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CONSERVATIVE THORACOPLASTY WITH EXTRAFASCIAL REFILLS*

BY

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The standard seven-rib thoracoplasty became established as an effective therapeutic measure in pulmonary tuberculosis by achieving cavity closure and sputum conversion in a high proportion of cases. Its satisfactory clinical results have tended to outweigh some of the disadvantages of the operation, and the deformity associated with "bedding-in" of the scapula and the reduction in respiratory function which follow the resection of portions of seven ribs have been accepted as part of the price payable by the patient. Removal of fewer ribs eliminates the problem of scapular displacement but creates another in the larger extrafascial space which remains. Where no steps are taken to maintain this space, re-expansion of the lung occurs readily, the apex often rising above the level of the clavicle and leading to incomplete closure of the cavity. In a search for a more conservative type of operation a variety of materials have been employed to fill the extrafascial space and maintain apical relaxation. From October, 1949, we have employed air as a maintenance medium, refilling the extrafascial space during the post-operative period until there is radiographic evidence of rib regeneration. When satisfactory ossification is apparent—usually about the twelfth post-operative week—refills are terminated. The space gradually shrinks, but any tendency of the apex to rise is checked by the barrier of regenerated bone.

Attention was drawn to the possibilities of this procedure by Aycock, Brantigan, and Welch (1940), when they reported their experiences with 40 cases; Konstam (1948) recorded 31 cases from the Surrey County Sanatorium, and later Tuxen (1950), working in association with Semb, recorded a large series, stressing the satisfactory clinical results and the minimal degree of deformity and functional loss. Personal visits to Ullevål Hospital and Vardåsen Sanatorium strengthened the impression gathered from the literature that the employment of extrafascial refills constituted a considerable technical advance.

A trial of the method along the lines indicated by Tuxen and Semb encouraged us to persist, and within six months it had become our standard procedure. Our original cases were those in which we would normally have carried out a seven-rib thoracoplasty. In many of them a five-rib operation sufficed when extrafascial refills were employed, and this lessening of the wear and tear on the patient led us to include cases in which we had previously hesitated to resort to major surgery. We found, also, that this conservative operation had distinct advantages in cases of bilateral disease.

CLINICAL MATERIAL

When we first became interested in this operation the employment of routine radiography in the Services was bringing to our notice an increasing number of cases with apical lesions of limited extent. These patients were usually in good general condition and free from symptoms, and in most cases an ordinary radiograph suggested that the lesion was probably stable: cultivation of the gastric washings often produced a positive result, however, and tomography of the focus frequently showed small broken-down areas nestling in its core. Such findings by themselves brought the patient into our list of "possibles" for active treatment. Then there were the following social factors which we think provide an argument for the translation of a patient from the "possibles" to the "probables," factors which also have a bearing on the choice of the form of active treatment. The majority of such patients are in the 20–30 years age group, at a time of life when they are struggling to get themselves established and want to devote themselves to their work with minds as free from worry as possible. The disappointment and alarm consequent on the interruption to their lives by tuberculosis can be miti-

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gated if we are able to give them a reasonable assurance that a permanent and effective control over the disease will be achieved. It is difficult to give such an assurance without some form of direct attack upon the lesion, and the method chosen must fulfil certain criteria if it is to be acceptable to the patient. These patients do not feel ill, and indeed many of them have been at work until the time of their admission. Accordingly the method advocated, in addition to offering good prospects of a permanent result, must not appear too radical, must carry a minimal risk of complications, must not interfere unduly with respiratory function, and must permit of the patient's return to work and relative normality within a reasonable time. The highly selective thoracoplasty made possible by the employment of extrafascial refills appears to fulfil these criteria better than any other method at our disposal. The patient has his operation, an adequate period of sanatorium treatment follows, and he may then be allowed to take up his normal life again. He remains a hospital or clinic patient for follow-up purposes only and is spared the necessity of taking his place in the weekly or fortnightly refill queue—that constant reminder that he is not as other men are. It may be said that it is unjustifiable to subject a patient to a mutilating operation which might eventually have proved to be unnecessary, but we do not believe that a limited thoracoplasty is a mutilating procedure. It entails what the word "thoracoplasty" itself implies, a remoulding of the chest wall overlying the diseased area; and such a restricted readjustment of the thoracic contours is hardly too high a price to pay for health and the ability to work.

We do not wish to suggest that we employ extrafascial refills to justify a thoracoplasty operation in cases where considerable doubt as to the necessity for operation exists. We now use the technique in practically all our cases of thoracoplasty, and we believe that it has justified its employment by making possible a more conservative operation.

Fig. 1 shows the quite considerable reduction in ribs sacrificed during the two years following our adoption of this method as compared with the preceding year, when we employed the standard thoracoplasty.

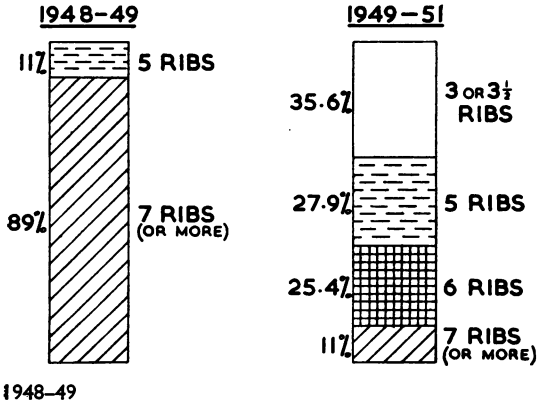

FIG. 1.—Comparison of numbers of ribs resected in thoracoplasties before and after the adoption of extrafascial air refills.

RESULTS

During the two years ending on October 31, 1951, modified thoracoplasties were carried out on 109 patients, nine of whom had bilateral operations. All the patients were from the Red Cross Sanatoria of Scotland and were operated upon at Tor-na-Dee Sanatorium.

TABLE I

THORACOPLASTY WITH EXTRAFASCIAL REFILLS, 1949–51

Age		Sex
20–29 years ..	68	Male, 98 (including 7 bilaterals. 6 others had contralateral thoracoplasty later)
30–39 ,, ..	33	Female, 11 (including 2 bilaterals. 1 other had contralateral thoracoplasty later)
40–49 ,, ..	8	
Total ..	109	Total, 109 (including 9 bilaterals)

Contralateral collapse at time of thoracoplasty } 16 cases (15 A.P.s + 1 extrapleural pneumothorax)

One hundred and one of these patients have since been discharged. Radiological examination indicated that in all cases closure of the cavity had been secured. The final bacteriological status of the 101 cases discharged showed that 100 were sputum-negative on direct smear. In the one case classified as positive the sputum had converted shortly after completion of the operation, but the

TABLE II

THORACOPLASTY WITH EXTRAFASCIAL REFILLS, 1949–51, IN 101 PATIENTS NOW DISCHARGED

Bacteriological Status on Discharge				
Direct Smear		Culture and/or Guinea-pig		
–	+	–	+	Not Done
100	1	73	8	20
101		101		

patient produced an isolated positive finding following a "cold" just before his departure. Eighty-one of the total had gastric washings examined by culture and animal inoculation. Seventy-three gave negative findings by all methods, while eight gave a positive result by animal inoculation. The remaining 20 were amongst our earlier cases in the series, before we had instituted gastric lavage as a routine for all patients before discharge.

There was no operative mortality in this series, the only death occurring as a result of air embolism after a refill on the forty-seventh day after operation.

Table III shows the total mortality in all thoracoplasty cases at Tor-na-Dee from July, 1947, to June, 1952.

TABLE III
MORTALITY OF THORACOPLASTY

Mortality at Tor-na-Dee in 251 Completed Thoracoplasties including Extrafascial Refill Cases in Next Column (426 Stages) July, 1947, to June, 1952	Mortality in 118 Completed Thoracoplasties with Extrafascial Refills (109 Patients) October, 1949, to October, 1951
Causes of death:	Cause of death:
Heart failure .. 2 (1, 2nd day) (1, 3rd day)	Air embolism during refill of extrafascial space on 47th day 1
Paroxysmal tachycardia .. .. 1 (15th day)	
Air embolism .. 1 (47th day)	
Total number of deaths .. 4 (1·6%)	Total number of deaths .. .. 1 (0·8%)

PRE-OPERATIVE PREPARATION

Many of those with limited apical disease and little or no sputum do not require a great deal in the way of preparation. Others with more extensive lesions receive prolonged preparatory treatment, in which chemotherapy, pneumoperitoneum, and postural treatment may all be used to produce as much contraction as possible in the original foci. We try not only to reduce the output of sputum in these cases but to render as many as possible sputum-negative before the operation, a policy which has, we think, contributed to the very low incidence of post-operative extension of disease which has been encountered.

OPERATIVE TECHNIQUE

Local anaesthesia has been employed in all cases.

The number of ribs to be resected and the degree of apicolysis desirable are decided at our joint weekly conference, attention being paid to the distribution of disease past and present, the extent of any contralateral disease, and the patient's age and lung function. In the standard thoracoplasty the rib resection is usually planned to include not only the diseased area but also one intercostal space and one rib below the level of the radiologically visible lesion. In thoracoplasty combined with refills the apicolysis is planned to free the lung well below the lesion on all its aspects: the number of ribs to be removed is not so important, and it is unnecessary to resect any below the lower limit of the lesion.

The patient's build and the relation of the scapula to the ribs are also taken into account in deciding the number of ribs to be resected, in order to avoid post-operative scapular trouble. Special caution is necessary in the case of kyphotic patients, as these are more likely to have scapular difficulties.

STAGES.—In a one-stage operation usually three and a half ribs are removed. If it is desirable to remove more ribs the operation is done in two stages, the first three ribs being removed at the initial stage. The extrafascial apicolysis is similar to that practised by Semb and Price Thomas, except that, to ensure the maximum concentric relaxation of the apex, the strip is extended anteriorly below the level of the lesion. If the apex is adherent posteriorly and cannot be stripped adequately, the posterior ends of the fourth rib, or the fourth and fifth ribs, are resected. It is important to complete the apicolysis at the first stage in all cases, as further stripping at the second stage is more difficult and an inadequate apicolysis means that full relaxation is not obtained. The strip is always extended over the aortic arch or azygos vein to the lung root on the mediastinal aspect. In some cases the apex may rise after the first stage and become re-attached: in such cases the lung is again freed to the desired level at the second stage. This separation of the re-attached apex is seldom difficult when the second stage has not been unduly delayed.

It does not appear to make any difference whether the muscles are sutured in one or two layers, in so far as the "air-tightness" of the space is concerned. Some patients, particularly older ones of the emphysematous or bronchitic type, cough explosively after operation and as a result cough out the air and lose the air-space.

In cases where a second stage is planned a two-layered continuous suture of No. 8 nylon is employed at the first stage, as this causes far less reaction in the muscle than catgut and facilitates suturing at the second stage. At the final stage a two-layer continuous catgut suture is used. The use of nylon at the final stage was abandoned, as in a few cases it gave rise to sinus formation later and had to be removed.

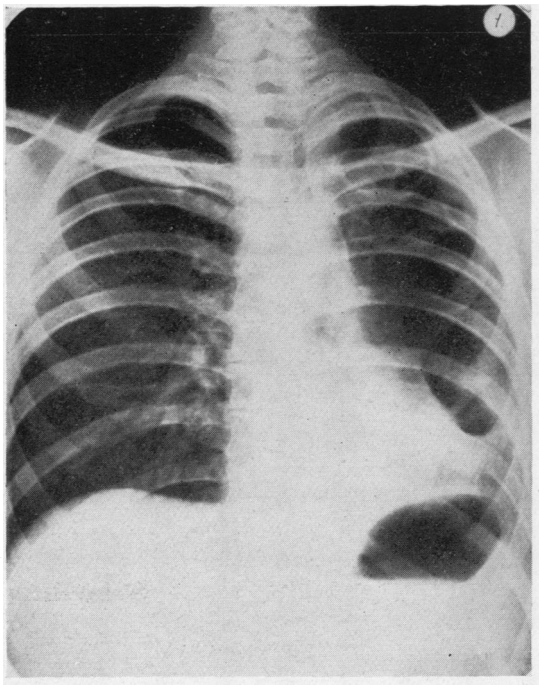

FIG. 2

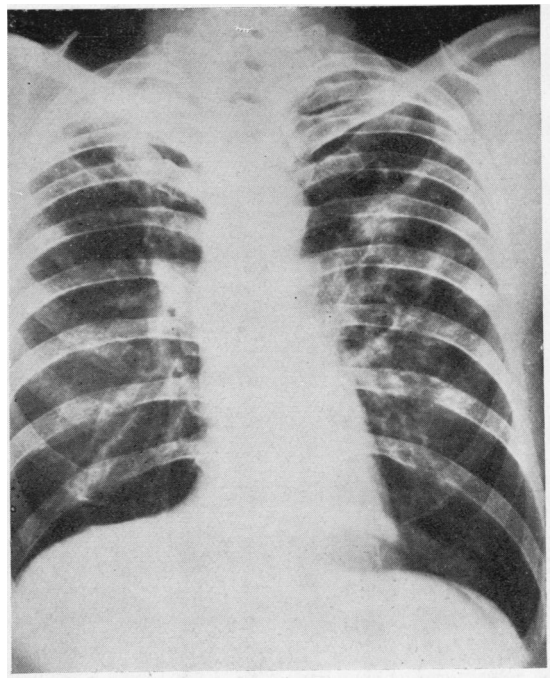

FIG. 4

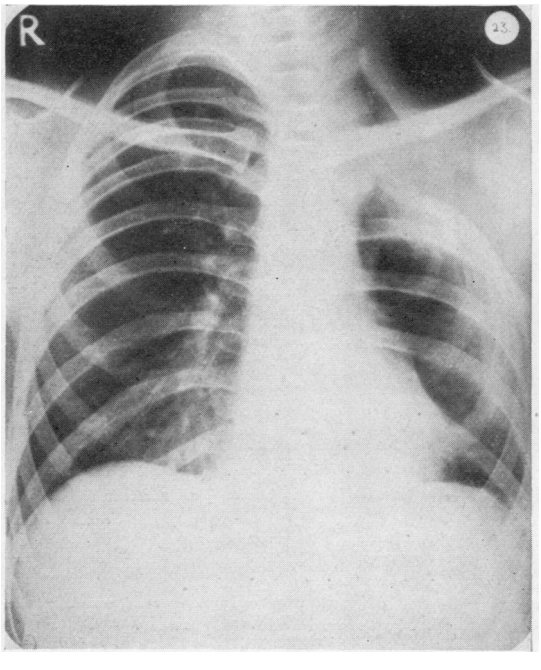

FIG. 3

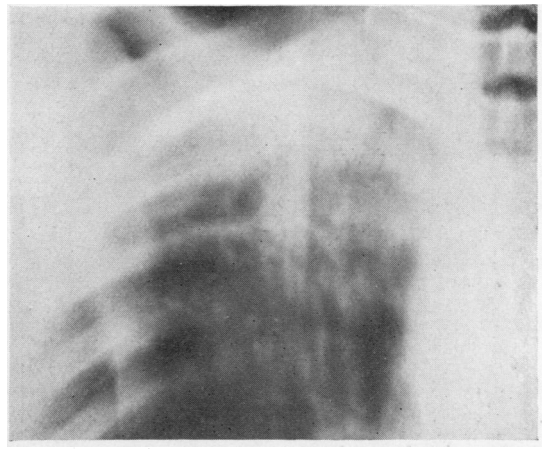

FIG. 5

FIG. 2.—Large cavity in left upper zone. Considerable pleura involvement after old pleural effusion.

FIG. 3.—After five-rib thoracoplasty with extrafascial refills. Gastric washings negative on culture and on animal inoculation.

FIG. 4.—Chronic cavity at right apex with recent spread to left middle zone.

FIG. 5.—Tomogram demonstrating right apical cavity.

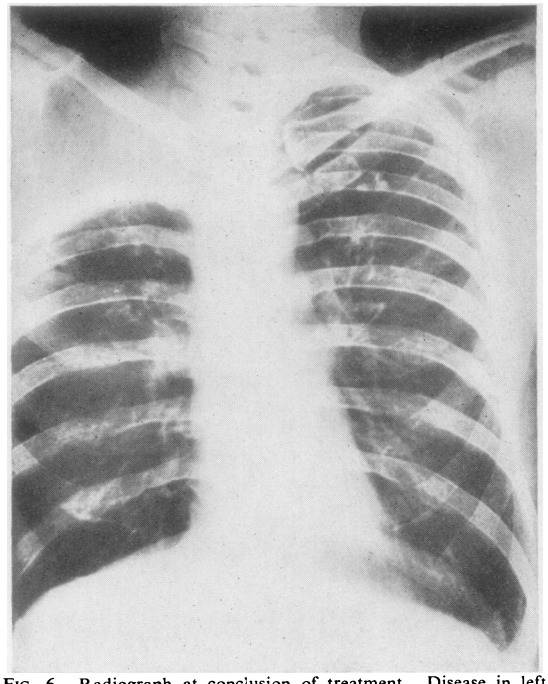

FIG. 6.—Radiograph at conclusion of treatment. Disease in left lung cleared satisfactorily with chemotherapy and cavity in right lung was treated by a one-stage thoracoplasty with extrafascial refills. Gastric washings were culture and guinea-pig negative on discharge.

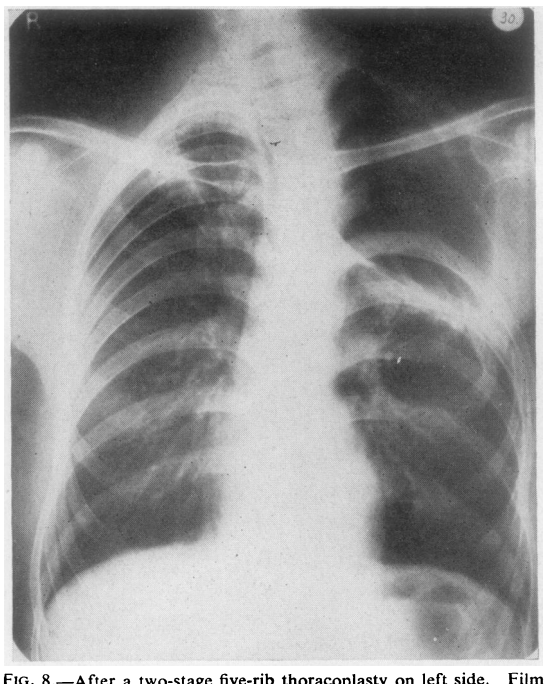

FIG. 8.—After a two-stage five-rib thoracoplasty on left side. Film taken four months after operation and just before termination of extrafascial refills.

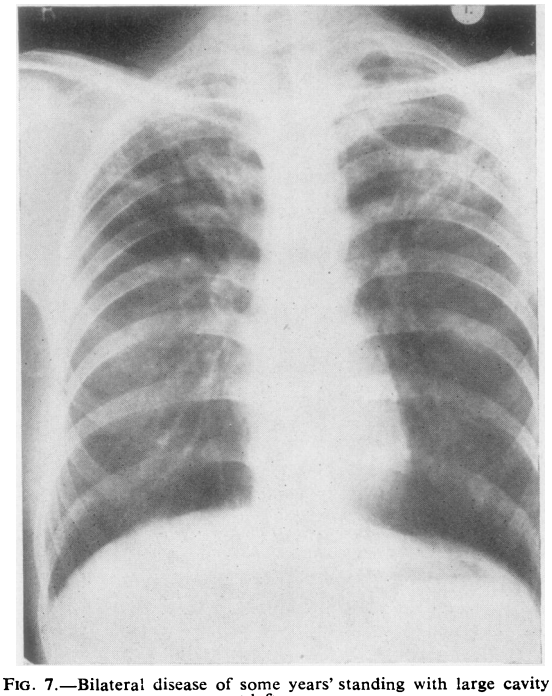

FIG. 7.—Bilateral disease of some years' standing with large cavity at left apex.

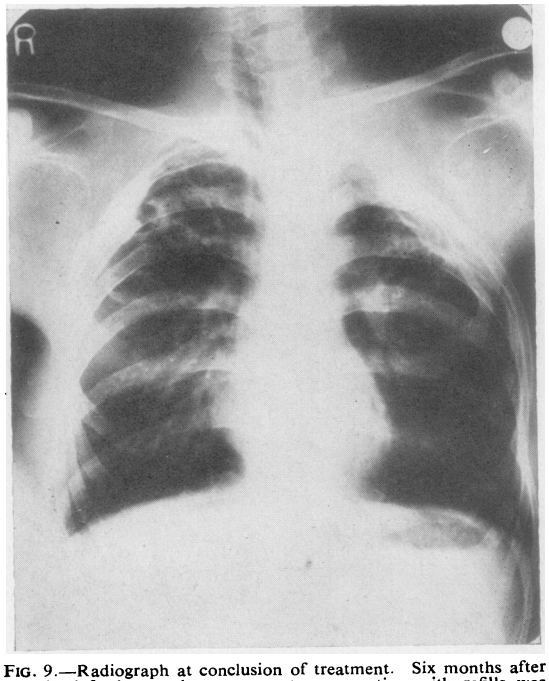

FIG. 9.—Radiograph at conclusion of treatment. Six months after the left thoracoplasty a one-stage operation with refills was carried out on the right side. Gastric washings and laryngeal swabs were negative on culture on discharge.

The pleura has been torn fairly frequently, and in a number of cases pneumothorax has been attributed to the anaesthetist's needle. The relatively high incidence of pleural tears is related to the type of case we are treating and to the extensive apicolysis which is practised. The pleura is often thin on the mediastinum and anterior chest wall, where it is most liable to injury. If possible, a surgical tear is rapidly mobilized and closed by ligature, and if necessary this is reinforced by sewing an intercostal muscle over the area. The pneumothorax is then aspirated completely, by means of an induction needle and a Maxwell box. Respiratory distress which may accompany the pneumothorax is quickly relieved once the tear is controlled and intrapleural air removed. In some cases the pleura is like tissue paper and a tear cannot be satisfactorily closed, so an intercostal catheter is inserted, usually in the ninth space posteriorly, and suction drainage applied at once. The lung expands, the tear quickly seals off, and in most cases the drainage tube may be removed in 48 hours. If a tube is not inserted the pleural defect tends to remain open for some time, fluid gravitates into the pleura (necessitating several aspirations), and the extrafascial space may be lost. We are now draining all those cases in which there is any uncertainty about the air-tightness of the pleural closure.

Post-operative Treatment

Normally the patient is returned to bed in a sitting position and an immediate radiograph is taken to confirm the extent of the strip and to ensure that there is no residual or unsuspected pneumothorax. Those whose post-operative condition necessitates it, and all the older patients, are kept temporarily in a recumbent position and gradually raised to a sitting posture as their condition improves. In some cases explosive coughing leads to a loss of the extrafascial space in the first few days: here it is important that the second stage should not be delayed more than 14 days, otherwise there may be difficulty in repeating the apical strip. Our normal plan is to perform the second-stage operation after an interval of a fortnight; but if delay is desirable on account of poor general condition, wound infection, or axillary thrombosis, the second operation may be postponed, provided the extrafascial space is maintained.

We have had little trouble with paradoxical respiration, apart from one period when we were resecting rather longer portions of the fourth and fifth ribs at the second operation. Any tendency to paradoxical movement may be minimized by placing pads of wool in the axilla and in the infraclavicular fossa and using a firm binder to support the chest wall.

Refills are begun on the tenth day following completion of the operation, the needle being inserted posteriorly between scapula and spine in approximately the fifth intercostal space. Normally we do not aspirate the exudate which has accumulated in the extrafascial space, unless all or most of the air remaining in the space after operation has been coughed out. In such circumstances, removal of a few ounces of the effusion is necessary before a satisfactory air space can be created: occasionally a very large post-operative effusion, which is producing an excessive degree of collapse, may require aspiration.

The amount of air given at the first refill is usually about 40 to 60 ml., depending on the pressure readings, which should not be permitted to rise above zero at this stage. Refills are repeated on the eleventh and twelfth days, the end pressure being raised to +4 cm. water, and then given every second or third day for the next week, the pressures being gradually increased. Once a satisfactory space has been established, refills may be given twice weekly and finally weekly, the end pressure being maintained at about +12 cm. water. Daily filling at the beginning is important, for it is essential to keep the apex well down: should it begin to rise at that stage it is likely to continue to do so. While the scheme outlined is that which is adopted in the average case, modifications may be necessary to meet individual situations. Careful radiological control is essential throughout, and procedure is governed by the behaviour of the apex and by the estimated degree of collapse which is required for the control of the original disease. Refills should be continued until there is satisfactory evidence of rib regeneration, which is usually apparent about the twelfth post-operative week. The termination of the refills may be followed by some slight apical rise as the residual air absorbs, but such rise is sharply limited by the regenerated ribs.

Late Post-operative Complications

There have been six instances of tuberculous infection of the extrafascial space. This was clinically apparent about the sixth week and was indicated by a mild degree of fever, a rise in the erythrocyte sedimentation rate, and an increase in a pre-existing post-operative effusion. In two tubercle bacilli were cultured from the fluid. All six responded rapidly to aspiration and the daily instillation of 1 g. of streptomycin, the average

amount of streptomycin required being 21 g. The extrafascial space obliterated satisfactorily at the conclusion of treatment, and no further trouble has arisen in any of these six cases. One case of air embolism, unfortunately fatal, occurred following a refill at the eighth week. Before this fatality we had been using much higher end pressures, and we think that these high pressures possibly favoured embolism. Since then pressures greater than +12 cm. water have not been employed.

TABLE IV

OPERATIVE AND POST-OPERATIVE COMPLICATIONS IN 118 COMPLETED THORACOPLASTIES (INCLUDING 9 BILATERAL CASES)

Pneumothorax:		
Surgical tears	25	
"Anaesthetic"	8	
Pleural effusion	10	
Haematoma of extrafascial space (1 required evacuating)	6	
Wound infection:		
Superficial	3	
Extrafascial space: pyogenic	3	(1 with superficial wound infection)
,, ,, tuberculous	6	
Axillary vein thrombosis	6	
Atelectasis (requiring bronchoscopy)	4	(3 associated with pleural tears)
Spread of disease	1	(contralateral)

Thoracoplasty combined with extrafascial refills naturally invites comparison with similar procedures designed to produce permanent collapse with minimal deformity, such as lucite and polythene plombage. We have no personal experience of either method, so are not in a position to make any comparison. On purely theoretical grounds one probably prefers to think of the space obliterating after three to four months rather than persisting and harbouring foreign bodies, however inert, indefinitely. Also, we appreciate that lung resection is now coming into the picture to such an extent that in future many cases similar to those included in our series may be dealt with by extirpation of the lesions. We consider, however, that thoracoplasty has passed through the furnace successfully and has given us durable results in the past, and that with this modification which has enabled us to reduce the extent of the operation we shall probably continue to use it until we are satisfied that the results of alternative procedures are equally durable and carry no greater mortality.

SUMMARY

A more conservative thoracoplasty operation made possible by the employment of air refills of the extrafascial space has been described. Details of the operative technique and of the post-operative complications encountered in 118 thoracoplasties in 109 patients, of whom nine had bilateral operations, have been given; and the immediate results, in terms of closure of cavities and conversion of sputum, have been recorded in 101 patients already discharged.

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