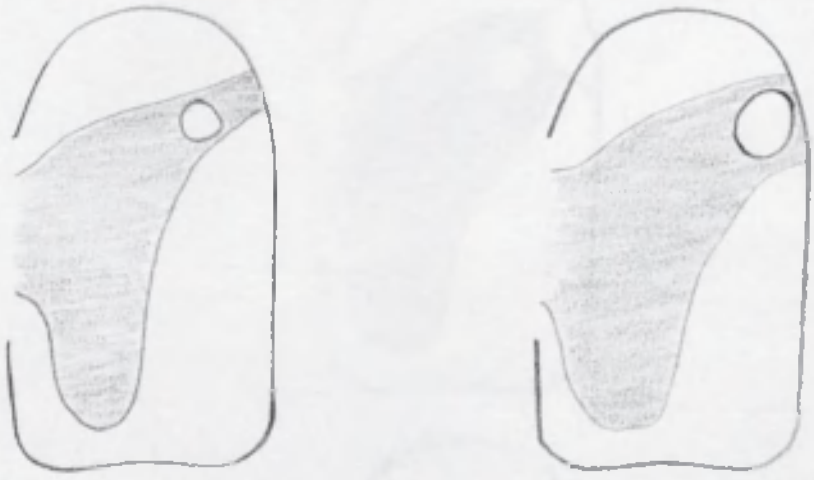
divided, as by so doing it saves refilling two cavities, and improves the collapse of the lung. The septum if left may act like an adhesion.

The septum may be divided at the time of the extrapleural operation, or at a later date by cauterisation through a thorascope. The more satisfactory procedure is to perform primary septal section - that is, unite the intra and extra pleural spaces at the original operation. When this is done the septum is more completely divided. Cauterisation of the septum through a thoracoscope is a difficult operation, as it is hard to distinguish between septum and lung, also the septum is surprisingly thick. The anterior and posterior ends of the septum, especially the latter, on account of the aorta, are not completely divided, and the lung remains incompletely collapsed.

It was at first thought that by performing primary septal section the effused blood would set up a pleural reaction with the possibility of an empyema developing later. Results have shown that this is not the case.

An extrapleural operation can also be used on those cases where, after an intrapleural pneumothorax has been induced, the diseased lung is held out by short dense bands or direct adherence of the lung over a localized area.

The diagrams show suitable cases for localized extra-pleural detachments.

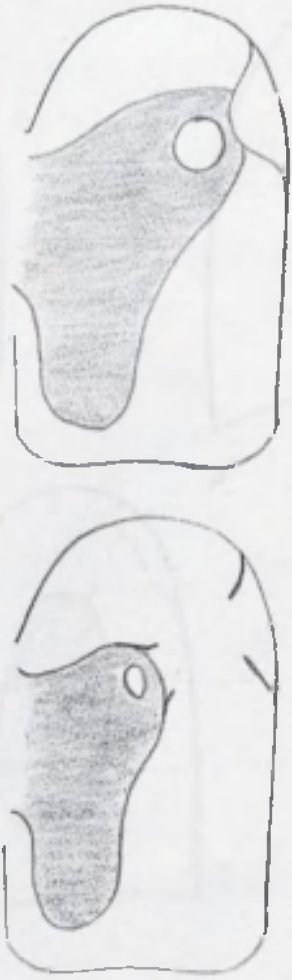


A thoracoscope should be introduced and if the adhesions are not suitable for cauterization, the area of attachment is carefully localized. X-rays taken in several planes help in determining the part of the chest wall overlying the adherent place.

In a number of cases it will be found possible to remove a part of an overlying rib, and come down directly on the area of attachment.

When this can be done the extrapleural strip is confined to the adherent site, and the parietal pleura is divided around as soon as this is mobilized. It is quite a simple matter to determine when all the adherent area has been stripped as the parietal pleura over the pneumothorax is

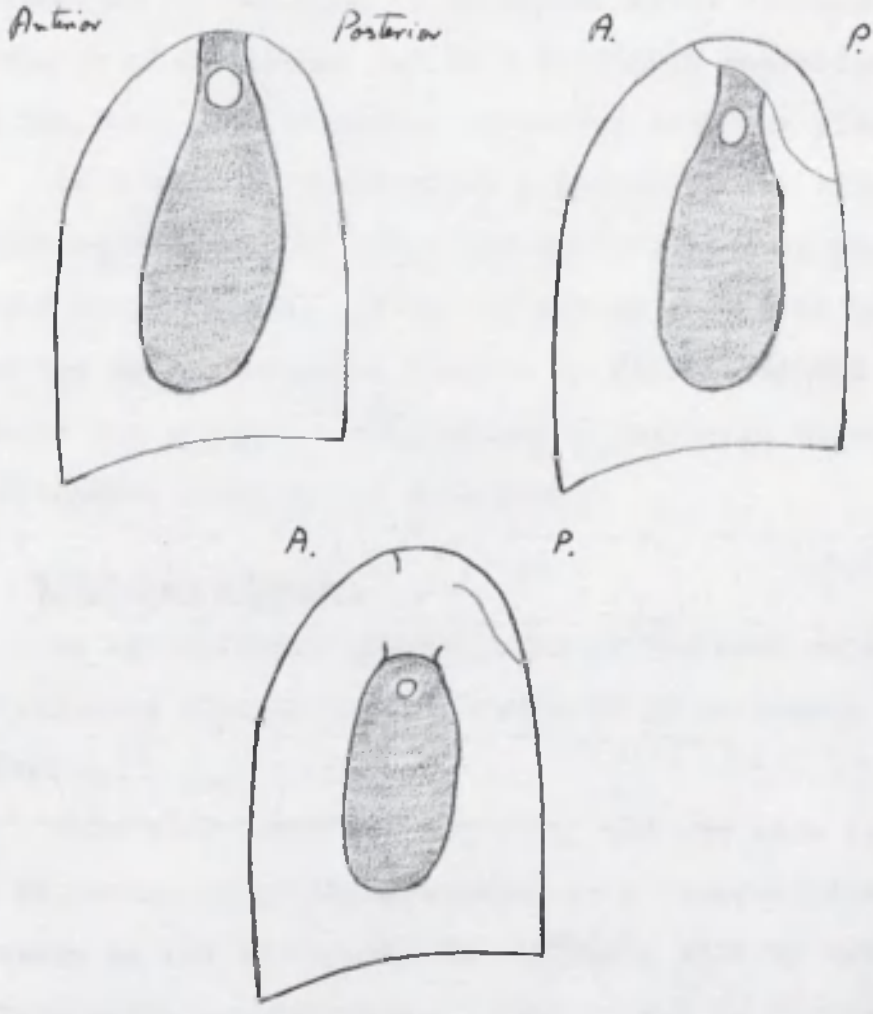
thin and bulging, unlike that attached to the lung which is fixed and hard.



This operation was satisfactorily carried out in Case No.40. Here, a part of the second rib was removed in the anterior axilla and a large cavity freed.

When the adhesions are attached to the apex or mediastinum, and direct approach is impossible, a part of the third or fourth rib is resected posteriorily and the parietal pleura stripped to beyond the area of adherence, when it is incised around allowing the attached lung to drop

Diagrams illustrate the procedure.



Remarkably little has been written about localized extrapleural strips. Sebestyen[69] described the procedure in 1932 when he gave the results of twelve cases. Three of his operations were unsuccessful. Of the remaining nine cases the pneumothorax was present in five a year after the operation. Oleothorax was induced in some of the cases. Seven of the patients on whom the operation was performed finally recovered.

Localized extrapleural pneumothorax is performed in preference to division of adhesions after thoracotomy. Open division of adhesions may be a difficult operation and there is the risk of introducing infection into the pleura.

In a case of tuberculous pyopneumothorax with the apical cavities held out by adhesions an extrapleural pneumothorax could be performed. Here the septum should be left intact and the pyopneumothorax treated by aspiration and wash-outs. Should the pleural cavity become secondarily infected then intercostal drainage is necessary.

3. Bilateral Disease.

An extrapleural pneumothorax is the most selective form of collapse therapy in the treatment of pulmonary tuberculosis.

When both lungs are affected, and one side is controlled by an intrapleural pneumothorax, or a thoracoplasty, apical disease on the other side can be dealt with by means of an extrapleural pneumothorax. Less tissue is thrown out of action with an extrapleural pneumothorax as compared to an intrapleural pneumothorax, and there is therefore less risk of dyspnoea.

In a case of extensive disease in one side and apical cavitation on the other, an extrapleural pneumothorax can be performed to collapse the apical cavities. Should the patient's condition be good enough a thoracoplasty can be done on the more extensively affected side in three months'

time.

In bilateral apical disease the question arises of whether a bilateral extrapleural pneumothorax can be performed. So far this has not been done at St. Mary Abbot's Hospital, but it is a procedure which will be used when a suitable case is found. A number of cases of bilateral extrapleural pneumothorax have been reported from the Continent and America.

As a rule an intrapleural pneumothorax is successful on one side, and an extrapleural pneumothorax can be done on the opposite side.

A small amount of recent spread to the opposite lung is not a contra indication for extrapleural pneumothorax. After the operation a period of rest with perhaps a course of sanocrysin is of value.

CONTRA-INDICATIONS

1. Where the disease extends below the level of the sixth rib posteriorily and the lower part of the lung is not controlled by an intrapleural pneumothorax.

2. Very large thin-walled cavities which would possibly be opened into at operation. The complication of opening the cavity accidentally is so grave that it is better not to operate in this type of case.

3. Old standing disease with thick walled cavities. The compressing force of the air is not sufficient to obliterate the cavities.

4. Dense fibrous disease of the lung with little evidence of excavation. Here the lung cannot be brought down to create a space sufficiently large for refills to be given. This type of case usually has also a thickened pleura which means that stripping will be difficult, or impossible.

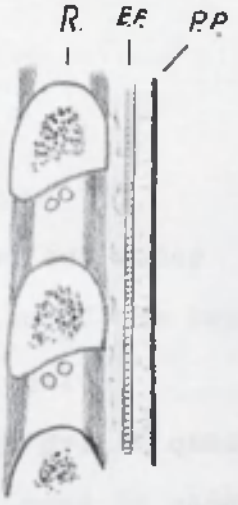
5. Where an intrapleural pneumothorax containing infected fluid is demonstrated. The presence of thick pus or secondarily infecting organisms would prevent operation. If, however, a case were one in which the fluid was thin (even if bacteriological examination demonstrated tubercle bacilli in it), the operation could be done, but the septum not divided.

6. Marked dyspnoea due to emphysema.

7. Cardio-vascular disease.

As a rule extrapleural pneumothorax can be performed in cases of cardio-vascular disease, but where there are signs of failing compensation it is better not to perform the operation.

Patients with high blood pressure run the risk of bleeding into the extrapleural space.



ANATOMY

R. Rib.

E.F. Endothoracic fascia.

P.P. Parietal Pleura.

Between the deep surface of the ribs and intercostal muscles on the one hand, and parietal pleura on the other, is a definite connective tissue sheet - the endothoracic fascia.

This fascia may contain fat in its meshes which helps in its identification at operation. Outside the endothoracic fascia, and joining it to the ribs, is a layer of areolar tissue containing abundant blood vessels and heterogeneous connective tissue.

Attempts to perform extrapleural pneumothorax in this layer are difficult on account of bleeding and adhesions. Many cases of extrafascial stripping have resulted satisfactorily, but the operation is technically more difficult.

The endothoracic fascia is separated from the parietal pleura by a thin layer of loose areolar tissue containing few large blood vessels and fibrous bands. This is the plane of cleavage for the operation.

ANAESTHETIC

Extrapleural pneumothorax can be carried out under local or general anaesthesia, or a combination of the two.

The premedication for operation under local anaesthesia is intensive, and consists of 1/3 gr. of omnopon an hour and a half before the operation, followed by another 1/3 gr. of omnopon with 1/150 gr. hyoscine half an hour before.

Where general anaesthesia is used 1/3 gr. omnopon or 1/12 gr. heroin is given half an hour before the operation is due to begin.

The general anaesthetics used are Gas-Oxygen, or Cyclopropane. Recently Gas-Oxygen has been used in preference on account of post-operative vomiting due to the cyclopropane.

An intravenous injection of 2 or 3 c.cm. of sod. evipan hastens induction when one of the gaseous anaesthetics is used.

The usual local anaesthetic drug is 1 p.c. Novocain and Adrenalin, but occasionally Novutox has been used as it is supposed to have a more prolonged action.

Two methods of local anaesthesia can be used:-

1. Paravertebral. Here the intercostal nerves are injected close to the spinal column. As the injection is made at a depth of two or three inches the nerves may not be located. It is therefore doubtful whether satisfactory anaesthesia will be obtained.

2. Intercostal. The various layers are injected with local anaesthesia down to the ribs and intercostal muscles. The needle is now inserted through the external intercostal muscle, and slow injection started. When the muscle is felt to distend along its course satisfactory anaesthesia will be obtained. The amount injected into each space is 5-10 c.cm. but with practice one gets to know the right amount by palpation of the distended intercostal muscle.

The first to the sixth spaces are injected: the upper and lower spaces are anaesthetized by touch alone.

No further anaesthetization is necessary.

Local anaesthesia is used in most cases, and it is only when a very nervous patient objects to this that a general anaesthetic is given.

Patients with profuse sputum must be done under local anaesthesia to prevent spread of the infection.

It is thought that more bleeding occurs during the operation when a general anaesthetic is given, whereas post-operative bleeding is more likely following local anaesthesia.

OPERATION

The patient is placed in the lateral position with the side to be operated upon uppermost. A table attachment is put in front of the patient's chest so that when the upper arm is pulled forward the gap between the vertebra and spine is increased. (A number of surgeons prefer to have the patient sitting.)

The skin incision is a vertical or oblique one about five inches in length and centred over the fourth rib. The incision lies midway between the vertebral border of the scapula and the spinous processes. The oblique incision runs parallel with the vertebral border of the scapula. There is more bleeding with the oblique incision, but the exposure is better and for this reason it is usually used. The underlying muscles are divided and the ribs exposed.

A piece, three or four inches in length, is resected subperiosteally from the third or fourth rib. As a rule the fourth rib is chosen - very occasionally the fifth rib is resected.

The intercostal nerve can now be picked up and divided. This prevents troublesome post-operative pain, and leaves an area of anaesthesia through which refills can be given painlessly.

The next stage of the operation is a delicate one, the

periosteum of the rib bed is incised, and the endothoracic fascia exposed - this can very often be identified by a small quantity of fat in its meshes. The strip is started with a finger, which gradually forms a space into which a malleable light can be inserted.

The parietal pleura can be recognized as a definite membrane, and strips from its attachment with a soft crackling sound. If care is not taken the parietal pleura may be incised or torn.

A considerable amount of stripping can usually be done with the finger, but as soon as possible a light should be inserted, and the rest of the dissection performed under direct vision.

It is best to commence the strip laterally, as there is less risk of dense adhesions in this direction.

The best instruments for stripping are small swabs on sponge holders, and a Tudor Edwards' illuminated blunt dissector.

When the axilla is rearched the apex is now attacked, and here strong fibrous bands may be encountered. These can be surrounded and pediculated - then divided with scissors.

Bleeding points are usually controlled with diathermy, but occasionally picked up with forceps and ligatured.

Once the apex is separated, from the of the strip

is easier, but for success the apex must be brought down. If this cannot be achieved the operation should not be proceeded with.

The mediastinal aspect is now dealt with, and the parietal pleura stripped off the great vessels. There is little risk to these important structures, as all the separation here is done by blunt dissection.

Most bleeding is seen posteriorily as the perforating intercostal vessels may be opened - these vessels can readily be controlled by coagulation with diathermy.

The usual strip extends down to the fourth rib in front and the sixth rib behind. The amount of the strip depends on the extent of the disease, and the term measured pneumolysis has been suggested. It is a great mistake to create a small extrapleural pneumothorax and hope to increase its size by high pressures at each refill. Should difficulty be experienced in obtaining a satisfactory strip the operation should be abandoned, as one reason earlier surgeons failed in extrapleural pneumothorax was because of inadequate collapse of the lung.

In some cases it is possible to obtain very extensive strips without difficulty but they are not worth doing.

If an intrapleural pneumothorax is present, and the two spaces are to be joined, the septum of the parietal pleura

is divided when the strip is finished. It is important that the division of the septum be complete, otherwise it acts like an adhesion and prevents satisfactory collapse of the lung.

That is why division of the septum through a thoracoscope at a later date has been abandoned. In this method the anterior and posterior parts were imperfectly divided.

The wound is now sutured completely. In none of our cases has a rubber tube been left in the extrapleural space as advocated by Graf.

Some surgeons leave saline in the space hoping to limit oozing of blood and to keep the apex down. This procedure we do not think necessary.

The first suture brings the intercostal muscles together, and in the majority of cases a practically air-tight closure can be obtained by careful stitching. The muscles are approximated in two layers of catgut.

The first refill is usually given on the table - a place close to the wound already anaesthetized is chosen for the pneumothorax needle puncture.

Complications during Operation

1. Tearing the parietal pleura: In the presence of an intrapleural pneumothorax no trouble results in those cases where the septum is to be divided. When the strip is completed the opening in the parietal pleura is enlarged and the two spaces allowed to communicate freely.

Where no intrapleural pneumothorax is present there is little damage done unless a free pleura is opened into. The sudden collapse of the lung when a free pleura is present causes severe dyspnoea which is especially troublesome if the operation is being performed under a local anaesthetic. The patient may become so excitable that the operation has to be completed with general anaesthesia. This complication is rare, as most cases have already had several attempts at induction of an intrapleural pneumothorax.

2. Tearing Lung: So long as the tuberculous area is not opened into, the rent can be sutured without the risk of subsequent spread of the infection. The tear in the lung is first surrounded with a fine catgut purse-string suture, and then several deeper stitches are inserted across the gap.

It is a very serious complication when the tuberculous focus is opened. This usually occurs when a superficially situated thin-walled cavity is present.

The problem now confronting the surgeon is - should an

attempt be made to suture the walls of the cavity together, and complete the operation in the usual manner? - or should a drainage tube be inserted and the apex collapsed later by a thorocaplasty? The latter method is the more satisfactory as the infection may subside after prolonged drainage. Where no drainage is done the infection spreads to the extrapleural space and wound, in most cases, with considerable danger to the patient's life.

3. Damage to Important Structures: When the apex has been collapsed the arch of the aorta, the subclavian vessels, the superior vena cava with its branches, and the lower cords of the brachial plexus are all exposed. There is little danger of damaging these structures, as practically all the stripping is done by blunt dissection.

4. Haemorrhage: Several bleeding points are usually encountered, and are readily controlled with diathermy, or pressure from a swab. Most bleeding is from perforating branches of the intercostal vessels in the paravertebral gutter.

5. Dense Adhesions may be encountered, especially at the apex. It may be possible to strip around the adhesion area, and then cut the adhesion close to the chest wall. This can only be done if the adhesion is not too close to important vessels, otherwise the risk of tearing or cutting

into them, and a fatal haemorrhage resulting, is too great.

6. Tuberculous Glands at the apex are occasionally found, and these are best carefully dissected out. If they are left they may ulcerate and set up a tuberculous inflammation of the extrapleural space.

Complications following Operation

1. Shock: This is surprisingly slight, and a few hours after the operation the patient is sitting up in bed, apparently little the worse for the operation. This is in marked contrast to the immediate post-operative appearance following thoracoplasty.

2. Haemorrhage: Should the patient suddenly collapse a few hours after the operation the cause is most likely to be bleeding into the extrapleural space. This will more probably occur when complete local anaesthesia has been used. Apparently a hyperaemia occurs after the ischaemia which undoubtedly takes place with local anaesthesia. The extrapleural space can hold several pints of blood, and unless a blood transfusion is given quickly the patient may die. It is therefore advisable to have the blood grouped prior to operation, and an efficient service of blood donors.

Following the haemorrhage no attempt is made to

introduce air, but the space is left for some days. Then an aspirating needle is inserted and serum withdrawn. This may be difficult as clots continually block the needle. By repeated aspiration a space is created into which air is introduced and refills carried out as usual. A more rapid method is to insert a trocar and cannula; after the trocar is removed connect the cannula to a suction apparatus and so evacuate the clot.

3. Surgical Emphysema: In practically every case some air escapes into the tissues, but fortunately it is usually small in amount, and gives rise to no symptoms, beyond crackling when the skin is pressed.

A few patients have been seen with marked emphysema extending up to the face, but no special treatment such as incision of the skin is needed.

Cases of mediastinal emphysema have been reported with distressing symptoms.

4. Immediate re-expansion of the lung after operation has been reported on several occasions. It appears to follow inadequate collapse of the lung accompanied by considerable coughing.

5. Delayed Obliteration of the Extrapleural Space may occur, weeks or months after the operation. Again inadequate stripping is an important factor in its

causation. Other reasons are refills given at infrequent intervals, and pressures kept too low; also infection may cause a process similar to obliterative pleurisy.

Should the space be seen to diminish on X-ray examination an attempt may be made by frequent refills and high pressure - up to + 25 + 30 - to halt the obliterative process. If this is not satisfactory, then sterile olive oil may be injected and an oleothorax commenced. The alternative to this is to perform an upper thoracoplasty and there is much to be said for this if the patient is well enough to stand the operation.

6. Spread of the tuberculous disease in the lung: The lower lobe on the side of the operation or the opposite lung may be involved. This spread occurs through the bronchi during operation. To prevent this, patients with profuse sputum should be given local anaesthesia, so that they can clear the bronchi with an occasional cough during operation. Tuberculous spread is shown by a swinging temperature some days after the operation, and the characteristic appearance of the lung on X-ray examination.

The treatment of this is at first rest, followed by injections of sanocrysin to harden the diseased lung.

7. Infection in the Extrapleural Space: This may be of a tuberculous or pyogenic nature. In a number of cases

tubercle bacilli are found in the fluid aspirated, the cause of this in the majority of cases being due to the tearing of lymphatics during the operation. These patients have the space aspirated at frequent intervals, and if the fluid is thick irrigated with saline or Dakin's solution.

Pyogenic infection is most unfortunate, as early drainage by intercostal tube or rib resection must be instituted. As these patients will later have an upper thoracoplasty the drainage tube is inserted anteriorily in the lowest possible position in the space. After a period of drainage and irrigation at a sanatorium, the upper five or six ribs are removed through the usual posterior thoracoplasty incision. Difficulty may be experienced with the rib resected for the extrapleural pneumothorax because of rib regeneration.

8. Infection of the Wound may result if a careful asceptic technique is not used. In a severe infection the wound may break down allowing a direct communication between the extrapleural space and the atmosphere.

9. Intercostal Pain: This may follow if the intercostal nerve is not divided at operation. The nerve appears to get involved in scar tissue, and a distressing neuritis results.

10. Cardiac Failure: Before operation the cardio-vascular system must be carefully investigated. Local anaesthesia is indicated in patients with cardiac disease.

11. Non-Tuberculous Bronchitis or Pneumonia.

12. Broncho-extrapleural fistula: This has been mentioned by several authors as a usually fatal complication. This occurred in only one case at St. Mary Abbot's Hospital, and was expected as the tuberculous cavity was opened into during the operation.

13. Fibrin Bodies: These are occasionally seen in the extrapleural space on X-ray examination. They may lie on the floor of the pneumothorax, or be attached to the inner aspect of the wound. They slowly disintegrate and may disappear.

14. Basal Atelectasis which is so often seen after thoracoplasty is seldom seen following extrapleural pneumothorax.

After-Treatment

While the patient is still on the operating table a refill needle is inserted into the extrapleural space through the anaesthetized chest wall close to the incision. The pressures are about atmospheric, and air is introduced until they reach about + 5 + 10 c.cm. of water. The amount of air required to obtain this pressure varies from 100 c.cm.

to 300 c.cm. depending on the size of the pneumothorax.

The patient is returned to bed and given an injection of morphia. For an hour or two the patient lies flat on the back and is then slowly raised to a sitting position. The pulse is carefully observed during this time as any increase in rate requires to stop the sitting up process. It is the practice of some surgeons to nurse the patient on the back, as they say it limits surgical emphysema.

In all the cases at St. Mary Abbot's Hospital, the surgical emphysema has been slight and the effusion, with the patient sitting, lies on the lung helping to prevent re-expansion.

On the evening of the operation a refill is given and about 100 c.cm. of air is necessary to maintain the desired pressure.

Refills are given daily for a fortnight. At first the pressures are left at + 5 + 10, but after a few days they are increased to + 10 + 15, and later to + 15 + 20. Higher pressures are sometimes used, but only if the extra-pleural space appears to be diminishing in size.

There is apparently no risk in maintaining these high pressures. It was at first thought that air embolism might result, but this complication seems very remote.

It is interesting to note that a few minutes after the desired pressure is obtained it drops several degrees. This phenomenon may be due to increased collapse of the lung or leakage of air.

Air appears to be absorbed more slowly from an extrapleural pneumothorax than from an intrapleural.

The manometer readings are less in an extrapleural pneumothorax; one would expect this in view of the smaller space.

When, however, an extra and intrapleural pneumothorax is combined the pressures are kept lower, slightly above atmospheric in fact. These cases are treated very much like an intrapleural pneumothorax, but at first refills are given every other day for a fortnight and then once a week.

An X-ray is taken the day following the operation and the amount of effusion noted. A collection of altered blood is always present and it should be aspirated as completely as possible. A large collection of fluid may strip the lung further and this is not wanted in cases of bilateral disease.

If the fluid is not aspirated quickly it may form fibrinous masses which cannot be removed and are a possible focus of infection.

The aspirating needle is inserted between the third and fourth ribs in the axilla and the patient is postured to remove the fluid.

At first the fluid is dark red but rapidly becomes brown from altered haemoglobin.

Once the effusion is aspirated it seldom reappears unless the pneumothorax becomes infected.

The complication of tuberculous infection of the pneumothorax has been seen at variable times after the operation. It does not appear to be as serious as the presence of tuberculous pus in the pleural cavity. Following repeated irrigations with Dakin's solution the infection subsides, and refills only can be resumed.

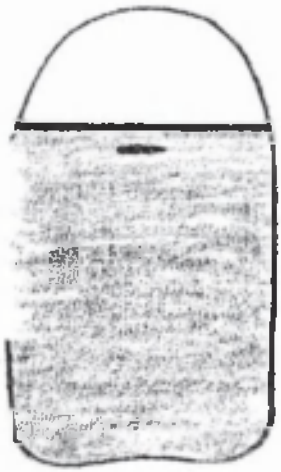
The patient is kept in bed for four weeks after the operation, and is transferred to a Sanatorium a week or two later. There they remain for six months to a year, and are subsequently sent home to attend the local tuberculosis dispensary for refills and observation. Refills are given weekly for the first year, and at the end of that time, if the pneumothorax is satisfactory, they are given once a fortnight.

End Results of Extrapleural Pneumothorax

The question arises - what will happen to the extrapleural space? Will the lung re-expand and obliterate the pneumothorax or will the thickened pleura prevent this re-expansion once the refills have ceased?

Theoretically the latter appears the most probable result. As reported from postmortem examination the floor of the pneumothorax is tough and fibrous with a firm attachment at the periphery to the chest wall.

As shewn in the diagram the lung is anchored by a roof of thickened parietal pleura.



It seems, therefore, impossible for re-expansion to occur once the pneumothorax has been present for some time

and a firm attachment formed between the parietal pleura and the chest wall.

Occasionally cases are seen where a gradual obliteration of the pneumothorax occurs. This process is similar to an obliterative pleurisy and may result in re-expansion of the lung and re-opening of the tuberculous cavity.

When the pneumothorax does not obliterate the space appears to organize after refills have ceased. An exudate fills the space and later becomes replaced by fibrous tissue.

A case demonstrating this point was recently seen at St. Mary Abbot's Hospital. The patient had had an extra-pleural pneumothorax performed three years before and refills discontinued after a year as she refused further treatment. She was admitted to St. Mary Abbot's Hospital with tuberculous peritonitis and the pneumothorax was completely organized. The lung disease appeared to have healed.

A number of cases will require thoracoplasty later; in fact, some surgeons consider extrapleural pneumothorax a preliminary to thoracoplasty.

It is not yet known whether it is safe to leave the pneumothorax after refills have ceased. If one considers

AS SENIOR MEDICAL OFFICER ATTACHED TO THE LONDON COUNTY COUNCIL THORACIC SURGICAL UNIT AT ST. MARY ABBOT'S HOSPITAL, KENSINGTON, SINCE 1936, I HAVE BEEN PRESENT AT ALL THE FOLLOWING OPERATIONS. A NUMBER OF THE OPERATIONS HAVE BEEN PERFORMED BY MYSELF - THE OTHER SURGEONS BEING MR. HOLMES SELLORS AND MR. R.C. BROCK. I AM GRATEFUL FOR THEIR PERMISSION TO DESCRIBE THE CASES.

Case 1. Annie Whelan. Age 19 years.

Admitted: 3.1.38.

History: 1931 Tuberculosis of the right knee joint.
Cough developed in January 1937 and the chest was X-rayed. Tuberculosis of the right lung being diagnosed.
Treated by rest for three months.
Artifical pneumothorax attempted, but failed.

On Admission the patient's general condition was good. She had a slight cough with purulent expectoration containing tubercle bacilli
B.S.R. 18 in one hour.
X-ray.

Right Extrapleural A.P. was performed on 20.1.38.
The operation was started under local anaesthesia. A fair number of fine adhesions were encountered but stripping was progressing satisfactorily when the patient suddenly coughed, rupturing the pleura and allowing air to enter a small pleural pocket. The patient now complained of severe dyspnoea and became excited. Cyclopropane was given and the operation proceeded satisfactorily.

Immediately after the operation 450 c.cm. of air was injected into the extrapleural space. On recovering from the anaesthetic the patient's general condition was good. The pressures were kept at about + 10.

Blood-stained fluid was aspirated from the extrapleural space on several occasions.

Sputum examined on 2.2.38 showed no tubercle bacilli.

COMMENT

This patient had a year's history with cough and positive sputum. She was a suitable case for either an upper thoracoplasty or extrapleural A.P. In view of the short history the latter operation was performed with complete success.

PRESENT HISTORY

She was discharged from Sanatorium in June 1938 and has been attending a tuberculosis dispensary.

The pneumothorax is being refilled at fortnightly intervals. Her general health is good. There is no cough nor sputum.

Case 2. Lilian Smith. Age 35 years.

Admitted: 10.9.37.

History: 1930 pleural effusion, admitted to hospital and treated for ten months.
October 1936 she had a slight haemoptysis.
Tubercle bacilli were found in the sputum for the first time.
A left artificial pneumothorax was attempted, but failed.
The patient was well nourished and of healthy appearance. The cough was most marked in the morning. Tubercle bacilli were present in the sputum.
Signs of cavitation were made out on examination at the left apex.
B.S.R. 13 in one hour.
The patient's first husband died of pulmonary tuberculosis in 1930.

X-ray showed cavitation at the left apex. Group of mottled shadows close to angle of right scapula, some being probably old.

On 23.9.37 left extrapleural pneumothorax was performed. The lung, which felt rather hard, stripped easily and a good collapse was obtained.
This was one of the first of our cases and the intercostal nerve was not divided. The patient suffered from considerable pain radiating round the left side of the chest for some weeks after the operation.
Post-operatively 200 c.cm. of air were injected to bring the pressures up to an average of + 15.
Air apparently escaped rapidly as 250 c.cm. were required on the night of the operation. On the

day following 200 c.cm. were injected.
Following this the usual 40 to 60 c.cm.only were required.
Aspiration was performed on several occasions.
The intercostal pain was not relieved by the usual electrical means and the nerve was injected

Four weeks after the operation the patient complained of dyspnoea. An X-ray showed a pleural effusion localized to the antero-lateral aspect of the right side of the chest. This fluid was aspirated and did not recur.

Several sputum examinations were carried out between 27.9.38 and 27.10.38, all being negative for tubercle bacilli.

COMMENT

Since this case, the intercostal nerve has always been divided with no further post-operative pain.

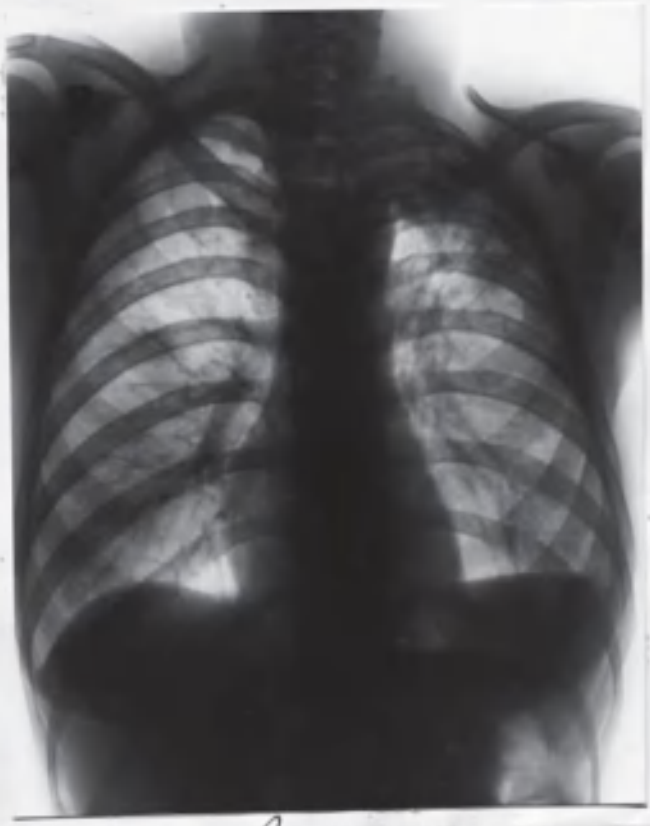
Refills can also be given through the anaesthetized area.

PRESENT HISTORY

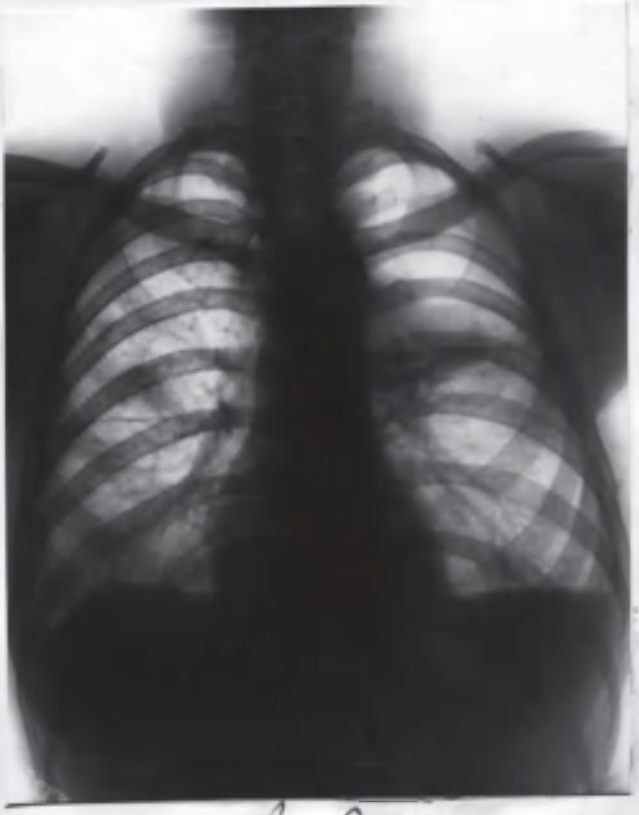
Refills are being continued at a Tuberculosis Hospital and the pneumothorax is being maintained. The general condition is good and she has no untoward symptoms. There is no sputum.

X-rays Nos. 1 and 2 show the condition before and after operation.

X-ray No.3 shows shows the pneumothorax two years after operation.



No. 1.



No. 2.

Case 3. Florence Hadfield. Age 38 years.

This patient, a professional dancer, complained of cough and pain in the right chest in 1938.

An artificial pneumothorax was induced, but satisfactory collapse was prevented by adhesions. She was admitted to St. Mary Abbot's Hospital in October 1938 with a cavity in the right upper lobe, insufficiently collapsed.

Thoracoscopy and division of adhesions was performed on two occasion, but an unsuccessful collapse resulted on account of direct adherence of the lung to the chest wall.

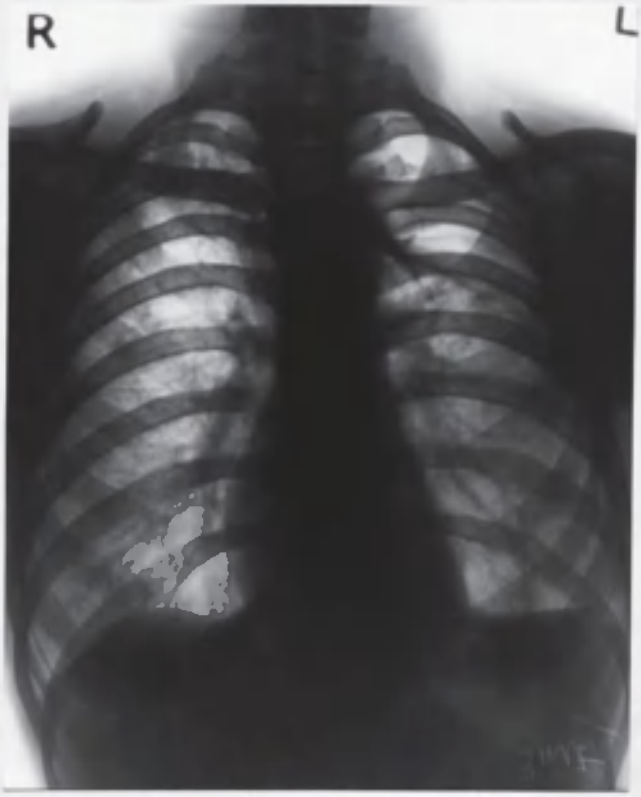
On 24.11.1938, with local anaesthesia, an extrapleural pneumothorax was performed, and the parietal pleura between the two pneumothoraces divided. This gave a good collapse of the lung. The lower part of the wound became inflamed and discharged pus for a time. This condition healed up with infra-red radiation, and did not give rise to any infection of the pneumothorax.

PRESENT HISTORY

The patient attends St. Mary Abbot's Hospital weekly for refills, and has resumed her employment - mostly film work.

Her health is excellent and she has no sputum.

X-ray No.4 shows the penumothorax one year and four months after operation.



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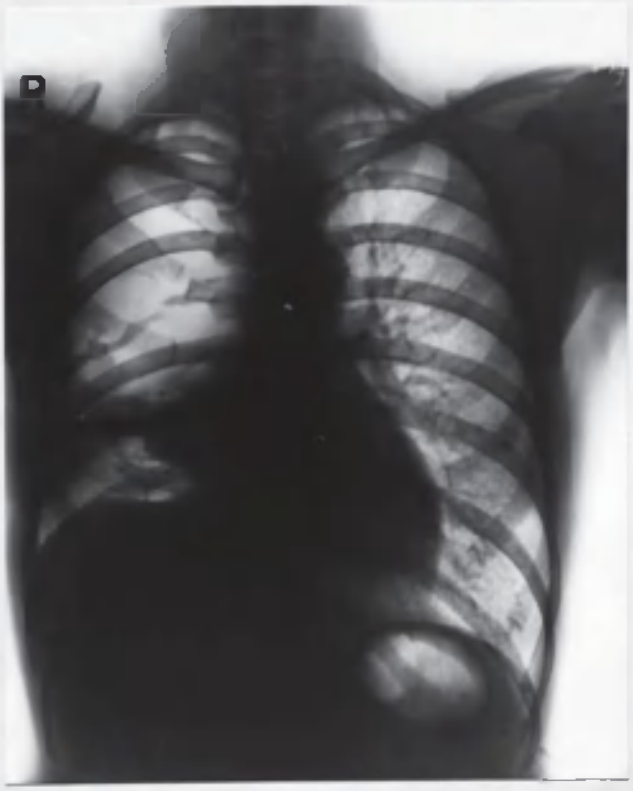


No 4.

Case 4. Edna Corfield. Age 35 years.

History: Onset in March 1934 with haemoptysis and cough.

Sanatorium treatment with sanocrysin in period up to February 1938 when admitted to St. Mary Abbot's Hospital.

The left phrenic nerve had been crushed on two occasions and an attempt at induction of a left artificial pneumothorax failed.

The patient was thin and not in good condition.

The sputum contained tubercle bacilli.

Examination revealed cavitation confined to the left apex.

An extrapleural pneumothorax was performed on 25.2.38, completely under local anaesthesia. A good strip was obtained without difficulty, but the pleura was accidentally torn and a small pleural pocket opened into. The opening was enlarged and the two spaces allowed to communicate freely.

The patient progressed satisfactorily and she went to a sanatorium on 18.3.38.

A sputum examination on 2.3.38 showed no tubercle bacilli.

COMMENT

In view of her poor general condition this patient was not a good subject for an upper thoracoplasty. In spite of a four years' history it was decided to attempt an extra-pleural pneumothorax and this operation was very successful.

PRESENT HISTORY

At Christmas 1938, this patient entered a general hospital and had right mastectomy and deep X-ray therapy.

She was readmitted to a sanatorium in February 1940 as her general condition was deteriorating. Here it was found that the opposite lung was affected with tuberculosis. The extrapleural pneumothorax is still maintained, giving a good collapse of the left upper lobe.

She is now doing short walks each day, the pulse and temperature being normal.

Case 5. Fanny Katensky. Age 33 years.

History of pulmonary tuberculosis began in 1926. Since then she had spent most of her life in various sanatoria in different parts of the country. She was transferred to St. Mary Abbot's Hospital on 4.10.37. The general condition was not good, she was thin and pale. She had dyspnoea on exertion with cough and sputum containing tubercle bacilli.

Clinical and X-ray examination of the chest showed a large cavity in the right upper lobe and some recent infiltration in the left lung.

In view of the active lesion in the opposite side and the patient's poor general condition she was not suitable for thoracoplasty. In spite of the long history an intrapleural pneumothorax was induced in the right side. This causeddiminution in the size of the cavity but satisfactory collapse was prevented by apical adhesions. Thoracoscopy was performed and the lung directly adherent at one point prevented any operative treatment. In view of this it was decided to perform an extrapleural pneumothorax later.

On 16.12.37 a right extrapleural pneumothorax was performed with local anaesthesia alone.

A good strip was obtained without difficulty. The parietal pleura was torn in several places and these were stitched with fine catgut.

On the day following the operation considerable surgical emphysema was present. This was due to coughing which the patient appeared unable to control. The swelling of face and neck became so marked that a doctor called hurriedly to the patient made incisions in the neck. I do

not think that this procedure was necessary as apparently there were no symptoms of embarrassment to respiration or difficulty in swallowing.

A good apical collapse was obtained and the patient allowed out on 8.2.38.

COMMENT

The length of the history made one feel that only a thoracoplasty could collapse the lung. This operation was ruled out on account of the patient's general condition and as the apex could not be collapsed by an intrapleural A.P. it was decided an extrapleural operation should be attempted. This operation was successful and it is an illustration that extrapleural pneumothorax should be attempted in cases of long-standing apical cavitation where thoracoplasty is contra-indicated.

The surgical emphysema was excessive - due to post-operative coughing. The patient was of a very nervous type and it rendered attempts at controlling the cough difficult.

It has been noticed that coughing is more severe after local anaesthesia.

SUBSEQUENT PROGRESS

This patient unfortunately developed serious mental symptoms and was admitted to a mental observation ward. During her mental treatment the refills were stopped, and

the tuberculosis infection became active. She died in April 1939, about eighteen months after the extrapleural pneumothorax.

Case 6. Irene Todd. Age 28 years.

History: Onset with pleurisy in 1932 when sputum examination showed tubercle bacilli. A year later a right-sided artificial pneumothorax was induced. Refills continued until 1936 when the left lung was found to be affected. In view of this the artificial pneumothorax on the right side was diminished and an attempt to induce an A.P. on the left side failed.

The patient was admitted to St. Mary Abbot's Hospital on 27.10.37. Examination revealed cavitation in the left apex and a small pneumothorax in the right side. In view of apparent lack of activity in the right lung it was decided to discontinue refills.

On 4.11.37 under complete local anaesthesia an extra-pleural pneumothorax was performed on the left side. Pain was only experienced when the stripping reached the sixth rib posteriorly.

Following the operation difficulty was experienced in refilling with air, so a portable X-ray was done and this showed a large amount of fluid in the space with deviation of the mediastinum to the right. Two hundred and fifty c.cm. of blood-stained fluid was removed from the space by aspiration. Three days later 270 c.cm. of similar fluid was withdrawn. Following this amounts of fluid varying between 120 and 240 c.cm. were removed.

On 22.12.37 the patient suddenly complained of severe pain in the right side of the chest and marked pyrexia. An X-ray showed that the pneumothorax on the right side had increased in size and some fluid had collected. A

spontaneous pneumothorax had developed on the right side. This was followed by an acute spread of the disease to the right lower lobe. In spite of this the patient's general condition remained fairly good and she was transferred to a sanatorium on 19.4.38.

COMMENT

This is an example of bilateral disease where one side was satisfactorily collapsed by extrapleural pneumothorax.

All the subsequent trouble with this patient came from the opposite side of the chest.

There was a greater collection of fluid in the extrapleural space than usual. Haemorrhage following operation under local anaesthesia being to blame.

SUBSEQUENT PROGRESS

A month after admission to Hospital (sanatorium) she still had two ounces of sputum daily, containing tubercle bacilli.

A severe haemoptysis, apparently from the right lung, caused this patient's death in September 1938.

Case 7. Doris Hawthorne. Age 25 years.

She complained of feeling tired in the latter months of 1937, and developed a severe cough. A course of sanocrysin was given and a left artificial pneumothorax was attempted, but did not succeed.

In April 1938, about six months after the onset of the symptoms she was admitted to St. Mary Abbot's Hospital. She had fibro-cavernous disease of the left apex with some infiltration of the rest of the lung. There was an evening pyrexia and the signs indicated activity of the lesion.

A left extrapleural pneumothorax was performed in June 1938 under general anaesthesia - cyclopropane. The apex was rather adherent but separated with careful dissection. Exactly a month after the operation the fluid aspirated from the extrapleural space contained tubercle bacilli.

This patient did not respond so well after the operation, as most others do. For some days she ran a temperature up to 103°, and examination of the chest revealed râles at the left base. This was probably not a spread of the tuberculous condition as the sputum was negative. Before operation the sputum had been positive for tubercle bacilli. The lung stripped further after operation in this case.

She was transferred to a Sanatorium in September 1938.

PRESENT HISTORY

Pleural wash-outs were given at the Sanatorium until July 1939, when it was decided to discontinue them and the refills.

A month later the pneumothorax was completely filled with fluid. She was discharged recently with a trace of negative sputum. The blood sedimentation rate is only 4 mm. in one hour.

Case 8. Marie Toso. Age 52 years.

A haemoptysis in 1936 started this patient's history. Several bleedings occurred, and an artificial pneumothorax was induced. She was admitted to St. Mary Abbot's Hospital in September 1938, with symptoms of cough and profuse sputum.

Thoracoscopy was performed and several adhesions divided, but in view of dense apical and mediastinal adhesions it was decided to perform an extrapleural pneumothorax. At operation dissection around the subclavian vessels was difficult, but was successful.

Before operation X-ray showed that a large cavity was in the right apex. This was satisfactorily collapsed by the extrapleural pneumothorax, and six weeks later she was transferred to a Sanatorium.

Thoracoplasty was excluded in view of the patient's age, and extrapleural pneumothorax was the only method left (after thoracoscopy had failed), of collapsing the cavity.

PRESENT HISTORY

The pneumothorax is being maintained satisfactorily, refills being given every fourteenth day. Her general condition is excellent.

Case 9. Marie Munro. Age 22 years.

She complained of loss of weight and lassitude in 1937; an X-ray of chest showed tuberculous infection, and she was sent to a Sanatorium.

A year and a half later she was admitted to St. Mary Abbot's Hospital with extensive cavitation of the left upper lobe and some slight infiltration of the right upper and middle zones. A left artificial pneumothorax was induced but only gave a partial collapse of the lung, the apex being held out by adhesions indivisible by thoracoscopy.

Under local anaesthesia a left extrapleural pneumothorax was performed on 25.8.1938. The strip in this case was easy, and the septum of parietal pleura was severed allowing the intra and extrapleural cavities to communicate.

During the operation the patient coughed up a considerable amount of sputum. A perfect collapse of the left upper lobe was obtained and the patient was transferred to a Sanatorium at the end of September.

PRESENT HISTORY

The patient improved considerably in a Sanatorium, gaining 12 lbs in weight. The extrapleural pneumothorax is well maintained. The state of the right lung remains the same.

X-ray No.5 was taken before operation and No.6 after.

No. 5

No. 6.

Case 10. Mary Murray. Age 26 years.

The history started in 1933 with cough and haemoptysis. She was admitted to a sanatorium, and a left artificial pneumothorax induced: this, however, was unsatisfactory and was abandoned after two months. The left phrenic nerve was avulsed in December 1934. The haemoptysis continued at intervals, and she was admitted to St. Mary Abbot's Hospital in September 1938.

An X-ray showed a high left diaphragm, and several cavities in the left lung. A tomograph confirmed the presence of tuberculous cavities and it was decided to perform an extrapleural pneumothorax. Paravertebral local anaesthesia was used, and after resecting a portion of the fourth rib a satisfactory strip was obtained.

The post-operative course was uneventful, and she was transferred to a Sanatorium six weeks later.

PRESENT HISTORY

This patient was seen in April 1940 when the pneumothorax was satisfactory, and giving a good collapse. X-ray showed no evidence of tuberculous disease of the lung.

Case 11. Lilian Stanley. Age 18 years.

This patient had been ill for four years with cough and sputum.

She was admitted to St. Mary Abbot's Hospital with a large cavity in the left upper lobe and positive sputum. An attempt to induce an artificial pneumothorax failed, and it was decided to perform extrapleural pneumothorax.

This operation was carried out in September 1938 - local infiltration anaesthesia being used.

Separation was easy, but when the apex was reached the patient complained of pain, and further injection of novocain failed to relieve it: sodium evipan was administered, supplemented by gas-oxygen anaesthesia.

The patient progressed favourably after the operation, and she was discharged to a Sanatorium in October 1938.

PRESENT HISTORY

About six months later the pneumothorax showed diminution in size, and oil was injected. This stayed the obliterative process. At present the oleothorax is working satisfactorily, and the general health is fairly good.

Case 12. Bruna Zani. Age 20 years.

In January 1939 she had influenza followed by cough and an X-ray showed pulmonary tuberculosis. Three attempts to perform a right artificial pneumothorax failed, and she was sent to St. Mary Abbot's Hospital.

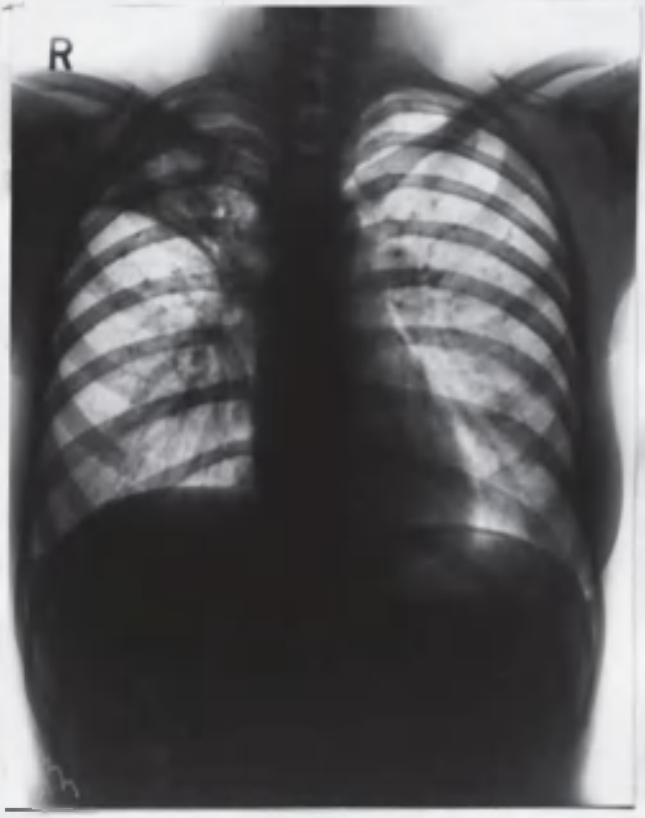
Examination revealed the presence of a large cavity in the right apex and tubercle bacilli in the sputum.

An extrapleural pneumothorax was performed with local anaesthesia and the lung stripped easily, as might be expected from recent disease. Seven weeks later she was transferred to a Sanatorium.

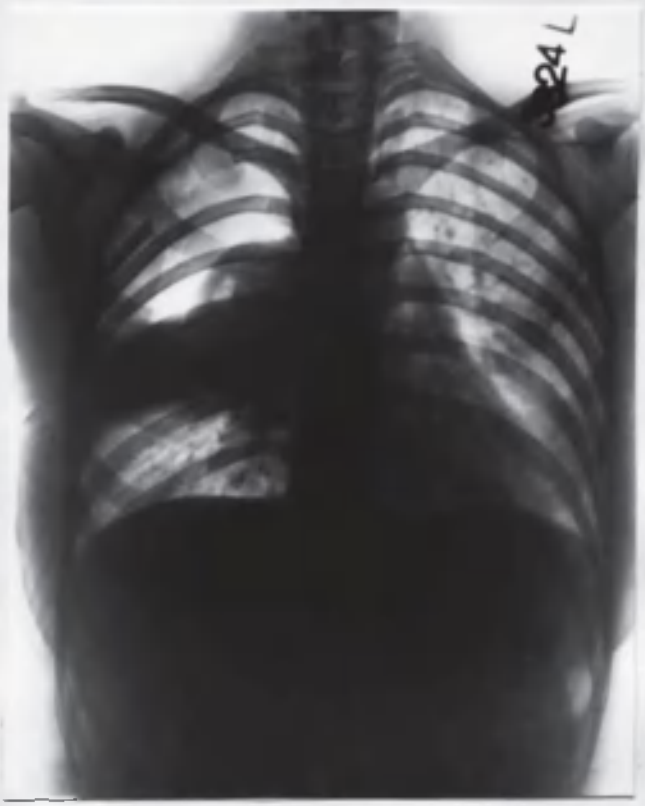
PRESENT HISTORY

Four months after operation, in October, the patient returned complaining of gastric trouble. The chest condition was very satisfactory, there being no cough or sputum. X-ray showed the pneumothorax had been maintained with no diminution in size. She is still satisfactory, there being no spread of the pulmonary condition.

X-Rays 7, 8 and 9.
No.9 was taken five months after operation. The change in the collapse of the upper lobe is striking.



No 4



No 5

Case 13. Joan Bridges. Age 15 years.

An attack of influenza in December 1938 was followed by a cough. An X-ray in February 1939 showed a large cavity in the left upper lobe while tubercle bacilli were found in the sputum. A left intrapleural pneumothorax did not succeed and she was admitted to St. Mary Abbot's Hospital for extrapleural pneumothorax. This operation was successfully performed under local infiltration anaesthesia in June 1939. No difficulty was experienced during the operation and a good collapse obtained.

A month after the operation the sputum was negative for tubercle bacilli and no cavity could be seen on X-ray examination. The patient was sent to a sanatorium five weeks after the operation.

In January 1940 she had no sputum and X-ray showed a good collapse of the left apex.

COMMENT

In view of the patient's age and the early nature of the disease thoracoplasty was not possible. She responded very well to extrapleural pneumothorax.

PRESENT HISTORY

She is still in a sanatorium, but will soon be discharged. There is no sputum and the chest is very satisfactory. The general health is excellent.

Case 14. Alphonse Rastello. Age 48 years.

In May 1938 the patient complained of cough and loss of weight. Pulmonary tuberculosis was diagnosed in August 1938 and a left artificial pneumothorax induced.

He was admitted to St. Mary Abbot's Hospital in October 1938 with a cavity in the left apex held out by adhesions. Thoracoscopy showed that the lung was directly adherent to the chest wall and extrapleural pneumothorax was advised.

In November 1938 this was attempted under local anaesthesia. The parietal pleura stripped laterally and anteriorily, but was not possible on the mediastinal aspect and the operation was abandoned.

In view of the short history it was thought that extrapleural pneumothorax would be possible but mediastinal adherence is difficult to deal with on account of the risk of tearing an important vessel.

This patient was sent to a Sanatorium to have a thoracoplasty later.

Case 15. Helena Dean. Age 26 years.

The history started in 1931 when she was diagnosed as suffering from pulmonary tuberculosis. Several periods of sanatorium treatment followed and she was admitted to St. Mary Abbot's Hospital in July 1937.

X-ray showed a large cavity at the right apex with surrounding infiltration. The heart and trachea were displaced to the right while some old infiltration was present in the left lung. The patient's general condition was not good and she was not considered well enough to stand thoracoplasty.

In spite of the long history - eight years - a right extrapleural pneumothorax was attempted. The parietal pleura could be separated with difficulty but the underlying lung was so dense and inelastic that the operation was abandoned.

The patient appeared none the worse for the operation and was transferred to a chronic tuberculous ward in another hospital three weeks later.

COMMENT

In view of the patient's poor general condition extrapleural pneumothorax was the only hope of collapsing the diseased lung, but the disease was too dense and fibrotic.

Case 16. Annie Biggs. Age 17 years.

This patient gave a short history, haemoptysis in January 1938 following severe colds. A right artificial pneumothorax was induced. This did not give a satisfactory collapse, and she was transferred to St. Mary Abbot's Hospital.

The lesion in the right upper lobe was dense in X-ray examination, and the pneumothorax only gave slight collapse.

In July 1938, under local anaesthesia, an attempt was made to perform extrapleural pneumothorax, but on account of the density of the lung tissue collapse could not be obtained, and the operation was abandoned.

In a girl it was hoped that the extrapleural pneumothorax would succeed, but this case has shown the uselessness of trying to perform the operation on dense fibrotic lesions.

This case is interesting in respect of the short history, and the dense lung disease.

X-ray No.10.

No. 9

No. 10

Case 17. Mary Agnelli. Age 25 years.

She complained of cough in January 1936, and she was diagnosed as having pulmonary tuberculosis. After some months in a sanatorium a right artificial pneumothorax was induced, and a course of sanocrysin given. The artificial pneumothorax did not collapse an apical cavity on account of the lung being directly adherent in the paravertebral groove.

She was admitted to St. Mary Abbot's Hospital in June 1937 and X-ray showed a large cavity in the right apex. The sputum contained tubercle bacilli. This patient had the first extrapleural pneumothorax in St. Mary Abbot's Hospital in July 1937.

A general anaesthetic - cyclopropane - was administered, and a very good strip obtained at operation. The septum of parietal pleura was not divided in this case. Air had to be aspirated from the intrapleural pneumothorax to prevent the septum from bulging into the wound.

The two pneumothoraces were refilled daily; the intrapleural usually required extraction of air to maintain the pressure at - 5, + 2, while the extrapleural pressure was left at about + 2 + 7.

400 c.cm. of dark blood-stained fluid was aspirated from the extrapleural pneumothorax a week after the operation.

Four weeks later it was decided to divide the septum and join the two spaces. A thoracoscope was introduced into the intrapleural space and the septum was seen bulging like the vault of the diaphragm. With an electric cautery the septum was divided as completely as possible. The septum was surprisingly thick and required considerable

effort to divide it, care having to be taken posteriorily on account of the vessels of the mediastinum.

The sputum became negative, and the patient's health much improved.

Fluid was aspirated on several occasions, but no organisms were grown on culture.

The patient was transferred to a Sanatorium in November 1937, but was readmitted in July 1938 with pus in the pleural cavity.

The fluid was turbid and contained many tubercle bacilli. Repeated aspiration and irrigation with half-strength Dakin's solution was commenced. X-ray examination showed the cavity still present in the lung. The question of thoracoplasty was raised, but this the patient refused.

A phrenic avulsion was performed and the patient again transferred to a Sanatorium.

In October 1939 the patient was transferred to a village settlement where she is now up all day and walks four miles. She has a trace of sputum and her general condition is much improved.

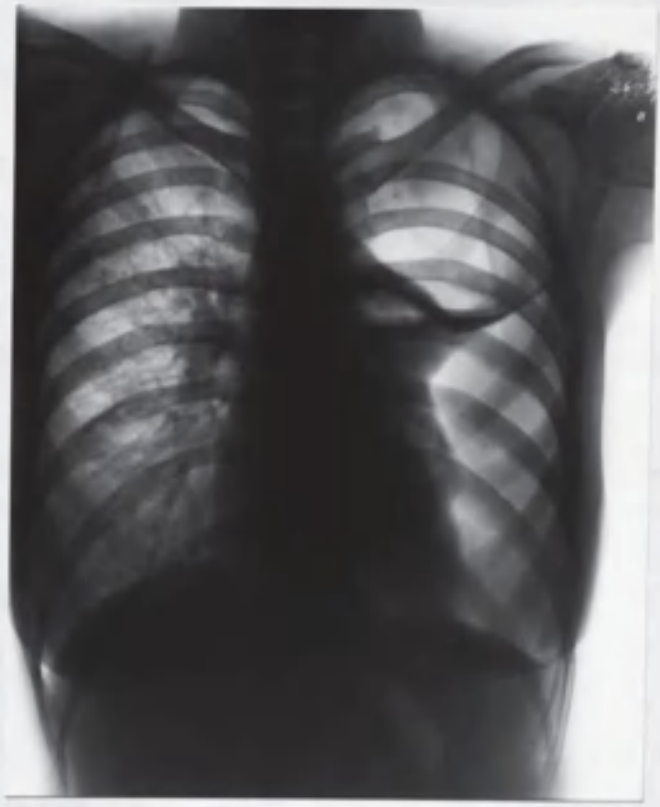
COMMENT

Tuberculous empyema is a complication following a division of the septum between intra and extrapleural spaces. This arises possibly from a superficial tuberculous nodule on the lung ulcerating into the pleural cavity. These nodular areas may be seen on thoracoscopy as greyish-white areas on the surface of the lung.

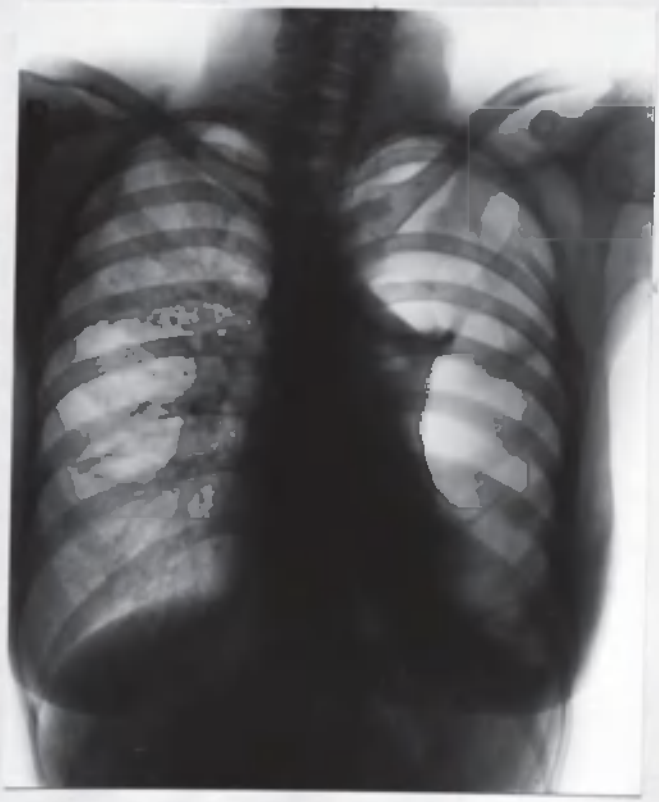
It is interesting to note that the pleural infection largely cleared up by repeated aspiration and irrigation.

This must be regarded as a favourable result in view of the patient's improvement almost three years after operation.

X-ray No.11. Shows the two pneumothorax pockets and No.12 after division of the septum.



No. 11.



No. 12.

Case 18. Grace Burnett. Age 16 years.

This girl was admitted to St. Mary Abbot's Hospital with a soft-walled cavity in the right apex, and tubercle bacilli in the sputum. She had received eight months' sanatorium treatment following the diagnosis of tuberculosis, but the sputum was increasing and the weight steadily decreasing.

As an artificial pneumothorax had not been previously attempted this was tried and a small pleural pocket discovered. To collapse the apical cavity a right extra-pleural pneumothorax was performed in November 1937. Local infiltration anaesthesia was used with success and a satisfactory strip obtained.

During January 1938 the extrapleural space was seen on X-ray examination to be diminishing in size in spite of increasingly positive pressures. Sterile liquid paraffin was injected on two occasions - first 25 c.cm. and later 30 c.cm. Three days after the second injection the temperature rose to 102° and persisted. Aspiration of the space showed the presence of pus which grew staphlococcus aureus on culture. In view of this an intercostal tube was inserted anteriorily.

The patient's general condition improved following this treatment and she was well enough to have a thoracoplasty started three weeks later. This operation was performed under gas-oxygen anaesthesia. The infection in the extra-pleural space had extended to the deeper part of the wound, and periostitis of the upper ribs made the operation difficult.

Portions of the first, second, third and fourth ribs were removed. In spite of the infection the wound healed readily. A further stage was performed six weeks later and

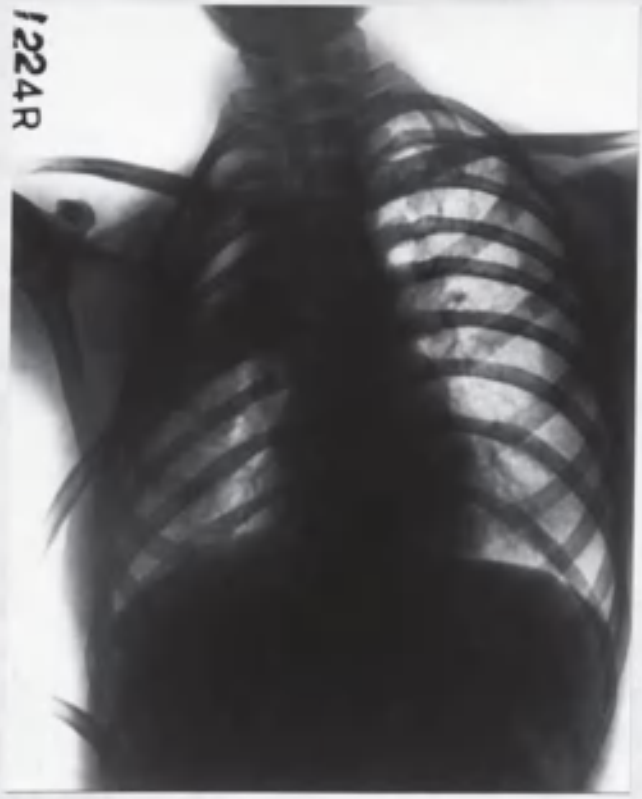
this so diminished the size of the extrapleural space that lipiodal injection showed only a narrow track. This track quickly healed and the patient was discharged to a Sanatorium with the sinus in front completely healed.

COMMENT

This patient was very suitable for extrapleural pneumothorax in view of her age, recent disease, and the thin-walled apical cavity. The complication of gradual obliteration of the extrapleural space occurred possibly due to infection which flared up after injection of oil. In view of the empyema drainage was necessary, followed by thoracoplasty in spite of the patient's age.

The result in this case is satisfactory as the patient's health has much improved.

X-ray No.13 shows the pneumothorax after drainage and No.14 after thoracoplasty. The lipiodal has not completely filled the space, but it can be seen as a narrow track.



No. 13

No. 14.

Case 19. Alice Hopkins. Age 33 years.

Haemoptysis in June 1938 took this patient to hospital where pulmonary tuberculosis was diagnosed, and a right intrapleural pneumothorax induced. The pneumothorax was soon abandoned on account of a contra-selective collapse.

She was admitted to St. Mary Abbot's Hospital in January 1939 with fairly extensive recent disease of the right apex and a moderate-sized cavity.

A right extrapleural pneumothorax was performed in January 1939. Local infiltration anaesthesia was used and a good collapse obtained. A month after operation pus containing a pure culture of pneumococci was aspirated from the extrapleural space. Drainage was instituted by insertion of a tube anteriorily after rib resection. Following this the temperature subsided and the patient's health improved. In June - five months after the extrapleural pneumothorax - a first stage thoracoplasty was performed. The third rib caused some difficulty on account of rib regeneration, but there was little evidence of the infection in the tissues. A second stage and axillary thoracoplasties were performed later.

Lipiodal injected into the sinus now showed a narrow track which quickly diminished in size and the tube was removed in January 1940.

The patient refused sanatorium treatment and comes to St. Mary Abbot's Hospital as an out-patient. The sinus has completely healed and X-ray shows a good collapse of the right apex. The sputum has been negative for tubercle bacilli since March 1939.

COMMENT

Pyogenic infection of the extrapleural space is a complication that requires early drainage as the patient's general health deteriorates rapidly. Once drainage is done the next step is thoracoplasty, but it is best to wait until the acute infection has subsided before starting.

Except for the difficulty with the third rib, part of which was removed during the extrapleural pneumothorax, no difficulty was encountered. The patient is now very well and performs her household duties without fatigue.

Case 20. Ernest Henry Brown. Age 30 years.

This patient was diagnosed as suffering from pneumonia in February 1937. Six months later he was admitted to a Sanatorium with pulmonary tuberculosis and was ordered rest. He returned to work in October 1937, but his symptoms of cough and loss of weight recurred.

X-ray examination revealed bilateral disease, most extensive on the right side. There were cavities in both apices and the disease on the left side was more recent - it seemed as though extrapleural pneumothorax might be successful. A decision was made to perform this operation on the left side, and later a thoracoplasty on the right.

An extrapleural pneumothorax was performed with combined local anaesthesia and gas-oxygen. A satisfactory collapse was obtained and the patient's general condition improved.

He was sent to a sanatorium for three months before thoracoplasty. The operation was not performed at St. Mary Abbot's Hospital, and we were notified that the patient collapsed and died after the first stage.

Case 21. Rose Robbins. Age 50.

Admitted on 29.6.37.

Two years' history of lassitude and fainting attacks. Diagnosed as pulmonary tuberculosis in April 1937 and right artificial pneumothorax commenced.

On admission the patient's general condition was not good. She had profuse sputum containing tubercle bacilli.

X-ray showed a cavity in the right apex which was not collapsed on account of adhesions.

Thoracoscopy was performed, but the adhesions were too dense for division.

On 12.8.37 a right extrapleural artificial pneumothorax was performed under general anaesthesia. The aneasthetic used was intravenous sodium evipan and cyclopropane. Stripping was difficult as the pleura was stuck in the neighbourhood of the adhesions. Small openings were accidentally made in the pleura on two occasions. However, a good strip was obtained and the pleural openings sutured.

The patient's general condition was poor following the operation and she did not rally, death occurring two days after the operation.

A post-mortem examination was held with the following findings.

The extra-pleural space contained 5 ozs of blood-stained fluid. The intrapleural space was clear. The only evidence of tuberculosis was in the right upper lobe where two large cavities were present. Marked oedema of the lower left lung was present.

Death was due to cardiac failure and pulmonary oedema.

COMMENT

This patient's age was 50 years and her general condition not good. The cavities would have resulted in death in a few months.

Division of the adhesions was the patient's best chance, but this unfortunately failed. Thoracoplasty was out of the question in view of the age and general condition.

This unfortunately was one of the early cases before local anaesthesia had been attempted. I feel sure that if this operation could have been completely carried out under local anaesthesia it would have been successful.

It will be noted that the openings in the parietal pleura were sutured. Now the whole pleural septum would be divided allowing the two spaces to communicate freely.

Case 22. Helen Dodgson. Age 38 years.

History: Onset in February 1937 with cough and pain in the chest. Period in a sanatorium with rest treatment.

Admitted: to St. Mary Abbot's Hospital on 8.2.38. The patient's general condition was good.

A large cavity was present in the left apex. The right lung did not appear involved. In view of the short history it was decided that an extrapleural pneumothorax would probably be successful.

On 17.2.38 extrapleural pneumothorax was performed under gas-oxygen and paravertebral anaesthesia. The intercostal muscle in the fourth space was divided and a good exposure obtained. The tuberculous cavity was very thin-walled and was unfortunately opened into. The surrounding area was carefully cleaned and the rent in the cavity wall sutured in several layers. The strip was completed and the wound sutured in the usual way. Aspiration of the cavity on the day following the operation gave 400 c.cm. of blood-stained fluid. For the next five days aspiration was performed and about 100 c.cm. removed on each occasion. No air was introduced as the pressures kept fairly high. The fluid removed from the pneumothorax gradually thickened in character and microscopic examination revealed more and more pus.

On 22.2.38 gram-positive cocci were found and it was decided to drain the pneumothorax which had become an empyema. An intercostal tube was inserted at the lowest point in the space, through the

axilla.
The patient's general condition had deteriorated since the operation and it became considerably worse by gross wound infection. The empyema cavity could be seen through the wound.
Blood transfusions were given, but without much effect and the patient died on 15.3.38.
A post-mortem examination was not allowed.

COMMENT

This was a very suitable case for thoracic surgery. The patient's condition was good and the disease localized to one apex. Opening into a tuberculous cavity during an extrapleural pneumothorax or thoracoplasty is a grave complication. This is the only case I have seen it occur in an extrapleural pneumothorax, but the effects in three cases of thoracoplasty have been noted. The wound broke down in all three cases and the patients' general condition poor with high, swinging temperature. None of these patients died, but it required months of infra red radiation and other treatment before the wound began to show signs of healing. In this case it was a definite mistake to close the pneumothorax cavity after the tuberculosis focus had been opened up. The pneumothorax should have been treated as an empyema from the time of the operation and a drainage tube left in the space. This would perhaps have prevented the severe wound infection and toxaemia. By leaving a drainage tube in the pneumothorax

it means abandoning the extrapleural operation. Graf leaves a tube in the extrapleural pneumothorax as a means of refilling the space and preventing surgical emphysema, not as a drain. When the empyema cavity has lost the acute infection an upper thoracoplasty can be performed and the tube removed when the space is reduced to a narrow sinus.

Case 23. Kathleen Ralph. Age 27 years.

The symptoms started in January 1938 with cough and sputum. Three months later pulmonary tuberculosis was diagnosed and she was admitted to a sanatorium where X-ray showed a cavity in the left upper zone, and some infiltration of the right apex.

The cavity increased in size, and a left intrapleural pneumothorax was induced. Adhesions prevented collapse of the cavity and she was admitted to St. Mary Abbot's Hospital in April 1939. X-ray showed very dense apical adhesions indivisible by thoracoscopy and it was decided to perform extrapleural pneumothorax.

This was done under local infiltration anaesthesia in June 1939. A good strip resulted, and the septum of parietal pleura was completely divided. A small amount of basal fluid formed, but did not require aspiration. The cavity had now collapsed and as the patient's general condition was very good she was sent to a Sanatorium less than a month after the operation.

The patient was seen eight months after the operation and X-ray showed an excellent pneumothorax for which she was having fortnightly refills.

COMMENT

This case illustrates the value of combining the two pneumothoraces and treating the space like the usual artificial pneumothorax. The recovery after the operation is shown by the rapidity with which she could be sent to the country. The patient is now attending a tuberculosis clinic for refills.

X-rays Nos. 15 and 16.

No. 15.

No. 16

Case 24. Cecil March. Age 36 years.

History: Right-sided pleural with effusion in July 1936.

Treated in sanatoria for six months. Went back to work for a year, then cough and haemoptysis started.

The patient was a powerful-looking man in fairly good condition.

Examination of the chest revealed the presence of a cavity in the right upper lobe.

X-ray showed a large cavity in the right apex with no evidence of disease in the opposite lung.

An ounce of sputum containing tubercle bacilli was brought up daily.

In view of the history of pleural effusion an artificial pneumothorax was not attempted.

Operation: A right extrapleural pneumothorax was performed on 31.3.38. The operation was carried out completely under local anaesthesia, skin infiltration and paravertebral injections being used.

In this case instead of resecting one rib only about half-an-inch of the third and fourth ribs were removed and the intercostal muscle in the third interspace incised. This gave a good exposure, but the question was would it give such an efficient closure?

A good strip was obtained without difficulty.

Pericostal sutures were inserted and the muscle and skin sutured in the usual way.

Immediately after operation 800 c.cm. of air was introduced into the space.

Larger amounts of air than usual had to be given in this case, on the day following the operation

200 c.cm., then 100, 160 and 300 c.cm. were given on subsequent days.
The sputum was negative for tubercle bacilli on 11.4.38.
The patient was allowed home on 2.5.38 and has been attending a tuberculosis dispensary since for refills.

COMMENT

This patient would have been a suitable case for upper thoracoplasty, but when it was suggested to him he refused. He, however, consented to have the smaller operation of extrapleural pneumolysis. The local anaesthesia worked well in this case. The paravertebral anaesthesia is, I think, a rather hit or miss type of anaesthetic and is not so good as direct injection into the intercostal spaces.

The method of opening the chest wall used in this case gave rather a better exposure, but not such a good closure as is shewn by the large refills that were necessary.

This case illustrated that once the patient has recovered from the operation and the extrapleural space is dry, dispensary treatment can be started.

PRESENT HISTORY

The Tuberculosis Officer complains that this patient is most infrequent in attendance at the Dispensary. Refills were given at such long intervals that the extrapleural space became too small for refilling to be possible, and the pneumothorax was abandoned.

The patient was last seen in June 1939 when he was symptomless, and his general condition fairly good.

Case 25. Kathleen Lynch. Age 24 years.

History: Onset of illness in 1937 and admitted to sanatorium. A right artificial pneumothorax was induced and partial collapse of the lung obtained.

Admitted to St. Mary Abbot's Hospital on 18.3.38 with large cavity in right upper lobe which was not collapsed by a partial pneumothorax.
The X-ray appearance did not hold out any hope for satisfactory collapse of the apex by thoracoscopy and cauterization of adhesions.
Extrapleural pneumothorax was performed on 31.3.38 under gas-oxygen anaesthesia. Access was obtained by resecting about an inch of the fourth rib at the angle and incising the intercostal muscle in the third space. A thin pleura was torn and the opening enlarged as widely as possible.
On the evening of the day following the operation the patient appeared distressed and complained of tightness in the chest. X-ray showed a large collection of fluid in the pneumothorax.
Aspiration was carried out every third day and as much as 570 c.cm. of blood-stained fluid removed.
Subsequent progress was satisfactory and the patient was discharged to a sanatorium on 30.4.38.

COMMENT

An excellent case for extrapleural pneumothorax with primary septal section. The large amounts of fluid aspirated was probably due to pleural exudation from irritation by blood.

PRESENT HISTORY

Shortly after admission to a Sanatorium, tuberculous pus appeared in the pneumothorax and pleural wash-outs were started. In April 1939 she was discharged, her health being fairly good, and there were no troublesome symptoms. She reported recently, and the pneumothorax is still present, though somewhat reduced in extent. The sputum is negative and there is no evidence of spread of the disease.

Case 26. Gertrude Bayne. Age 40 years.

Onset in December 1936 with cough and sputum.

Haemoptysis in April 1937 and attempt at right artificial pneumothorax failed.

Admitted to St. Mary Abbot's Hospital on 21.9.37 with positive sputum and cavitation at the right apex.

An extrapleural artificial pneumothorax was performed on 30.9.37 under cyclopropane anaesthesia. A piece - 4 inches - of the fourth rib was resected and a fairly good strip obtained. The pleura was adherent at the mediastinum and as the pulse rate which had remained at 80 went up to 136 whenever this region was touched, further stripping there was abandoned.

The pressures were maintained at + 5, + 15 by introducing from 20 to 100 c.cm. of air.

Seven sputum examinations were carried out after operation and all were negative.

Transferred to a sanatorium on 23.11.37 with a most satisfactory result.

PRESENT HISTORY

This patient's general condition is reported by the tuberculosis officer as excellent. She has no symptoms and no sputum. The pneumothorax was discontinued in October 1939 when she left London for the country shortly after the outbreak of war.

Case 27. Dorothy Sage. Age 19 years.

A persistent cough and loss of weight followed by a slight haemoptysis in May 1937 made the patient attend a hospital where pulmonary tuberculosis with cavitation in the left apex was diagnosed. An intrapleural pneumothorax was induced, but dense adhesions held out the upper part of the lung. Thoracoscopy showed a very thick system of adhesions indivisible by cauterization.

In November 1937 a left extrapleural pneumothorax was performed and a good strip obtained.

Local infiltration anaesthesia was used and the patient complained of discomfort but no actual pain. The septum of parietal pleura was not divided at the operation. Afterwards pressures were taken of both pneumothoraces, air usually having to be removed from the intrapleural, and small quantities added to the extrapleural spaces. Two months later the pleural septum was divided by thoracoscopy. Several active tuberculous foci were seen on the visceral pleura and soon fluid containing tubercle bacilli was being aspirated from the pleural cavity.

Pleural wash-outs were started and the patient was transferred to a Sanatorium to continue this treatment.

Her general health much improved and she was allowed home in October 1938 to attend a tuberculosis dispensary.

PRESENT HISTORY

The Tuberculosis Officer reports that this patient is well. She has no cough or sputum and the weight is steady. Refills were stopped in January 1939, the reason not being given.

Case 28. Elizabeth Donovan. Age 37 years.

This patient had a long history starting in 1929 with cough and haemoptysis. She was diagnosed as suffering from pulmonary tuberculosis, and admitted to a sanatorium for eight months. After a short period of work the symptoms recurred and she was re-admitted. A right artificial pneumothorax was attempted but failed. During the next eight years the patient was in ten different hospitals and sanatoria.

She was admitted to St. Mary Abbot's Hospital in 1938 with a large cavity in the right apex and positive sputum. In October 1938 a right extrapleural pneumothorax was performed with paravertebral anaesthesia. The strip was fairly easy, part of it being in the extrafascial plane.

The post-operative course was uneventful and the patient was discharged to a sanatorium four weeks after operation.

X-ray showed a good collapse and the sputum was negative on discharge.

This case is interesting in view of the long history: i,e., nine years.

PRESENT HISTORY

On 1.4.1940 this patient still had the extrapleural pneumothorax, but it was reduced in size. Pus containing tubercle bacilli is withdrawn from the space at intervals. The sputum is negative and the patient can attend to her household duties. In view of a recent slight temperature she has been recommended for a further period of Sanatorium treatment.

Case 29. Valentine Adams. Age 25 years.

The history started in 1935 with cough and loss of weight. At first she refused sanatorium treatment, and attended a tuberculosis dispensary. An artificial pneumothorax was tried but failed. A right phrenicectomy was performed, and a course of Sanocrysin given.

She was admitted to St. Mary Abbot's Hospital for a right upper thoracoplasty. A further attempt to induce a right artificial pneumothorax failed and the question arose whether to do an extrapleural pneumothorax or a thoracoplasty. After consideration it was decided to try the extrapleural pneumothorax.

This was done in January 1939 under gas-oxygen anaesthesia, and in spite of a four years' history an easy strip resulted. During the operation the azygos vein was torn and ligatured.

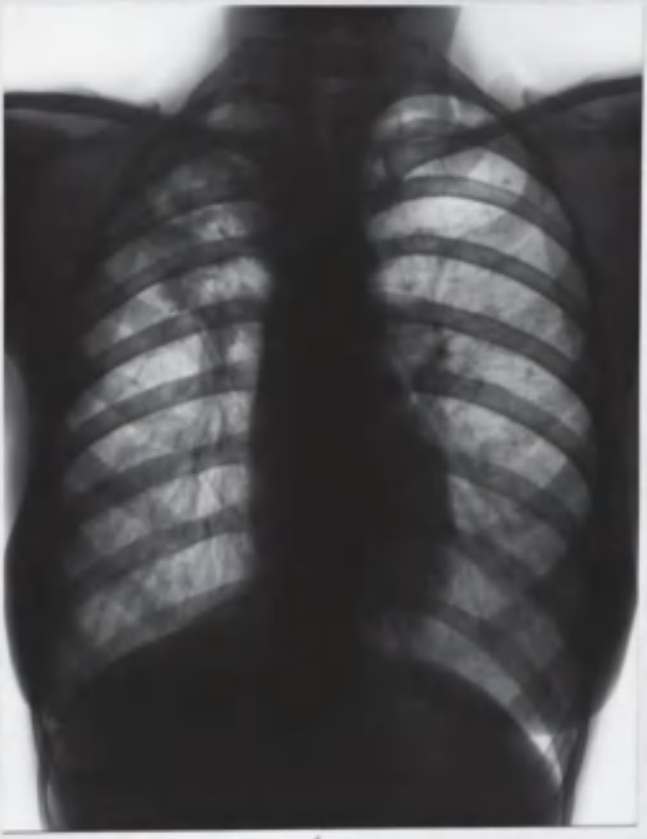
The patient made an uninterrupted recovery, and was discharged to a sanatorium three weeks after the operation.

The sputum was negative before and after the operation.

PRESENT HISTORY

She made good progress during the first eight months at a sanatorium, but, following a cold, developed pus in the pneumothorax. The pus contained tubercle bacilli. Now there is little fluid in the pneumothorax and it is sterile. She will shortly be allowed home to attend a tuberculosis dispensary. The sputum has been negative during her stay in the sanatorium, and X-ray shows the right apex collapsed.

X-ray Nos. 17 and 18.



No. 14.

No. 15.

Case 30. Joan Dixon. Age 21 years.

Her history started in 1926 with pleurisy, and three years later, at the age of 12, she was suspected of having pulmonary tuberculosis. She was under dispensary care for four years.

During a medical examination in 1934 a cavity was found in the lung, and a period of sanatorium treatment started. A right phrenicectomy was performed and a course of sanocrysin given.

For a period of three years she led an active life, working as a hairdresser, skating and swimming.

In 1938 she complained of not feeling well, and an artificial pneumothorax was attempted without success.

She was admitted to St. Mary Abbot's Hospital in December 1938, with a large cavity in the base of the right lung.

It was decided to perform a basal extrapleural pneumothorax under local anaesthesia. A portion of the eighth rib was resected through a posterior incision, and the lung stripped from the chest wall, diaphragm and lower mediastinum.

The operation presented no technical difficulties and the lower lobe was well freed. Immediately after the wound was sutured - 200 c.cm. of air was injected.

The basal cavity diminished considerably in size, but unfortunately fluid infected with tubercle bacilli formed in the extrapleural space. Irrigation was started, and the patient was transferred to a sanatorium to continue this treatment.

PRESENT HISTORY

She was discharged from the sanatorium in September 1939, and attended a tuberculosis dispensary, where she has put in attendance at infrequent intervals. Her general condition is good, and she has recently been married.

X-ray. No.19.

Case 31. Rose Connolly. Age 35 years.

Following influenza in 1937 this patient had a cough and loss of weight. Eighteen months later her chest was X-rayed and pulmonary tuberculosis diagnosed.

She was admitted to St. Mary Abbot's Hospital in February 1939 with a right intrapleural pneumothorax, the apex being held out by adhesions. A cavity was present in the apex and the sputum was positive for tubercle bacilli.

Thoracoscopy failed to divide the adhesions on account of their density.

An extrapleural pneumothorax was performed in March 1939 and the septum of parietal pleura divided. A good collapse resulted and the patient was transferred to a Sanatorium in May 1939. She was discharged in September 1939 fir for her household duties.

PRESENT HISTORY

She is now attending a Tuberculosis Dispensary, refills being given every three weeks. The pneumothorax is being maintained satisfactorily, but the sputum is still positive. Her general condition is moderately good.

Case 32. Pamela Yates. Age 18 years.

The patient's family gave a history of pulmonary tuberculosis. Complaining of cough she was X-rayed in September 1938 and tuberculous infection of the right lung diagnosed. An artificial pneumothorax was induced, but a satisfactory collapse prevented by apical adhesions. Thoracoscopy revealed a mass of adhesions indivisible by a cautery.

A right extrapleural pneumothorax was performed in June 1939. The operation was commenced under local anaesthesia, but as the patient became excitable chloroform was given on an open mask. A good strip was obtained and the intra and extrapleural spaces were made to communicate. After the septum was divided several adhesions to the lower lobe were cut with a cautery. The operation gave an excellent collapse of the left lung.

On admission to St. Mary Abbot's Hospital some disease was also seen in the left side. This increased after the extrapleural pneumothorax, and a cavity became demonstrable. In July 1939 a left intrapleural pneumothorax was induced. Fluid now appeared in the right pleural cavity, and examination showed it to be infected with tubercle bacilli.

The patient's general condition deteriorated, and she was transferred to another hospital.

Case 33. Ellen Larkin. Age 21 years.

Admitted to hospital in April 1938 with cough and streaking of sputum with blood.

The upper half of the right lung showed tuberculous infiltration and in July 1938 an intrapleural pneumothorax was induced. This collapsed the base, but left the apex untouched on account of the direct adherence of the lung to the chest wall.

The pneumothorax was allowed to come out and she was transferred to St. Mary Abbot's Hospital in July 1939. A right extrapleural pneumothorax was performed in August 1939 without difficulty under local infiltration anaesthesia. As no intrapleural pneumothorax remained and the base of the lung was not affected the parietal pleura was not incised.

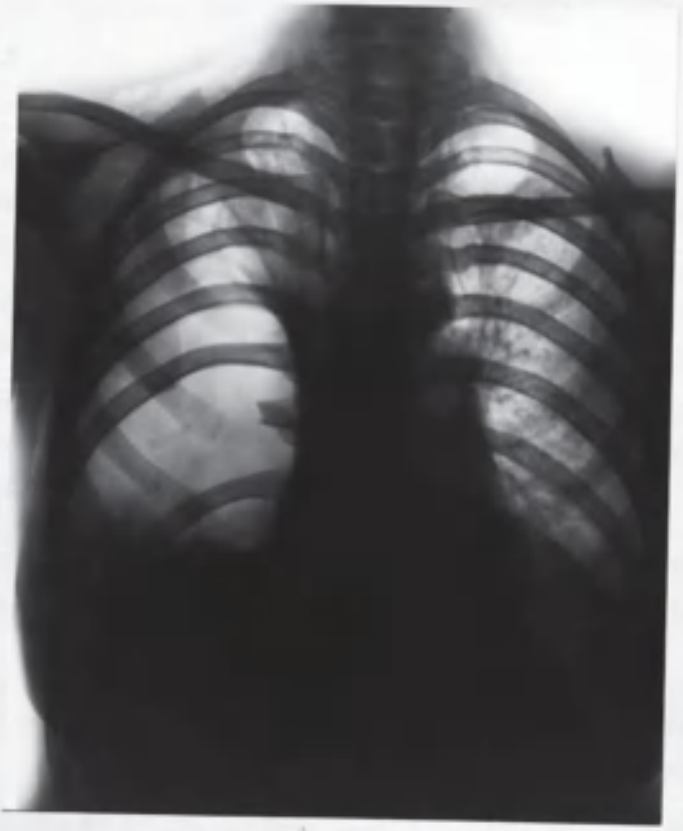
This patient improved considerably after operation; she gained weight and the sputum became negative. X-rays showed collapse of the apical cavity.

She lives close to the Hospital, and has been attending weekly for refills. She did not go to a Sanatorium after operation.

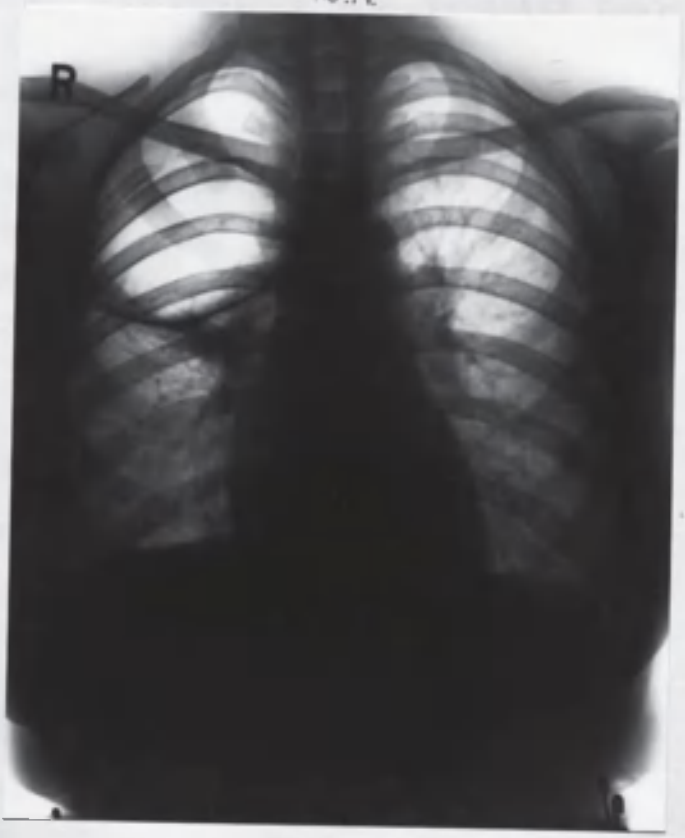
PRESENT HISTORY

For the past four months this patient has been working normally and there has been no spread of the disease. The pneumothorax space is maintained by weekly refills. The general health is excellent and the weight is stationary.

X-ray No.20 was taken six months after operation.



No. 19



No. 20.

Case 34. John Sewell. Age 16 years.

Cough started in February 1938, followed by tiredness and night-sweats. Six months later he was admitted to Hospital and X-ray showed bilateral tuberculosis with a large cavity in the left apex. A left intrapleural pneumothorax was induced in August 1938, but adhesions prevented collapse of the cavity. Thoracoscopy succeeded in cutting some of the adhesions, but they were too dense for complete division.

A left extrapleural pneumothorax was performed and made to communicate with the intrapleural pneumothorax by wide division of the parietal pleura septum.

Unfortunately the visceral pleura contained a number of tuberculous nodules - one about the size of a sixpence was on the point of perforating. This nodule was gently swabbed away. The patient went downhill rapidly after operation, the cough became worse and pyrexia developed. Fluid formed in the pneumothorax and at first examination showed no organisms. The fluid quite suddenly became infected with staphlococcus aureus and the patient died. No post-mortem was possible, but death was probably due to an extension of tuberculous lesion in the lungs and secondarily infected pneumothorax.

X-ray No.21 shows the rapidly spreading disease in left upper zone.

No.22 was taken after operation.

No. 21.

No. 22

Case 35. Edith Dennis. Age 26 years.

Haemoptysis started this patient's symptoms in 1937. A left artificial pneumothorax was induced, but fluid quickly appeared and refills were discontinued.

She was admitted to St. Mark Abbot's Hospital in February 1939 with cough and sputum containing tubercle bacilli. X-rays showed fairly active disease of the left apex, but no pneumothorax or fluid.

A left extrapleural pneumothorax was performed in March 1939 under gas-oxygen anaesthesia. Some tough adhesions were found at the apex, but separation was possible, except at the mediastinum, and a limited collapse only obtained.

She was transferred to a sanatorium at the end of April 1939.

PRESENT HISTORY

Her general condition is very good. There are no abnormal physical signs in the chest and the pneumothorax is well maintained.

The pulse and temperature are normal and she has recently gained 7 lbs in weight.

Case 36. Ellen Watts. Age 25 years.

In November 1937 she complained of loss of appetite and diminishing weight. Attendance at a tuberculosis dispensary revealed pulmonary tuberculosis. An X-ray at this time showed bilateral infiltration, with a large fluid-containing cavity in the left supraclavicular region. The cavity appeared to diminish in size and a year later (January 1939) a left intrapleural pneumothorax was induced. Many adhesions prevented satisfactory collapse of the apical cavity. Thoracoscopy and division of adhesions was performed, but several short dense bands close to the subclavian vessels were not touched.

In June 1939 a left extrapleural pneumothorax was performed under local anaesthesia. During the strip parietal pleura was opened, and when sufficient collapse obtained, it was divided allowing free communication between the intra and extrapleural spaces.

A month later a left phrenic crush was performed and the patient sent to a Sanatorium, with sputum now negative for tubercle bacilli.

PRESENT HISTORY

She is still in the sanatorium as her home conditions are unsatisfactory.

The last positive sputum was in July 1939. Her health is excellent and the pneumothorax is satisfactory.

Case 37. Joan Fuggle. Age 15 years.

This girl was healthy until March 1937 when she had a cold followed by lassitude, loss of weight, and night sweats.

In June 1937 she had a severe haemoptysis, and was admitted to hospital where a left artificial pneumothorax was induced, but an inadequate collapse resulted.

She was admitted to St. Mary Abbot's Hospital in March 1938, and an X-ray showed a large cavity in the left upper lobe.

In April 1938 an extrapleural pneumothorax was performed under local anaesthesia (infiltration). Except for an area at the apex, the strip was easy, and the intra and extrapleural pneumothoraces were made to communicate by dividing the partition of parietal pleura.

Twenty-four hours after the operation the patient collapsed, and presented the appearance of severe internal haemorrhage. A continuous intravenous drip saline was started within a few minutes, and a pint of citrated blood given as soon as it was available. A needle was inserted into the pneumothorax, but no swing registered on the manometer. Aspiration withdrew clotted blood which repeatedly blocked the needle.

The patient obviously had a large haemorrhage into the pneumothorax space. The haemoglobin was 58% four days after the collapse, but it rapidly increased on intensive iron therapy. Attempts to find an air space failed for two months, but eventually a needle introduced high up in the back was successful, and refills restarted.

The patient's general health was good, and she was transferred to a sanatorium.

Perhaps a trocar and cannula should have been inserted and the blood clot removed by powerful suction.

PRESENT HISTORY

After leaving the sanatorium she attended a tuberculosis dispensary where weekly refills were given. The tuberculosis officer reports that she was in good health when he last saw her a few months ago. She has transferred to the country.

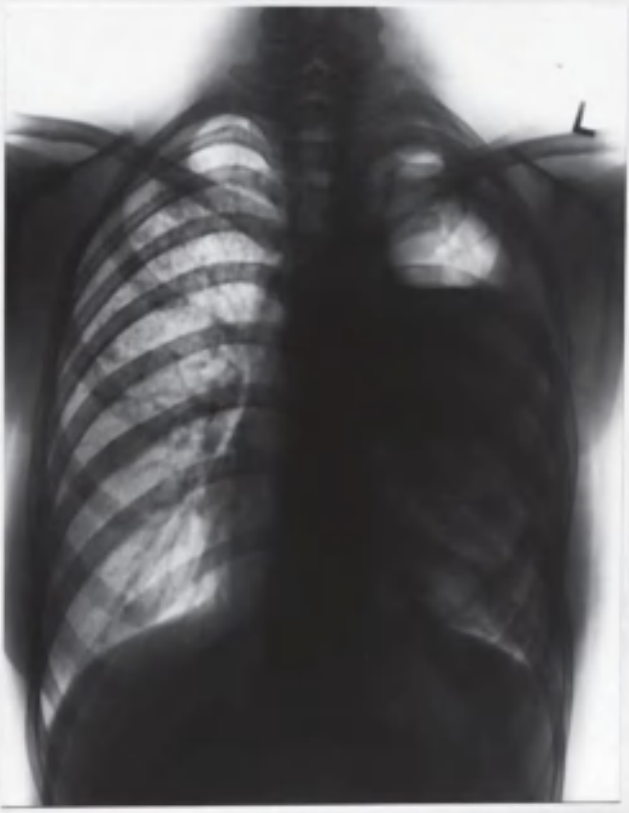
X-rays Nos.23, 24 and 25.

No.24 was taken after haemorrhage into the pneumothorax.

No.25 shows the pneumothorax four months later.

No. 23.

No. 24.



No. 95.

Case 38. Ellen Barrett. Age 46 years.

Onset in 1934 with cough and breathlessness which lasted until 1937 when she was examined by a doctor. The sputum was positive for tubercle bacilli, and an artificial pneumothorax induced.

The pneumothorax was not satisfactory, and after some months it was abandoned.

She was admitted to St. Mary Abbot's Hospital on 26.6.1938 with extensive tuberculous infection of the left apex and cavitation.

On 11.8.1938 a left extrapleural pneumothorax was performed under general anaesthesia - cyclopropane being used. A portion of the third rib was excised, and the strip was performed without difficulty. 200 c.cm. of air were given on the operating table.

This patient progressed very well after the operation and she was discharged to a Sanatorium on 16.9.38.

PRESENT HISTORY

In January 1940 the patient ceased working on account of ill health. A specimen of sputum, at this time, showed tubercle bacilli. She was readmitted to a sanatorium on February 12th and has responded readily to treatment.

The sputum is now negative for tubercle bacilli and the pneumothorax is satisfactory.

Case 39. Ivy Marney. Age 24 years.

History: Influenza in September 1936 followed by cough. Two months later she had haemoptysis, then lassitude, night sweats and loss in weight. An attempt to induce a right artificial pneumothorax failed.

Admitted to St. Mary Abbot's Hospital on 17.12.37. Examination revealed fibro-cavernous disease of the right upper lobe.

The patient's general condition was good, but in view of the comparitively short history it was decided to perform an extrapleural pneumothorax. This was carried out on 10.2.38 and a good strip obtained without difficulty. Some enlarged glands were found in the extrapleural tissues and they were carefully removed without contaminating the wound. The entire operation was performed under local anaesthesia.

The patient soon recovered from the operation and was discharged on 18.3.38.

COMMENT

This was an ideal case for extrapleural pneumothorax and an excellent result obtained. Where enlarged glands are found in the operative field they may be removed, as there is the risk of disseminating the tuberculous infection should the glands rupture.

PRESENT HISTORY

She was discharged from the sanatorium in July 1938, fit for her household duties.

She is free from symptoms.

Case 40. Violet Hill. Age 20 years.

General malaise and severe cough commenced in November 1938, but it was not until March 1939 that a diagnosis of pulmonary tuberculosis was made. A left intrapleural pneumothorax was induced, but the large cavity in the upper zone was held out close to the chest wall.

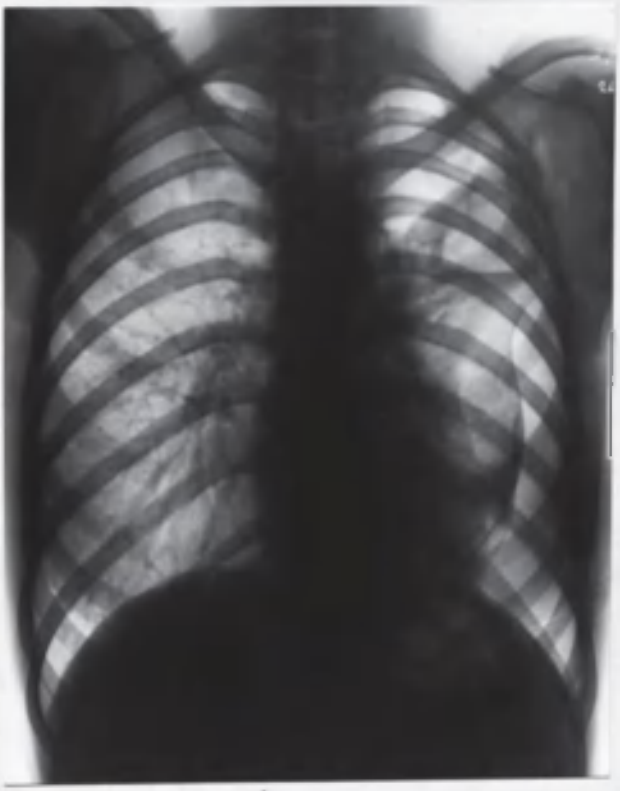
Thoracoscopy at St. Mary Abbot's Hospital showed that the lung was directly adherent to the chest wall. Actually that area of adherence was localized to one area about two inches in diameter.

It was decided that this was a suitable case for localized extrapleural separation.

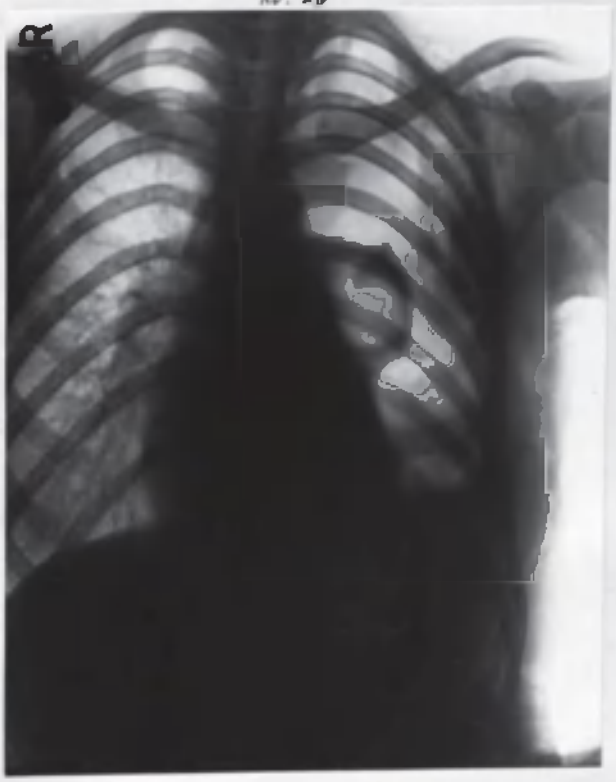
Local anaesthesia was used, and an incision made in the axilla. A portion of the second rib was resected, and the extrapleural strip was performed with ease. After the parietal pleura was separated over the adherent area, it was divided circularly close to the lung. This was the first of this particular kind of operation I performed, and I was impressed by the ease with which the procedure could be carried out as compared to an open division of adhesions.

The cavity in the lung slowly collapsed and cannot be seen on recent X-ray examination.

X-ray Nos. 26 and 27.



No. 26



No. 27.

Case 41. Jessie Craze. Age 36 years.

Following the birth of her second child in 1938 she had a slight haemoptysis. Bilateral apical tuberculosis was diagnosed and a period in a Sanatorium followed. She attended a tuberculosis dispensary from October 1938 to January 1940 when she was admitted to St. Mary Abbot's Hospital.

X-ray showed bilateral disease, the left side more recent than the right.

Several thin-walled cavities were present in the left apex while the right upper lobe showed fibro-cavenous disease with the fibrosis predominating.

About two ounces of sputum containing tubercle bacilli were brought up daily.

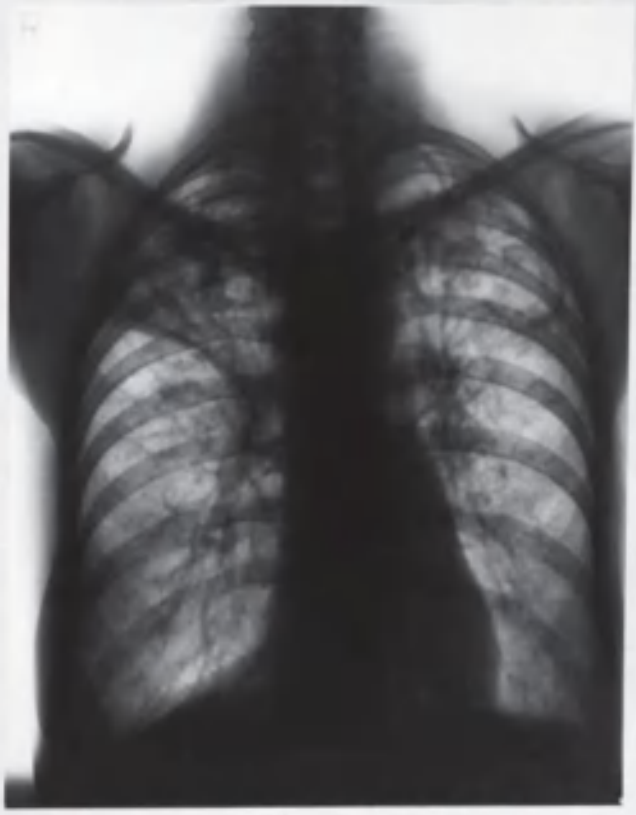
After discussion it was decided to perform extra-pleural pneumothorax on the left side, and if this was successful to do a thoracoplasty on the right side.

Using local anaesthesia only, a very good pneumothorax was obtained after removing a portion of the fifth rib.

The operation was performed on the 16th February 1940 and the patient has improved in health since.

An upper stage thoracoplasty will be performed in May or June. The disease on the right side looks too fibrous for a bilateral extrapleural pneumothorax.

X-rays Nos. 28 and 29.



No. 28.

No. 29.

Case 42. Kitty Thurgood. Age 31.

A cough started in March 1939 and was followed by loss of voice two months later.

A left intrapleural pneumothorax was induced, but a large apical cavity remained held out by dense adhesions.

Thoracoscopy in February 1940 at St. Mary Abbot's Hospital showed indivisible adhesions. The cavity appeared rather thick-walled, and the question of thoracoplasty or extrapleural pneumothorax was discussed.

The latter was decided upon, as the patient had no desire for thoracoplasty if it could possibly be avoided.

Performed under local anaesthesia in February 1940 the extrapleural pneumothorax was difficult on account of dense adhesions. It was, however, possible to make them into a bundle by stripping around, and as they were not near important structures, division was performed with a scalpel.

The parietal pleura was divided, and one pneumothorax constituted.

The cavity is closing very slowly and to hurry matters a bronchial balloon may be inserted according to the technique of Brookes.

RESULTS

Forty-two cases of extrapleural pneumothorax have been performed at St. Mary Abbot's Hospital.

If the recent operations and the three cases where a pneumothorax could not be established at operation are excluded, this leaves thirty-six cases to follow up.

These thirty-six operations were all performed between July 1937 and August 1939.

The following table gives the results of the surviving cases.

Number of case	Length of time since operation	General Health	State of Pneumothorax	Sputum now + or -
1	2 yrs. 3 mths.	Good	Satisfactory	-
2	2 yrs. 6 mths.	"	"	-
3	1 yr. 6 mths.	"	"	-
4	2 yrs. 3 mths.	Fair	"	+
7	1 yr. 10 mths.	Good	Refills discontinued	-
8	1 yr. 6 mths.	"	Satisfactory	-
9	1 yr. 8 mths.	"	"	-
10	1 yr. 7 mths.	"	"	-
11	1 yr. 7 mths.	"	Oleothorax	-
12	1 yr.	"	Satisfactory	-
13	10 mths.	"	"	-

17	2 yrs. 9 mths.	Good	Satisfactory	Occasional +
18	2 yrs. 6 mths.	"	Olecthorax followed by Thoracoplasty	-
19	1 yr. 3 mths.	"	Thoracoplasty	-
20	10 mths.	"	Satisfactory	-
24	2 yrs. 2 mths.	Fair	Obliterated	+
25	2 yrs. 2 mths.	"	Reduced in size	-
26	2 yrs. 7 mths.	Good	Refills discontinued	-
27	2 yrs. 6 mths.	"	Refills discontinued	-
28	1 yr. 7 mths.	Fair	Reduced in size	-
29	1 yr. 3 mths.	Good	Satisfactory	-
30	1 yr. 4 mths.	Good	Reduced in size	-
31	1 yr.	Fair	Satisfactory	+
32	10 mths.	Poor	Infected	+
33	9 mths.	Good	Satisfactory	-
35	1 yr.	"	"	-
36	10 mths.	"	"	-
37	2 yrs.	"	Reduced in size	-
38	1 yr. 8 mths.	"	Satisfactory	-
39	2 yrs. 2 mths.	"	Reduced in size	-

Good results have been obtained in twenty-two out of the thirty-six cases giving a percentage of sixty-one. In four of these cases the pneumothorax is reduced in size

while in three refills have been discontinued, one or two years after operation.

Oleothorax has only been instituted twice and one of the cases had a thoracoplasty later. Compared to American and Continental custom this is a very small number of oil replacement.

Six of the patients died.

No. of Case	Cause of Death	Length of time after operation.
5	Severe Mental Disorder and spread of Lung Condition	18 months.
6	Infection in opposite lung	10 months.
20	Thoracoplasty on opposite side	4 months.
21	Cardiac Failure	2 days.
22	Opening of Tuberculous cavity at operation	1 month.
34	Spread of Pulmonary Tuberculosis and infection in pneumothorax	1 month.

There were therefore three deaths shortly after operation giving an early mortality of 8.3%.

If all the forty-two operations are taken into account the post-operative mortality is 7.1%.

Pus containing tubercle bacilli was demonstrated in the pneumothorax in eight cases with the following results.

No. of cases	Infection cleared	Infection still present	Health Satisfactory
8	5	3	7

All these cases were treated with pleural lavage, saline or Dakin's solution being used.

An interesting comparison is between the results following extrapleural pneumothorax alone and combined intra and extrapleural pneumothorax.

	No. of Cases	Pneumothorax still present
Extrapleural Pneumothorax	21	15
Combined Intra and Extra-pleural pneumothorax	9	8

Only one case of the combined pneumothorax has obliterated and this was done by stopping the refills fifteen months after operation.

CONCLUSIONS

Extrapleural pneumothorax is a valuable addition to the methods of surgical collapse in pulmonary tuberculosis.

Care must be exercised in selecting the right type of case, and though extrapleural pneumothorax is not intended to replace thoracoplasty it will in a number of cases give a good result where previously thoracoplasty would have been attempted.

Cases of early active disease, or tuberculous pneumonia, should not be treated by extrapleural pneumothorax, as there is a risk of spread of infection. In this type of infection there is more bleeding, and tuberculous fluid may be found outside the parietal pleura during the operation. An early severe infection of the pneumothorax may spread to the wound and give rise to a cutaneous fistula.

When cavitation has appeared, and the lesion is less active but still unstable, extrapleural pneumothorax is to be preferred to thoracoplasty.

Extrapleural pneumothorax has largely replaced plombage (or the introduction of wax).

Oleothorax is still used as a primary procedure by some surgeons, but the majority prefer to perform extrapleural pneumothorax and, if the space shows signs of diminishing, introduce oil to hold the lung down. Oleothorax may also be instituted for tuberculous infection of the extra-

pleural space.

There is no doubt that a number of cases of extra-pleural pneumothorax will have a thoracoplasty performed at a later date. These patients will be in a better physical condition to stand the extensive rib resection, and unless the lung has re-expanded will not require apical collapse by the Semb method.

The results given in the literature after a period of one or two years is 55 - 70 per cent of successful cases. At St. Mary Abbot's Hospital, 61 per cent showed good results in cases operated upon during the period July 1937 to August 1939.

In view of the fact that many operations are performed in fairly ill patients these results must be looked upon as very satisfactory.

COMMENTS ON LITERATURE

The authors are enthusiastic about extrapleural pneumothorax, but a number state that it must not replace thoracoplasty, and should only be used for the recent unstable type of disease. On the other hand some continental surgeons perform extrapleural pneumothorax in preference to thoracoplasty.

It is, however, agreed that extrapleural pneumothorax has not been given a long enough trial to warrant dogmatic opinions in regard to the indications.

The value of the operation in cases of bilateral pulmonary tuberculosis is stressed - either bilateral extrapleural pneumothorax or some other method of collapse on one side, and extrapleural pneumothorax on the other.

Children and young adults should not have thoracoplasty in view of the scoliosis and resulting deformity; extrapleural pneumothorax is recommended in the young.

It is the practice of a number of surgeons to have the patients sitting during the operation. Local anaesthetic is injected into the extrapleural space several times during the operation by Paul Geary.(21) Everingham (17) injects saline into the space, and removes it forty-eight hours later, the object being to hold the lung down and minimize post-operative bleeding.

All modern authors agree that a liberal collapse must be obtained for the operation to be a success. Roberts[61] mentions two cases in which he performed a second extra-pleural strip on the same side with success. The majority of surgeons, however, state that oil should be injected if the pneumothorax space is becoming obliterated.

Villegas[74] and Nissen[52] state that the operation is easy on the patient and surgeon; there are a number of complications, but the incidence of serious trouble is small.

Everingham[17] reports a case of cerebral air embolism during refill - the symptoms, however, passed off within a few minutes.

Leaving a catheter in the space at the end of the operation has been given up by most of the surgeons who adopted the method of Graf, the risk of infection being too great.

Nissen[52] reports one serious case of surgical emphysema; other authors state that the emphysema is usually only slight.

A post-mortem performed on a case ten days after operation, reported by Geary,[21] showed a fibrous capsule two millimetres thick surrounding the extrapleural space. Geary[21] also describes two cases of basal extrapleural pneumothorax.

A medical extrapleural pneumothorax is mentioned by Villegas.[74]

Jean Chenebault[13] reports 115 cases of extrapleural pneumothorax - the operations were performed by well-known French surgeons, with the following results:

45 favourable results
21 incomplete results.

These were grouped together and called satisfactory with a percentage of 53.3. The bad results (42.7%), consist of cases where the pneumothorax has obliterated or the patient has died.

In two recent American reports[36, 39] the following results are given:

1. Forty-seven patients had fifty extrapleural pneumothorax pockets established. The lung cavities were closed and the sputum rendered negative in 72.3% of the cases. The remaining cases had residual positive sputum. This report also describes three successful cases of bilateral extrapleural pneumothorax.

2. Twenty-one cases operated upon twelve to eighteen months previously were mentioned. Of these cases 61% had good results: that is, closure of cavities and improved health.

Maurer and Saritsch[45] report 78 operations at the

Hospital, Paris.

40% showed excellent results.
30% good or improved results.

They give a high percentage of haemorrhage into the pneumothorax - 20%.

In six cases the operation could not be completed. Their late mortality is high, possibly due to poor after-treatment.

Nissen[52] states that he was the first to re-introduce the operation and after nine years' experience thinks that thoracoplasty and plombage are superior to extrapleural pneumothorax.

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