SURGICAL COLLAPSE THERAPY IN PULMONARY TUBERCULOSIS

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History

The lethal lesion in pulmonary tuberculosis is the tuberculous cavity. Persistent patency of a cavity after operation gives rise to a persistent positive sputum, this in its turn has a direct influence on the expectation of life (Grenville-Mathers and Trenchard, 1952).

The value of collapse therapy in enabling tuberculous cavities to close, was pointed out by Foralini when artificial pneumothorax therapy was introduced. Tuffier (1895) and Sauerbruch (1920) were pioneers in the introduction of surgical methods designed to achieve permanent collapse of the lung.

The 'thoracoplasty' Sauerbruch introduced which consisted of the removal of up to ten ribs at one session, allowing lateral collapse only, carried a high mortality and morbidity. It was successful in cavity closure in only 35 per cent. of patients.

The next major step forward in surgical collapse therapy was taken by Holst and Semb (1936) who, dissatisfied with the results of the Sauerbruch operation, aimed to design a procedure which carried a lower mortality but which had a higher rate of cavity closure. They laid down the principles that the diseased area should be allowed to collapse in a concentric manner, that is both from above downwards as well as laterally, and that as little undiseased lung as possible should be collapsed by the operation.

Using these principles Semb (1936) designed the classical *extra-fascial para-vertebral thoracoplasty* which is still widely and successfully used. This procedure achieved a much higher rate of cavity closure with a much lower mortality. Within recent years Price Thomas (1942) has modified Semb's operation, increasing the number of stages from one to two or even three, extending the area of extra fascial 'stripping' and decreasing the length of the anterior ends of the ribs removed. These modifications enabled the cavity closure rate to approach 90 per cent. and the operation remains the procedure of choice in a high proportion of patients in whom permanent surgical collapse is necessary.

Concurrently with the development of thoracoplasty, it was recognized that the operation had disadvantages; it was a mutilating procedure, it often required three or even four stages and the collapse was irreversible. In order to avoid some or all of these drawbacks, many other operations were devised. Graf (1936) introduced the principle of the *extra-pleural pneumothorax and oleothorax*, which was performed in one stage and had the theoretical advantage that it was reversible. Baer (1913) had previously used wax to fill the space created by stripping the apex of the lung and attempts had also been made to fill this space with muscle and with fat.

Morrison Davis (1933) was another pioneer in the development of the principle of the extra-pleural operation and there was a wave of enthusiasm for it in Britain. However, owing to high morbidity it soon lost favour, although it has remained popular on the Continent to this day.

Recently, since the introduction of inert plastic materials, the principle of *plombage* has been successfully re-adopted by Wilson (1946), Cleland (1948) and Morrison Davis (1951). The operation of *extra-periosteal plombage* using various forms of inert materials (lucite balls, polythene packs and sponges, etc.) is now widely used. It combines the advantages of a one-stage procedure without deformity or gross loss of pulmonary function, with a high sputum conversion rate and a low morbidity.

Finally, many surgeons recognizing the risk of leaving foreign material, however inert, permanently in the body, but attempting to achieve a one-stage operation, have described modification of the standard thoracoplasty. The risks of *paradoxical respiration* which are associated with extensive rib resection have to be overcome. At the same time an attempt has to be made to prevent 'apical creep,' that is re-expansion of the lung months or years after the operation, which may lead to re-activation of the disease in the re-expanded area.

Holst (1935), Edwards (1949) and Sellors (1953) have all described techniques in which, by various

means the ribs are used to prevent paradoxical respiration and 'creep.' Aycock *et al.* (1940) have described a method in which the extra-periosteal space is filled with air and the periosteum over the apex is so held in place until it regenerates bone.

All these methods remain experimental until it is clear that they fulfil the all-important criterion, that they shall produce a sputum conversion rate as high as that given by thoracoplasty with extra-fascial apicolysis.

Although at present the trend is towards a one-stage procedure, a survey of operations being carried out shows that thoracoplasty remains the most popular form of surgical collapse.

Indications

Collapse operations for tuberculosis may have either of two purposes; to allow cavities to close or to prevent re-activation of disease in an area which is healed but is unstable and liable to break down in the future. Although resection is rapidly increasing in popularity, the question which should guide the decision as to the form of surgery in any given case is 'Why not a thoracoplasty?' The contra-indication to collapse operations are as follows:

1. Cavities so placed that they could not be closed by collapse operations.

2. Cavities so placed that a collapse operation would destroy the function of an unjustifiably large portion of normal lung.

3. Pathological conditions unsuitable for collapse therapy.

1. Under this heading the *basal segmental cavities* are included. (A high proportion of cavities in the apex of the lower lobe can be closed by collapse operations if a sufficiently extensive 'strip' is carried out.)

2. *Apical lower lobe* cavities unassociated with upper lobe disease come under this heading and possibly lesions of the anterior segment of the upper lobe should be regarded as unsuitable for thoracoplasty.

3. Perhaps the commonest lesion in this category is the *solid tuberculous focus*, other pathological conditions not susceptible to treatment by surgical collapse are *tuberculous bronchiectasis*, particularly in the lower lobe, *destroyed lungs*, particularly when associated with *bronchostenosis*, and pyopneumothorax associated with *bronchopleural fistula*.

Extent of Operation

Not only does the choice of operation depend on the pathology and anatomical distribution of the disease, but also the extent of the necessary collapse is governed by these factors.

It has long been the practice to remove ribs to the extent of one rib and an inter space below the

cavity. As the majority of lesions are in the posterior segments of the lung this 'rule of thumb' works well. However, it is preferable that the extent of rib removal should be governed by the anatomical site of the cavities:

Cavities in the apex of the upper lobe: five ribs.

Cavities in the posterior segment upper lobe: six to seven ribs.

Cavities in the anterior segment upper lobe: five to six ribs with extensive anterior strip.

Cavities in the apex of the lower lobe: eight to nine ribs.

In all cases the apicolysis must extend downwards at least to the level of the arch of the azygos vein or of the aorta.

Staging of the Operation

The major limiting factor in the number of ribs which can be removed and the extent of the strip at any stage is the post-operative paradoxical movement. The area where this movement is most likely to occur is over the *front* end of the ribs, where the chest wall is unsupported and where the underlying lung is frequently undiseased and freely mobile.

Ribs overlying fibrous diseased lung can be removed with impunity, therefore most judgment is required as to the extent of the *anterior ends* which are removed at each stage. The more widespread the disease and the poorer the respiratory reserve, the more stages should be undertaken. It is seldom wise to attempt a seven or eight rib thoracoplasty in one stage.

Apical Re-expansion

As one of the major principles in thoracoplasty is apicolysis it is important that the diseased lung should not re-expand to its original position; the cavity might well re-open were this to occur.

Many modifications of the standard thoracoplasty have been made to obviate the risk of re-expansion. If an adequate mobilization of the diseased area has been carried out, particularly during the later stages, it is very unlikely that there will be re-expansion in the hard fibrosed lung, and re-expansion occurring anteriorly in undiseased segments will not lead to re-activation of the disease. If, on the other hand, the original mobilization was inadequate no matter which of many techniques is used to prevent re-expansion, cavitation is liable to persist.

All these considerations as to the extent of mobilization apply equally to operations in which the principle of extra-periosteal plombage or extra-pleural pneumothorax are used. One of the main advantages of these procedures is that paradoxical movement is reduced to a minimum so that com-

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plete mobilization can safely be performed at one stage.

Operative Technique. Thoracoplasty First Stage (Fig. 3a)

The incision depends on the eventual number of ribs it is intended to remove. The greater the number the farther the incision is carried down before it is turned forwards. The trapezius, rhomboids and the posterior half of the latissimus dorsi are divided. The serratus anterior is freed from the second and first ribs and the scalenus posterior and medius are divided at their insertion to the second and first ribs respectively.

The third rib is freed from its periosteum for half its length or until soft lung is encountered underneath it (whichever is further) and is removed, being divided posteriorly at the costo-transverse joint.

The second rib is removed from the joint to a point just short of the cartilage, care being taken to leave the periosteum behind so that its regeneration may play a part in the prevention of anterior re-expansion. The first rib is stripped of periosteum, the scalenus anticus is divided at its insertion and the costo-clavicular ligament is partially divided. The rib is then removed from the costo-transverse joint to the cartilage.

The stage is now set for the apicolysis; this may be done in the extra-pleural plane, but preferably the bands of Sibilleau are deliberately divided and

FIG. 1.—A diagram to show the extent of rib removal and 'strip' after the first stage of a thoracoplasty.

the strip is made in the *extra-fascial* plane allowing the endo-thoracic fascia to go down with the apex (Price Thomas, 1942).

The apex is mobilized to the first interspace in front to the arch of the azygos or aorta on the mediastinum, and to the neck of the fourth rib posteriorly (Fig. 1).

At the *second stage* 14 days later after due consideration of the risks of paradoxical movement and of the extent of the disease; decreasing segments of the fourth, fifth and sixth, or even seventh, ribs are removed as well as the remaining anterior end of the third rib. The apicolysis is carried down posteriorly to allow complete relaxation of the diseased area (Fig. 2).

FIG. 2.—A diagram to show the extent of removal and 'strip' at the completion of a thoracoplasty. The dotted area indicates the extent of extra mobilization after the first stage.

Third or even fourth stages may be required at fortnightly intervals if the disease is very extensive or if it has been considered advisable to limit the extent of rib removal at earlier stages.

Extraperiosteal Plombage (Fig. 3b)

The approach is similar to that for thoracoplasty except that the scaleni are not divided. The second rib is stripped and divided posteriorly. The ribs below this are freed from their periosteum to the extent governed by the amount of collapse required, the intercostal bundles and the periosteum are divided posteriorly and these fall away from divided ribs with the lung.

The periosteum on the lower border of the first rib is stripped from the under surface and an

apicolysis is carried out in a similar manner and to the same extent as that described under thoracoplasty.

All that remains is to fill the extra-periosteal space with some inert material, the best to date being 1 in. solid lucite spheres. These are put in in sufficient numbers to maintain the apex in its new position. The second rib is then fixed back in place and the wound is closed.

Extra-pleural Pneumothorax (Fig. 3c)

A shorter periscapular incision is made and a

FIG. 3.—(a) Thoracoplasty. (b) Extra-periosteal plombage. (c) Extra-pleural pneumothorax. P represents intercostal periosteal layer.

length of the fourth rib is resected. The extra-pleural plane is entered through the rib bed and the apex of the lung is stripped off the endo-thoracic fascia to a similar extent to that for the two preceding operations. When absolute haemostasis has been achieved, and this may be difficult, the wound is closed with particular care to ensure that the intercostal layer is air tight. The collapse is then maintained by filling the space with air at suitable intervals.

Results of Collapse Operation

As the extent and the type of tuberculous lesions which are subjected to surgery vary so enormously, the statistical results in any series must depend to a very large degree on the type of case operated upon. For instance, if a high proportion of the patients are suffering from advanced bilateral disease the mortality rate may well be as high as 10 per cent., whereas if the majority of the operations performed were for 'minimal' apical lesions without cavitation, no mortality greater than 1 per cent. would be acceptable.

The overall mortality for thoracoplasty is approximately 3 per cent., and it is the same for plombage operations. In published series (Price Thomas, 1952; Sellors, 1947; Laird, 1953) it is in the same order.

In terms of *sputum conversion* the results of most collapse operations give figures ranging around 80 per cent. successes, but before conversion can be accepted at least three negative sputum or gastric lavage cultures are required, as the more thorough the search for bacilli the more often they are found. Short of post-mortem evidence *cavity closure* is almost impossible to prove. In terms of return to their *previous occupation* Price Thomas states that in his experience over 80 per cent. of the patients surviving operation are back in their original job. *Early post-operative morbidity* is higher after thoracoplasty than after plombage operations, but late tuberculous infection of the extra-pleural space is the bugbear of the latter operation in which foreign bodies are left *in situ*, and it still occurs sufficiently often for many surgeons to doubt the justification of the pro-

cedure. This criticism also applies to extra-pleural pneumothorax, in which late tuberculous infection is not uncommon; this operation has the added disadvantage that refills are required weekly and that despite this inconvenience the lung seldom re-expands when refills are discontinued and so its basic purpose is not achieved.

Summary

1. Surgical collapse therapy has a large place in the treatment of pulmonary tuberculosis.
2. The decision as to the extent and the type of collapse should be based on as complete as possible *anatomical* and *pathological* diagnosis of the disease.
3. *Thoracoplasty* has the disadvantage that it has to be done in more than one stage, but the long-term results are probably better than those in any other collapse operation.
4. *Extra periosteal plombage* has the advantage of being a one-stage procedure, but the disadvantages inherent in any operation in which foreign material is left *in situ*.
5. *Extra-pleural pneumothorax* has a high morbidity and seldom achieves its object, that is that it can be abandoned when the underlying disease is controlled.

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