CAVITATION IN PULMONARY TUBERCULOSIS:

ITS PROGNOSIS AND TREATMENT.

T H E S I S

for the degree of

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submitted by

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Prior to the recognition of Pulmonary Tuberculosis as a specific disease the occurrence of excavation in the course of "phthisis" was noted and commented upon by even the earliest observers. CELSUS, GALEN and ARETAEUS recognised it and the statement of the latter that "phthisis was the result of ulceration of the lung" remained undisputed until the birth of the science of morbid anatomy at the close of the eighteenth century. At this time three stages of tuberculosis were recognised and classified according to their clinical manifestations:

1st Stage - characterised by cough, fever and general malaise;

2nd Stage - by more frequent cough, loss of weight, dyspnoea and hectic fever;

3rd Stage - by night-sweating, abundant sputum and extreme toxaemia with marked cachexia.

Post-mortem study led to the recognition and description of three stages in the pathology of tuberculosis:

(1). Stage of accumulation of tubercles.

(2). Stage of softening.

(3). Stage of evacuation of the softened material and the resultant cavity.

As LAENNEC had not yet given the world his discovery of auscultation, the pathological changes could not be followed at the patient's bedside and not/

not unnaturally the results of the morbid anatomists were seized upon and correlated stage by stage with the clinical picture. Thus the third clinical stage of tuberculosis became synonymous with the stage of excavation.

This was the state of knowledge until the nineteenth century. In that period LAENNEC (1) described the physical signs of pulmonary tuberculosis in its clinical stages, and, as a result of his observations, came to the conclusion that cavity-formation represented a form of "cure". He stated that often when stethoscopic evidence indicated the fresh formation of a cavity there was a corresponding striking improvement in the patient's condition with a fall in temperature and diminution of sputum. He considered that a cavity was an entirely local lesion not giving rise to general signs.

JACCOUD (2) later came to the same conclusion that cavity formation represented a form of "cure", because, in his opinion, excavation was the stage preceding cicatrisation which process could not proceed until the pathological products had been evacuated. It required, however, the advent of radiology to demonstrate conclusively that cavity formation was not entirely confined to the third stage of pulmonary tuberculosis/

tuberculosis and that cavities themselves could be classified into types.

Prior to the X-ray epoch the word "cavity" was generally taken to represent what we now regard as a chronic cavity or to use JACQUEROD'S classification, a third degree cavity. This was the type with which the morbid anatomists were familiar and which they described in such detail.

The description given by WILSON FOX (3) cannot be improved upon..... "Their wall is thick, the lining membrane is covered with an ashy grey, opaque, soft, false membrane in which are occasionally nodular masses resembling the soft granulations found in the rest of the pulmonary tissue. When this membrane is stripped off a dense and highly vascular tissue is seen beneath, almost uniformly red and very frequently marked by punctiform extravasations. External to this is a grey, dense, homogeneous, glistening tissue extending over variable depths from a quarter to half an inch and beyond this again is frequently a firm and grey homogeneous anaemic infiltration". But with the application of radiology to the chest a new vista was opened up. Cavity formation was recognised as something other than the terminal stage of phthisis and became instead an object/

object of intense interest to the clinician, a phase calling for prompt and decisive treatment.

That by means of careful X-ray examination, cavity formation can be recognised in its earliest stages and its subsequent progress followed, is now undisputed. This has led to a new classification of prime importance to the clinician because of its bearing on prognosis and the line of treatment to be adopted.

This modern view of pulmonary excavation has been very clearly expounded by JACQUEROD (4) and WOHLERS (5). The former, relying practically entirely on radiology, divides cavity formation into three stages, describing in detail the X-ray appearances and symptoms concerned with each stage.

He begins his description by referring to those cases in which a circular shadow with a comparatively ill-defined outline and a shaded centre appears on the radiogram, but in which neither the symptoms nor the physical signs commonly associated with excavation are present, where there is no sputum and where the signs are either negative or limited to a little harshness of respiration and a few fine crepitations. This he calls a First degree cavity or/

or, alternatively, "la lesion precavitaire" for serial observations have shown the possibility of this X-ray shadow disappearing completely in certain cases, while in others it has progressed and gone on to the formation of an undoubted vomica with all its signs and symptoms. In these cases the term "lesion precavitaire" is probably the more accurate for it would seem to be the stage immediately preceding the evacuation of the caseous contents of the diseased focus.

Second degree cavity .... this is the stage following the evacuation of the softened material where a well-defined ring with a clear centre appears on the film without the thickened wall and surrounding induration of the classical cavity. Pathologically the walls of this cavity are composed of freshly infiltrated tissue consisting of a zone of tuberculous pneumonia with central caseation but without an organised fibrous membrane. Clinically this stage is accompanied by a varying amount of mucopurulent sputum containing T.B. but the physical signs may be very indefinite and may vary considerably.

Third stage cavity .... this is the picture appearing in the chronic and long-standing case. The circular shadow is clearly defined with its thickened/

thickened wall and clear centre, and the signs of cavernous breathing and whispered pectoriloquoy are nearly always present. The sputum is characteristic, being purulent and nummular and usually T.B. positive.

It will be seen that this classification is largely dependent on X-ray evidence and not all observers are in agreement as to the significance of those annular shadows appearing on the radiogram without confirmatory signs and symptoms. JACQUEROD mentions three sources of error (1) the small encysted pneumothoraces remaining when an artificial pneumothorax has been stopped; (2) small mediastinal herniae occurring in the healthy lung during the course of an artificial pneumothorax; (3) exaggerated shadowing of the vascular and bronchial tree which may assume a circular outline in certain cases. American writers in particular have cast doubt upon the X-ray diagnosis of cavitation. In 1918 a publication by the staff of the Trudeau Foundation (6) suggested that these circular shadows were frequently due to partial pneumothoraces and AMBERSON (7) in 1921 put forward the suggestion that they might be due to localised pleural thickening resulting from the obliteration of the interlobar fissures by pleural adhesions. In Germany DAHLSTEDT (8) gave it as his opinion/

opinion that in all cases where the circular shadow became smaller, this shadow was not due to a cavity but indicated a partial pneumothorax, while ASSMAN (9) considered that every annular shadow on a radiogram was conclusive evidence of the existence of a cavity. There is a lack of confirmatory post-mortem evidence, as these "soft" cavities seldom come to the post-mortem table at that stage, but in 1923 GRAFF and KUPFERLE (10) published a number of important observations from Berlin showing the great frequency with which the radiological evidence of excavation corresponded exactly with the findings at autopsy. BURNAND has also stated that in all his cases in which post-mortem evidence could be obtained the pathological findings confirmed the existence of cavities, not only where the radiogram was definite, but even where the appearances had been merely suspicious. MORLAND (11) in 1932, emphasised the importance of valvular obstruction which allowed weakened alveoli to become pumped up, leading to the formation of emphysematous bullae which cast a circular shadow on the X-ray film.

In a recent communication BURRELL (12) has dealt with the present view of the "X-ray" cavity. He considers that these shadows, which, he asserts, appear/

appear exclusively in tuberculous cases, are not localised pneumothoraces nor are they due to local pleurisy and thickening ("pleural rings") but that they indicate either true tuberculous cavities or air cysts formed by a valvular opening into the air cells. He goes on to state that at the Brompton Hospital where an annular shadow has been shown by radioscopy before death a cavity in the corresponding portion of the lung has invariably been found at post-mortem examination, though sometimes a cavity found at autopsy has not previously been disclosed by radiological investigation. He adds that air cysts are not found in the post-mortem room apart from those rare cases in which death following spontaneous pneumothorax in the apparently healthy has occurred where a ruptured air vesicle has been found to be the cause. He sums up with the statement that when a definite annular shadow is shown in the lung by X-rays there is probably a cavity but adds that if on sub-sequent radioscopic examination that shadow is not to be seen it does not follow that the cavity has closed.

The latest views on this subject were crystal-lised by the various speakers at a meeting of the Tuberculosis Association in October, 1933.

Dealing with the question "Do annular shadows represent/

represent air spaces in the lungs?" BURTON WOOD (13) of the Victoria Park Hospital gave it as his opinion that they did for the following reasons:

(1). That annular shadows were peculiar to pulmonary tuberculosis which was the great cavitary disease.

(2). That their appearance was closely associated with the presence of T.B. in the sputum.

(3). That a cavity of this type might break down again with the reappearance of T.B. in the sputum.

(4). That these shadows were not annular but spherical as could be easily seen by moving the position of the patient.

(5). That on healing annular shadows left a permanent scarring on the lung.

(6). That although direct pathological evidence was lacking indirect evidence was supplied by the thickened wall cavity. Since soft walled or annular cavities were characteristic of early disease they could not be found in post-mortem examination of patients dying from pulmonary tuberculosis.

Whilst agreeing with WOOD that annular shadows represented air spaces in the lungs J. V. SPARKS (14) qualified this statement by saying that such air containing spaces were not necessarily due to true cavity formation but might be formed by emphysematous bullae, by localised bronchial dilatation in bronchiectasis and also by the destruction or absence of lung tissue in certain forms of pulmonary neoplasm. He laid particular stress upon the value of frequent serial/

serial X-ray examinations and of diagnostic pneumothorax in doubtful cases in addition to oblique, lateral, tangential and stereoscopic radiograms.

To sum up, the general trend of the British and Continental Schools seems to be to regard the appearance of a circular shadow in the X-ray film as strong presumptive evidence of excavation even without other signs. The position may be put briefly thus:

There are (1). Cases in which the correlation of radiological and physical signs is so definite as to place the diagnosis beyond doubt.

(2). Cases in which the radiological evidence is definite, the physical signs inconclusive, but the symptomatology, character of sputum, etc. is sufficient to warrant a positive diagnosis.

(3). Cases in which the radiological evidence is suggestive but the physical signs and symptoms are negative.

Most authorities, apart from the American school, prefer to regard these as cavities and from the clinical point of view it is safer to do so as the evidence so often shows that confirmatory signs are forthcoming at a later date if the X-ray warning be disregarded.

HEALING AND PROGNOSIS.

To what extent does a cavity influence the prognosis in a case of pulmonary tuberculosis and how often is spontaneous healing of such a lesion to be expected? In searching for an answer to these questions we immediately come up against the problem of the type of the cavity and on this, to a great extent, depends the prognosis. For this reason any generalisations on the subject of cavitation are apt to be misleading and, in consequence, statistics usually make gloomy reading.

GRAFF (15) in 1921, stated that the presence of a cavity portended the death sentence of a patient but modified this remark by adding that the sentence might not be carried out for several years.

BARNES and BARNES (16) in a study of 1454 cases with cavitation found a mortality of 80 per cent within a period of one year.

FISCHEL (17) has found the results in cases which received institutional care only so poor that he concluded that the existence of a cavity invariably called for more active therapy aiming at its obliteration before the patient's discharge.

FOWLER (18) of Pinewood Sanatorium has stated that/

that in cases of fibrocaseous cavity the results of sanatorium treatment without intervention were very poor, no less than 60-80 per cent of the patients dying within a period of five years, while WATT (19) in a series of 109 cases of cavity treated without collapse found that at the end of five years 82 per cent were dead, 7 per cent alive but unfit for work and only 11 per cent were working.

The analysis of cases with cavities given in the annual report from the TRUDEAU Sanatorium (20) in 1931, showed that there, cavities disappeared from the X-ray film with about the same frequency under ordinary general and resting treatment as in those cases receiving collapse therapy. The figures given were 77 per cent in the first group and 79 per cent in the second, but collapse treatment was only given to those patients who, after a preliminary period of observation, failed to show a natural tendency to closure.

In a recent series of figures from Loomis sanatorium, MacMAHON and KERPER (21), in investigating 296 cases with cavitation, found that 22 per cent secured spontaneous closure. In addition 83 of the 296 cases received collapse therapy and secured closure thereby; altogether using all forms of treatment/

treatment, closure was obtained in 39 per cent and an additional 25 per cent were much improved.

These last two groups of figures, however, are immediate results and no follow-up is yet available.

From a study of the figures published up-to-date the general impression to be gathered is that the presence of a cavity is of extremely grave prognostic significance, but a closer study of the subject may help to clarify the position.

The authorities quoted so far, however, have made no attempt to differentiate between acute and chronic cavities, and any figures quoted have referred to cavitation in general which may account in part for the apparent heavy mortality recorded. To place a young adult with a recent soft-walled lesion of the right upper lobe in the same group with a middle-aged patient who shows chronic bilateral excavation is apt to obscure the issue when an attempt is made to draw general conclusions from such a grouping.

For the purpose of giving a prognosis regarding excavated lesions, a brief study of the two groups of cavities, the acute and the chronic, their methods of healing and the factors influencing healing is necessary.

The acute cavity.

In the opinion of VIRCHOW all lesions of pulmonary tuberculosis originated from miliary tubercles either solitary or in conglomeration, and these were regarded as the only specific lesion produced by the tubercle bacillus. He observed also, that in the neighbourhood of the chronic foci, there existed areas showing simple congestive or inflammatory changes, but these were regarded as non-tubercular and no particular significance was attached to them. In other words the difference between "productive" and "exudative" lesions was not recognised at that time. Prior to the discovery of the tubercle bacillus WILSON FOX and GREEN had described pneumonic tubercular lesions, and in 1885 THAON proved that the tubercle bacillus was really the sole cause of these pneumonic lesions. Later, in Germany, the distinction between fibrotic and inflammatory foci was recognised and the terms "proliferative" and "exudative" applied to them.

The importance of the distinction lies in the fact that the exudative stage precedes the proliferative, and, whilst the lesions are in this inflammatory stage, healing by resolution may take place. On the other hand, this inflammatory reaction may go on/

on to breaking down of the lung tissue, necrosis, and cavity formation, thus leading to the application of the term, acute cavity.

The anatomical features of the latter are in striking contrast to those of the chronic cavity. It is soft-walled, surrounded by simple inflammatory tissue, without an organised pyogenic membrane, and, here, healing by resolution is possible. To quote JACQUEROD'S (22) words, "in these cases a cavity is not the final phase of pulmonary tuberculosis but is one of the earliest and most easily curable". The process of resolution, which is similar to that seen in a simple pneumonia, occurs in the wall of the cavity, leaving nothing at the site of the lesion except a vesicle similar in nature to an emphysematous bulla which, later, is swallowed up by the hypertrophy of the surrounding tissue and vanishes, leaving in the radiogram a simple linear scar. This is a possible method of healing which does take place in favourable cases, but certain conditions must be present for its accomplishment. These have been enumerated by POTTENGER (23) who studied the question of healing in acute cavities and published his observations in 1932.

He/

He lays particular stress upon the following points:

(1). The patient's power of reaction has not been broken down by a long illness.

(2). As a result of the large reinoculation of tubercle bacilli which were responsible for the cavity formation the patient's specific resistance is temporarily raised.

(3). The cavity, as a rule, is formed in tissues which prior to the time of infection had not departed far from the normal.

(4). The lung has a normal elasticity and usually is not bound by pleural adhesions, therefore it compensates readily and closes the cavity by fibrosis aided by emphysema.

(5). There is no rigid fibrous wall to hold the cavity patent.

The same author enumerates the following conditions as being unfavourable to the healing of this type of lesion:

(1). A cavity situated near the apex and covered by a pleural cap.

(2). Cases in which the contralateral lung is affected. Here the difficulty arises from the absence of sufficient compensatory emphysema in the contralateral lung to relax the tissues around the cavity.

(3). When the apices and the upper mediastinum are adherent.

(4). Cavities situated near the diaphragm or at the hilum. Here the greater motility of the diaphragmatic area and the lessened elasticity of the hilar tissues constitute barriers to effective closure.

Regarding/

Regarding the same question, JACQUEROD (4), in 1928, stated that the appearance in pulmonary tuberculosis of a cavity as the initial lesion need not necessarily be regarded as a particularly grave prognostic feature, and that, under certain conditions, a recently formed cavity is one of the most easily curable lesions. The conditions which he demands are a good general resistance on the part of the patient, a sound alimentary system, the absence of fever and the ability to follow out a regime of strict and prolonged rest.

The chronic cavity.

In dealing with the factors which influence healing in the chronic cavity, however, the conditions show a marked change and mechanical factors take first place. To quote POTTENGER'S (23) words, "The healing of early cavities depends primarily on the patient's ability to marshal an adequate defence, both specific and non-specific, and secondarily is a question of mechanics. The healing of the late cavity is primarily a mechanical problem ... the fact that the disease has become chronic denotes resistance."

Take the picture of the chronic case.

Here/

Here we are dealing with gross structural changes of long-standing occurring in a patient of an entirely different type. The lung has become infiltrated with fibrous tissue, its elasticity and ability to compensate for loss of parenchyma by emphysematous changes is diminished, and the chance of spontaneous closure of a chronic cavity depends on its power of shrinkage and retraction. When a cavity has reached the third clinical stage and is composed of thick and rigid fibrous walls, healing is only possible by drying of the walls, by encystment, by its obliteration by means of calcium deposition or by complete fibrous transformation of the entire area. (Jacquerod). This latter method is the most common and may be brought about by massive fibrous change and shrinkage of an entire lobe, sometimes indeed of an entire lung, and is accompanied by displacement of the mediastinum to the affected side and by falling in of the chest wall. The shrinkage of the diseased lung and the consequent changes in the thoracic contents demand a corresponding increase in the size of the centra-lateral lung which becomes emphysematous and thus assists in the pushing over of the mediastinum. When lesions exist in the opposite lung which are of sufficient severity to interfere with this process of compensation/

compensation then complete healing of the cavity by fibrosis is not possible. Thus the presence of dense pleural adhesions (preventing shrinkage inwards), a fixed mediastinum, and bilateral disease are all points unfavourable to healing in these chronic cases. Further points having a direct bearing on the chances of healing were enumerated by MacMAHON and KERPER at the conclusion of their recent paper. They considered that the following facts should be taken into consideration as regards prognosis:

(1). The side on which the cavity was situated. They found that spontaneous closure occurred twice as often in the right lung as in the left and three times as often as in bilateral cases.

(2). The size of the cavity. Their results showed that the chance of spontaneous closure was inversely proportional to the size of the cavity.

(3). The nature of the cavity wall. Here the conclusion drawn was that the thicker the wall the poorer became the chance of healing.

(4). The situation of the cavity. According to their figures a central location gave twice as good a healing prognosis as a peripheral situation.

They concluded also that age was a factor of little consequence in these cases and that gain in weight was an unreliable index of cavitary healing.

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In discussing chronic cavity the word "healing" has so far been taken to mean closure of the cavity but healing in the sense that the patient is rendered non-infectious and is able to resume his occupation may be brought about without actual obliteration of the vomica. This may be seen in those cases spoken of by BURRELL as "dry cavities" where the shadow is still visible on the X-ray film but the patient has no sputum and no systemic disturbance. This is only possible when the focus is situated in the upper lobe where the slope of the bronchus has permitted adequate drainage. Again, another form of "cure" may be seen where the cavity persists but where there is incomplete drying of its walls. In these cases a small quantity of sputum remains but it does not contain tubercle bacilli and the patient's general condition and working capacity is compatible with complete clinical cure. A further method is seen in certain other cases where the main bronchus to a lobe becomes obstructed, with consequent massive shrinkage of the lobe and the encystment of the cavity in the midst of sclerosed tissue. This latter is described by JACQUEROD who expresses himself as unable to form an opinion as to whether the blockage of the bronchus is primary or secondary.

To/

To sum up: the question of prognosis in cases showing excavation involves the consideration of many factors, particularly an estimation of the acuteness or chronicity of the process, the extent of the lesion, the anatomical features of the cavity and the general resistance of the patient. Spontaneous closure does occur both in the early and the chronic type, but in the latter a good prognosis is not absolutely dependent upon obliteration of the cavity.

TREATMENT OF CAVITATION.

Having considered the problem of prognosis in cases of tuberculous excavation in the lungs, attention is next directed towards the question of treatment.

Reduced to its simplest form the problem resolves itself into two alternatives, whether to utilise simply what may be termed general sanatorium treatment, or to supplement such treatment by one or other of the various forms of collapse therapy. By many authorities the presence of excavation is considered the indication par excellence for collapse of the diseased lung. EDWARDS (24), writing in "Tubercle" in June, 1930, stated that in his opinion a cavity of any size was always an indication for artificial pneumothorax. This view has also been endorsed by LESLIE (25) and PACKARD (26) in America. But a study of the statistics and opinions quoted in the preceding section indicate that this rather sweeping statement is not universally applicable, and that cases do occur where pulmonary excavation heals without the aid of collapse therapy and where the patient is enabled to obtain arrest of the infection by ordinary general sanatorium treatment.

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In considering the methods of treatment available for dealing with cavitation, first and foremost must be placed rest, for this, as in every form of tuberculosis, is the basis of all treatment in cavity cases. And in this instance rest implies rigid rest in bed over a prolonged period.

In suitable cases rest may be supplemented, but never replaced by, any or several of the various forms of collapse therapy such as artificial pneumothorax, phrenicectomy, scalenectomy, extrapleural pneumolysis with or without paraffin packing, or thoracoplasty. Artificial pneumothorax in its turn may be supplemented by intrapleural section of adhesions, open operation for the same purpose or by oleothorax.

These then are the methods of treatment available. Before proceeding to a detailed consideration of cases and the results of treatment, a brief review of the more recent literature on the subject, particularly that dealing with the application of surgical measures, may be of value.

Artificial pneumothorax is taken first of all as being the longest established method of collapse. The field of application of this procedure has been considerably widened during recent years by the increasing/

increasing use of bilateral compression and also by the advances made in the use of the thoracoscope and the technique of adhesion cutting. Simultaneous bilateral pneumothorax was first advocated by ASCOLI in 1912, but it is only in recent years that it has passed the experimental stage and been enrolled amongst the relatively effective measures against bilateral tuberculosis. In theory at any rate this would seem a tremendous advance particularly when combined with cauterisation of adhesions, but in practice the field is limited. Of necessity the collapse obtained on both sides must be partial or selective in character and it is difficult to see how any great benefit is to be obtained in cases of bilateral thick-walled cavities, although POLLOCK and MARVIN (27) have advocated its trial in such circumstances. In the soft-walled variety, however, where pressure is being exerted upon comparatively compressible tissue there would appear to be a wider range of application of this measure. But even then, the necessity for close supervision of the case over long periods, especially following discharge from an institution, may prove a matter of difficulty from the point of view of both the physician and of the patient, who might be inconvenienced/

inconvenienced by the necessity for frequent absences from work. Still there is no doubt that there is a place, albeit a limited one, for bilateral artificial pneumothorax in the treatment of bilateral excavation.

The operation of intra-pleural pneumolysis must also be considered in connection with artificial pneumothorax for any proceeding that will dispose of the sanatorium bugbear of a suspended cavity is deserving of the most careful consideration. FOWLER, addressing the Tuberculosis Association in October, 1933, drew attention to the vastly better results obtained in pneumothorax cases at Pinewood Sanatorium during the previous two years when section of adhesions was carried out whenever possible, and made a plea for early thoracoscopy in all cases where a cavity was being held out by adhesions. By this means he claimed that pneumothoraces which were likely to be unsatisfactory could be detected and more appropriate treatment advised without loss of time. MATSON (28) reports a series of 62 cases, 43 of which were successful and 18 much improved, while DIEHL and KREMER (29) have performed 272 operations with a resultant complete pneumothorax in 63 per cent. On the other hand O'BRIEN (20) reviewing/

reviewing 2000 pneumothorax cases studied over a period of five years at the Herman Keifer Hospital, Maybury Sanatorium, and the American Legion Hospital at Battle Creek, found that only sixteen operations of adhesion cutting to secure collapse of cavities were necessary.

The value of phrenicectomy or phrenic evulsion in the treatment of cavitation is still in doubt. While opinion is unanimous as to the beneficial result in basal excavation, the question of whether it produces any permanent effect on cavities situated in the upper lung field has resulted in conflicting reports. MORRISTON DAVIES (31) is of opinion that upper lobe and even apical cavities can be influenced to such an extent that they disappear after phrenicectomy, but states that it is unreasonable to expect such a result if the cavity is large and rigid-walled. H. E. WATSON (32) reports that of 42 upper zone lesions with varying degrees of excavation 19 were benefited as a result of phrenicectomy and 20 were worse or dead. Of these 17 had large rigid-walled cavities, and only five of this type benefited to any extent, while of these five only two were fit for work. In six cases with soft-walled cavities, four showed improvement/

improvement, and in seven cases with multiple excavation only one improved as a result of the operation.

NAEGELI and SCHULTE-TIGGES (33) also report results in 55 cases of cavitation treated by phrenicectomy as an independent method, 30.8 per cent being much improved with T.B. negative sputum, 43.7 per cent improved but still T.B. positive, and 25.4 per cent worse. In this report no details were given as to the type of cavity.

Continuing the favourable comments BERNARD and POIX (34) in 1931, reported nine cases with single cavities treated by phrenicectomy alone in which favourable results were recorded in eight with a complete clinical cure in five.

JOHNS and COLE (35) consider that phrenic evulsion is indicated for recent superficial thin-walled cavities and for moth-eaten soft-walled cavities while O'BRIEN draws attention to its use in those pneumothorax cases where string-like adhesions are holding a cavity open. His argument here is that the diaphragmatic rise causes sufficient relaxation of the adhesions to permit the cavity to close under increased intra-pleural pressures.

Bilateral phrenicectomy was first reported by/

by CURTI (36) in 1927, with a relatively good result but cases are too few for any conclusions to be drawn as to its possibilities and efficacy. GRAVESEN (37) writing in 1932 on selective collapse in bilateral disease, dismisses it by stating simply that it has been carried out.

In spite of the favourable figures mentioned phrenicectomy still remains of limited value as a single procedure in cases of tuberculous excavation. While admitting its beneficial influence in basal cavities, and in soft-walled lesions around the mid-zone, exception can be taken to its employment in cases where the cavity is located in the upper lobe or at the apex on the grounds that:

(1). It is impossible to say beforehand whether even a moderate degree of collapse is likely to ensue.

(2). It is a permanent and irradicable procedure.

(3). It is not sufficiently selective in its action, e.g. in upper lobe lesions the main pressure is exerted primarily upon the lower and better portion of the lung, and in event of cure the patient is deprived of the use of so much effective lung tissue.

The operation of scalenectomy is still sub judice although I believe that in America Fisher has reported favourable results in a series of cases where this operation was performed some time subsequent/

subsequent to phrenicectomy. MORRISTON DAVIES has also combined this operation with phrenicectomy in 11 cases, but is unable to say how much of the resultant benefit was due to the division of the muscles and how much to the diaphragmatic paralysis. The main objection to the proceeding is that it entails a major operation with its attendant risks and offers relatively minimal results, and it seems doubtful whether it will ever deserve more than mention as a method which has been tried in the treatment of lung cavities.

Let us take next the operation of apicolysis with or without plombage. There is little to be learned concerning the results of this operation from British sources and practically all the literature on the subject comes from Continental surgeons. SACHS and SPERL (38) give the following indications for the operation:-

(1). As an independent procedure in bilateral cases where thoracoplasty is contra-indicated, pneumothorax is ineffective or impossible and one side has a large rigid cavity resisting closure.

(2). Cases of upper lobe cavities where thoracoplasty is contra-indicated.

(3). When patients refuse thoracoplasty.

They report results of 8 cases in which complete disappearance/

disappearance of the cavity was noted only in one case whilst two patients developed exacerbations in the contra-lateral lung. They conclude that at best as an independent procedure plombage can only be a substitute when other operative measures for various reasons are impossible.

BRIT and SCHOLZ (39) consider that it is initially preferable to thoracoplasty in cases of large upper lobe cavities with widespread pleural adhesions and but little involvement of the remainder of the lung.

FELIX (40) reviewing 100 cases of plombage from Saeurbruch's clinic, states that the primary indication for plombage is large upper lobe cavities but concludes that:-

(1). It should never be used if pneumothorax is feasible or if thoracoplasty can promise success.

(2). It can occasionally be very useful as a complementary measure where thoracoplasty has failed to secure a satisfactory collapse of cavities.

DENK and DOMANIG (41) publishing results in 30 cases consider that it is an unsatisfactory procedure because of the failure to secure efficient compression of the cavity particularly when it is situated in the hilar region.

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In July, 1931, PROUST and MAURER (42) reported a series of cases of apicolysis without plombage in which they contended that the use of a graft was unnecessary as the apex, when freed from its attachment to the thoracic cage, contracted by virtue of the natural elasticity of the lung. A series of X-rays was included to show that this type of apicolysis was quite effective in securing the obliteration of cavities without the necessity of packing.

BEHRENS (43) in a recent publication writes enthusiastically regarding his experiences with plombage. He considers an old fibroid lesion with small cavities where the sputum remains positive as being the chief indication for operation, and mentions that in such a case the presence of tuberculous changes in the contra-lateral lung constitutes an absolute indication for interference. Not only this, but plombage is to be recommended in those cases which would permit of an upper thoracoplasty as being by far the more conservative procedure. He believes that it should also be considered in cases of extended, slightly advanced, and productive tubercular processes so as to eliminate a comparatively small apical cavity, and states that phrenicectomy/

phrenicectomy and pneumothorax of the opposite side, and under certain conditions thoracoplasty are not absolute contra-indications for plombage.

As regards results, he quotes figures to show that in 38 cases a good result (sputum negative and fit for work) was obtained in 22 instances, improvement in seven, four showed no change and five were dead. Two of the improved and one of the dead cases had the operation performed on both sides.

In spite of the apparent good results obtained by BEHRENS there is evidently no great unanimity of opinion regarding the value of apicolysis. Performed by a surgeon with experience in this type of work and on carefully selected cases it would appear to be of value, but its superiority over a partial upper thoracoplasty has not yet been clearly shown. The disadvantages of the introduction of a foreign body in the shape of paraffin packing have also to be borne in mind, and cases are quoted of infection of the plombage bed with consequent rupture to the surface, of broncho-pleural fistulae, of slipping and sinking of the paraffin packing, and BEHRENS himself mentions two instances in which rupture of the cavity wall occurred during operation with death from septicaemia in each case.

Last/

Last on the list of methods of operative collapse comes thoracoplasty, of the advantages of which there appears to be little doubt. Its use has been extended during recent years and its application on selective lines and lately to bilateral cases has strengthened its claim to be one of the most effective methods of dealing with chronic cavitation. JOHNS and COLE (35) make the very definite statement that for the closure of cavities in the treatment of the more advanced tuberculous patient they have found selective thoracoplasty to be the most effective measure, and that in unilateral cases with little other lung damage a partial thoracoplasty is their choice. They strongly advocate its wider use and record a series of cases in which removal of the ribs immediately overlying the cavities had resulted in their complete obliteration.

SCHEDTLER (44) also writes enthusiastically regarding the results of this operation and considers it specially suitable for cases showing well localised, sclerotic tuberculous cavities and for cases where artificial pneumothorax has failed owing to small apical adherent cavities. FISCHEL (45) recently published a series of 22 very chronic excavated cases where partial upper thoracoplasty had/

had been successful in securing complete obliteration as shown by lipiodal injected prior to and after operation. In these, in addition to rib resection, the parietal pleura had been widely separated from the chest wall by digital manipulation.

MORRISTON DAVIES' (46) figures show that in cases operated on between 1922 and 1927, 52 per cent are alive and well while 14 per cent are alive and moderately well. ALEXANDER, collecting world statistics on this subject, found that 36.8 per cent were cured whilst a further 24.4 per cent were improved as a result of the operation.

Up until recently thoracoplasty had been exclusively confined to cases of unilateral disease, but the widening range of applicability of the operation is shown by the publication of an account of a successful bilateral thoracoplasty by GRAVESEN in 1931. This was performed at Vejlefjord Sanatorium for bilateral apical excavation and although at the time of publication the patient was still T.B. positive, the sputum had been greatly reduced in amount, temperature had become normal, and she was able to move about in comfort. A similar case was reported by ALLEN (47) in 1932, where closure of the cavities/

cavities had been achieved and the patient had resumed his work.

The figures published up-to-date are evidence in themselves that the possibilities of a successful thoracoplasty must always be taken into consideration in dealing with third stage excavation. Cases that formerly would have been regarded as hopeless, those patients in whom strong adhesions prevented the collapse of a rigid-walled cavity by other means, now have a chance of reasonable health offered to them. The operation needs no further recommendation.

For the purpose of determining the results of treatment in cases of pulmonary excavation a series of one hundred consecutive cavity cases was selected from the case records in Tor-na-Dee sanatorium. The earliest selected was admitted to the sanatorium at the end of 1924, while the latest was in January, 1930. Their subsequent progress was followed up until the end of 1932, thus giving a period of after history varying in individual cases from seven to two years. All the records of cases admitted to the sanatorium during that period were examined and those in which there was definite evidence of cavitation were taken in order of their admission until the hundred had been obtained. No attempt was made at this stage to select any special type or degree of cavity.

In determining the presence or absence of cavitation both physical findings and X-ray evidence were taken into consideration, and where the former were indefinite the symptomatology was correlated with the radiogram in arriving at a decision. It can be safely claimed that no case has been included in the series in which any doubt existed as to the presence of a cavity.

All/

All the relevant facts concerning the selected material have been embodied in the tables appended which have been divided into two sections, A containing the details of those patients who were alive at the end of 1932, and B dealing with those who had died.

In these tables the sex of the patient, month and year of admission to the sanatorium, together with the duration of the illness (as far as the latter could be determined from the patient's history) have been included. The pulmonary condition is briefly described with the use of symbols, the red letters R. and L. indicating the right and left lungs respectively. The black letter L followed by a numeral indicates the number of lobes in each lung which were diseased, and the abbreviation cav. or cavs. with the succeeding bracketed number and the letters U.L. or L.L. describe the type and situation of the cavity. Thus taking a case at random the symbols R. L1. L.L2. cav.(3) U.L. may be interpreted as follows:- the right upper lobe and both lobes of the left lung are diseased whilst the latter lung contained a third stage cavity in the upper lobe. The letter S indicates the presence or absence of systemic disturbance (toxaemia, etc.) and T.B./

T.B.+ or T.B. negative refers to the sputum. The columns headed "Treatment", "Result" and "1932" are self-explanatory.

In Table B the immediate cause of death, e.g. haemorrhage, has been given as often as it could be ascertained, but this was not always possible in the case of those patients who had already left the sanatorium. In the actual typing of the cavities the classification used is that of Jacquerod which was described in an earlier part of this thesis and the bracketed figures (1), (2) and (3), indicate first, second and third stage cavities respectively.

TABLE A.

Containing details of cases alive at the end of 1932.

No.	Sex.	Date of Admission.	Duration of Illness.	Condition on Admission.	Treatment.	Result.	1932.
1.	M.	Dec. 1924.	years.	R. L3. cavs.(3) U.L. S. T.B.+.	General.	Disch. Aug. 1925. Improved.	Working but condition unstable. T.B.+.
2.	M.	Mar. 1925.	years.	R. L1. L. L2. cav.(3) U.L. S. T.B.+.	General. A.P. failed. Phrenic Ev.1929. Thoracoplasty 1930 & 1932.	Condition I.S.Q.	Still in San.
3.	F.	Apr. 1925.	3 yrs.	R. L3. cav.(3) U.L. L. L1. S. T.B.+	General.	Disch. Sept.1925, At own request.	Lost sight of.
4.	M.	Apr. 1925.	1 year.	R. L3. cav.(2) U.L. L. L2. cav.(1) U.L. T.B.+	General.	Disch. Apr. 1928. Much improved. T.B.neg. Cav. obliterated.	Full work. T.B. neg.
5.	M.	May, 1925.	1 year.	R. L3. cav.(3) U.L. L. L2. S. T.B.+	General.	Disch. June, 1926. Improved. T.B.neg.	Light work. T.B.neg.
6.	M.	May, 1925.	3 yrs.	R. L3. cav.(3) U.L. L. L1. S. T.B.+	A.P. - partial & abandoned. Phrenic Ev. 1927. Thoracoplasty 1930.	Disch. July, 1928. Condition I.S.Q.	Still in San. elsewhere. Chronic invalid.
7.	M.	May, 1925.	years.	R. L1 L. L2. cav.(1) U.L. S. T.B.+	General.	Disch. Mar. 1928. Much improved. T.B.neg. Cav. obliterated.	Full work. T.B.neg.
8.	F.	Sept.1925.	3 yrs.	L. L2. cav.(1) U.L. S. T.B.+.	A.P. - effective.	Disch. May. 1926. Much improved. T.B.neg. Cav. oblit.	Normal life. T.B.neg. A.P.stopped 1931.

No.	Sex.	Date of Admission.	Duration of Illness.	Condition on Admission.	Treatment.	Result.	1932.
9.	M.	Nov. 1925.	years.	R. L3. L. L2. cav.(3) U.L. S. T.B.+	General.	Disch. July, 1926. Much improved. T.B.+. Cav.much smaller.	Full work & in good health. T.B.+
10.	M.	May, 1926.	8 yrs.	R. L1. L. L2. cav.(2). U.L. S. T.B.+	A.P. - partial & ineffect. Stopped Jan. 1928 = Spread in R. Lung. General.	Disch. Aug. 1929. Much improved. T.B.neg. Cav. oblit.	Full work. T.B.neg.
11.	M.	Dec. 1926.	years.	R. L1. L. L1. cav.(3) U.L. S. T.B.+	General.	Disch. July, 1927. Much improved. T.B.+ Cav.still seen. A.P. refused.	Working. T.B.+. Well but subject to periodic haemoptysis = high B.P.
12.	M.	Jan. 1927.	years.	R. L3. cav.(2) U.L. L. L1. S. T.B.+	General.	Disch. May, 1927. Much improved. T.B.+ Cav.not oblit.	Well. Full work T.B.neg.
13.	M.	Jan. 1927.	years.	R. L2. cav.(2) U.L. L. L2. cav.(1) L.L. S. T.B.+	General.	Disch. May, 1928. Much improved. T.B.+. Cav.L.lung closed. " R. " smaller.	Well. Working. Cav.oblit. T.B.+.
14.	F.	Mar. 1927.	years.	R. L3. cav.(2) U.L. L. L1. S. T.B.+	A.P. ineffect. & abandoned. General.	Disch. July, 1928. No improvement.	Much worse. Cav. L.U.L.

No.	Sex.	Date of Admission.	Duration of Illness.	Condition on Admission.	Treatment.	Result.	1932.
15.	M.	Apr. 1927.	years.	R. L3. cav.(3) L.L. L. L2. S. T.B.+	General.	Disch. Oct. 1927. Very well. T.B.neg.	Re-adm. 1931. Much worse. Cavities both lungs.
16.	M.	May, 1927.	1 yr.	L. L1. cav.(1) U.L. S. T.B.+	General.	Disch. June, 1927. Very well. T.B.neg.	Re-adm. June, 1929. Much worse. Chronic invalid.
17.	M.	Aug. 1927.	years.	R. L1. L. L.2. cavs.(2) U.L. S+. T.B.+.	A.P.failed. Phrenic.Ev.Feb.1928. Thoracoplasty Nov. 1928.	Disch. Sept.1929, for disciplinary reasons.	Chronic invalid. T.B.+.
18.	M.	Aug. 1927.	1 year.	R. L2. cav.(3) U.L. L. L1. S. T.B.+	General. A.P. refused.	Disch. Aug. 1928. Improved. T.B.+.	Working but health unstable. T.B.+.
19.	F.	Aug. 1927.	3 yrs.	R. L3. cav.(2) U.L. L. L1. S. T.B.+	General. A.P.later but ineffective.	Disch. Feb. 1929. Improved but T.B.+. Cav.not oblit.	Fairly well. T.B.+.
20.	F.	Sep. 1927.	years.	R. L2. cav.(3) U.L. L. L2. S. T.B.+.	General. 1929. A.P.failed. Sanocrysin.	Disch. July, 1931. Slightly improved. T.B.neg.	Rather worse. T.B.+.
21.	F.	Sep. 1927.	2 yrs.	R. L1. L. L1. cav.(3) U.L. T.B.+	General. Sanocrysin. A.P. 1929 - effective.	Disch. Apr. 1930. Much improved. Cav.oblit. T.B.neg.	Very well. T.B.neg. Still A.P.
22.	M.	Jan. 1928.	1 yr.	R. L1. cav.(3) U.L. L. L1. S. T.B.+	General. Sanocrysin. A.P. 1928 - partial & effective.	Disch. May, 1930. Much improved. T.B.neg.	Very well. Still A.P. T.B.neg.

No.	Sex.	Date of Admission.	Duration of Illness.	Condition on Admission.	Treatment.	Result.	1932.
23.	F.	Feb. 1928.	years.	R. L3. cav.(3) U.L. T.B.+.	A.P.before admission. Cavity patent. Sanocrysin.	Disch. June, 1930. Much improved. T.B.neg. Cav. closed.	Very well. T.B.neg. Still A.P.
24.	M.	Mar. 1928.	1 yr.	R. L3. cav.(3) U.L. L. L2. S+. T.B.+.	General. Sanocrysin.	Disch. June, 1929. Improved. T.B.+.	Well. Light work.
25.	F.	Mar. 1928.	5 yrs.	R. L2. L. L2. cav.(1) U.L. S. T.B.+.	General. Sanocrysin.	Disch. June, 1930. Unimproved.	I.S.Q.
26.	F.	Mar. 1928.	years.	R. L1. L. L2. cav.(3) U.L. S. T.B.+.	General. Nov.1928 Spont.Pneum. L.side. Kept up as A.P. - effective.	Disch. Oct. 1930. Improved. T.B.neg. Cav.oblit.	Very well. Still A.P.
27.	F.	Mar. 1928.	1 yr.	R. L1. cav.(1) U.L. L. L1. S. T.B.+.	General.	Disch. Sept. 1928. Much improved. T.B.neg. Cav.obliterated.	Very well. T.B.neg.
28.	M.	Mar. 1928.	years.	R. L1. cav.(2) L.L. L. L1. S+. T.B.+.	General.	Disch. Mar. 1929. No improvement.	I.S.Q.
29.	F.	Mar. 1928.	years.	R. L3. cav.(3) U.L. L. L2. cav.(3) U.L. S+. T.B.+.	General.	Disch. Apr. 1928. No improvement.	Bed ridden.
30.	F.	May, 1928.	3 mths.	L. L1. (cav.(1) U.L. S+. T.B.+.	General. A.P.Aug.1928 - obliterated. Sanocrysin.	Disch. Jan. 1932. No improvement.	I.S.Q.

No.	Sex.	Date of Admission.	Duration of Illness.	Condition on Admission.	Treatment.	Result.	1932.
31.	F.	June, 1928.	2 yrs.	L. L2. cav.(3) U.L. S. T.B.+.	A.P.failed. Phrenic Ev.Feb.1929. Thoracoplasty Mar. 1929.	Disch. Sep. 1929. Improved. T.B.neg. Cav.oblit.	Very well. T.B.neg.
32.	F.	July, 1928.	30 yrs.	R. L3. cav.(3) U.L. L. L1. S. T.B.+.	General.	Disch. Jan. 1929. Improved. T.B.+. Cav.not oblit.	Very well. T.B.neg.
33.	F.	Aug. 1928.	9 mths.	R. L3. cav.(2) U.L. S. T.B.+.	General.	Disch. Nov. 1928. Much improved. T.B.neg. Cav.oblit.	Very well. T.B.neg.
34.	M.	Sep. 1928.	2 yrs.	R. L1. L. L2. cav.(2) U.L. T.B.+.	General. A.P. Jan. 1930 - ineffective.	Still in San. Much disabled.	
35.	M.	Nov. 1928.	2 yrs.	R. L3. cav.(2) U.L. L. L1. S. T.B.+.	General. Sanocrysin.	Disch. July, 1930. Improved. T.B.neg. Cav.much smaller.	Well. Normal life.
36.	F.	Nov. 1928.	3 yrs.	R. L1. L. L2. cav.(3) U.L. S+. T.B.+.	General. July,1929 A.P. - ineffective. Apr.1930. Phrenic Ev. May, 1931 - Thoracoplasty - good collapse.	Disch. July, 1931. Improved. T.B.neg.	Fairly well.
37.	F.	Nov. 1928.	2 mths.	R. L3. cav.(3) S+. T.B.+.	General. Disease developing. L.Lung prevented A.P.	Disch. Aug. 1929. Improved. T.B.neg. Cav. obliterated.	Well. T.B.neg.

No.	Sex.	Date of Admission.	Duration of Illness.	Condition on Admission.	Treatment.	Result.	1932.
38.	M.	Dec. 1928.	4 yrs.	R. L1. L. L2. cav.(3) U.L. T.B.+.	A.P. ineffective. Thoracoplasty 1930.	Disch. June, 1932. Much improved. T.B.neg. Cav.oblit.	Very well. T.B.neg.
39.	M.	Dec. 1928.		R. L1. L. L2. cavs.(1) U.L. S. T.B.+.	General. Jan. 1929, A.P. - effective.	Disch. Oct. 1929. Much improved. T.B.neg. Cav.oblit.	Very well. A.P.stopped.
40.	M.	Jan. 1929.	yrs.	R. L1. L. L2. cav.(2) U.L. S. T.B.+.	General. A.P. failed. Sanocrysin.	Disch. July, 1930. Much improved. T.B. neg. Cav. oblit.	Very well. T.B.neg.
41.	M.	Apr. 1929.	3 mths.	R. L1. L. L2. cav.(3) U.L. S. T.B.+.	General.	Disch. May, 1931. Much improved. T.B.neg. Cav.oblit.	Very well. Full work. T.B.neg.
42.	M.	Apr. 1929.	1 yr.	R. L3. cav.(1) U.L. L. L2. cav.(2) U.L. S. T.B.+.	General.	Disch. Dec. 1929. Improved. T.B.+. Cav. smaller.	Very well. Full work. T.B.neg.
43.	F.	Apr. 1929.	yrs.	R. L1. cav.(3) U.L. L. L2. T.B.+.	General.	Disch. July, 1929. Slightly improved. T.B.+. Cav.not oblit.	Chronic invalid. T.B.+.
44.	F.	June,1929.	1 yr.	R. L3. cav.(3) U.L. L. L1. S. T.B.+.	General.	Disch. Aug. 1929, against advice. No improvement.	Chronic invalid. T.B.neg.
45.	F.	Aug. 1929.	4 yrs.	L. L2. cav.(3) U.L. T.B.+.	General. A.P.failed. Nov.1930. Phrenic Ev. Jan.1931. Thoraco- plasty.	Disch. April,1931. Much improved. T.B.neg.	Very well. T.B.neg.

No.	Sex.	Date of Admission.	Duration of Illness.	Condition on Admission.	Treatment.	Result.	1932.
46.	M.	July,1929.	1 yr.	R. L2. cav.(3) U.L. L. L2. cav.(2) U.L. S. T.B.+.	General.	Disch. Nov. 1929, at own request. I.S.Q.	Chronic invalid.
47.	M.	Aug. 1929.	2 yrs.	R. Ll. L. L2. cav.(1) U.L. S. T.B.+.	General.	Disch. Jan. 1930. Much improved. T.B.neg. Cav.oblit.	Very well. T.B.neg.
48.	M.	Jan. 1930.	8 mths.	R. Ll. L. L2. cav.(2) U.L. T.B.+.	General. Aug.1931.- A.P. - effective.	Disch. June, 1932. Much improved. T.B.neg.	
49.	M.	Jan. 1930.	1 yr.	R. L3. cav.(1) U.L. L. Ll. S. T.B.+.	General.	Disch. July, 1930. Improved. T.B.+. Cav. oblit.	Very well. T.B.neg.

T A B L E B.

Containing details of cases dead at the end of 1932.

No.	Sex.	Date of Admission.	Duration of Illness.	Condition on Admission.	Treatment.	Immediate Result.	Death.
1.	M.	Oct. 1924.	15 yrs.	R. L3. cav.(3) U.L. L. L2. cav.(3) U.L. S. T.B.+.	General.	Disch. Dec. 1924, at own request.	July, 1925 - haemorrhage.
2.	M.	Oct. 1924.	4 yrs.	R. L1. L. L2. cav.(3) U.L. S. T.B.+.	General.	Disch. Nov. 1924, at own request.	Dec. 1926 - haemorrhage.
3.	M.	Nov. 1924.	6 yrs.	R. L3. cav.(3) U.L. L. L2. cav.(3) U.L. S+. T.B.+.	General.	No progress. Died, July, 1926.	
4.	M.	Nov. 1924.	yrs.	R. L3. cav.(3) U.L. L. L2. S+. T.B.+.	General.	Disch. Mar. 1925. No progress.	Mar. 1925.
5.	F.	Dec. 1924.	13 yrs.	R. L3. L. L2. cav.(2) U.L. S+. T.B.+.	General.	Disch. May, 1925. Much improved. T.B.neg.	May, 1928. Influenza.
6.	M.	Feb. 1925.	1 yr.	R. L3. cav.(3) U.L. L. L2. cav.(2) L.L. S. T.B.+.	General.	No progress. Died June, 1926.	
7.	M.	May, 1925.	2½ yrs.	R. L3. cavs.(3) U.L. L. L2. S+. T.B.+.	General.	Disch. Feb. 1926. Improved. T.B.+.	Died, 1928.
8.	M.	June,1925.	yrs.	R. L3. cav.(3) U.L. L. L2. S+. T.B.+.	General.	Disch. Dec. 1925. Improved. T.B.+.	Died, Sept. 1926. Haemorrhage.
9.	M.	June,1925.	3 yrs.	R. L3. cav.(3) U.L. L. L2. S+. T.B.+.	General.	Disch. Aug. 1927. Improved. T.B.+. Cav. smaller.	Died,Nov.1932. Flare-up of old lesion.
10.	M.	June,1925.	3 yrs.	R. L3. cav.(3) U.L. L. L1. S+. T.B.+.	General. Oct.1925- A.P.- ineffective.	Disch. May, 1926. No progress.	Died, Aug. 1926.

No.	Sex.	Date of Admission.	Duration of Illness.	Condition on Admission.	Treatment.	Immediate Result.	Death.
11.	F.	July, 1925.	2 yrs.	R. L3. cav.(3) U.L. L. L2. S+. T.B.+.	General.	No progress. Died Aug. 1925.	
12.	M.	July, 1925.	2 yrs.	R. L3. cav.(3) U.L. L. L2. T.B.+.	General.	Disch. May, 1928. Very well. T.B.neg.	Died, Jan.1932. Relapse.
13.	M.	Aug. 1925.	1 yr.	L. L2. cav.(2) U.L. S+. T.B.+.	General. Temperament prevented A.P.	Disch. May, 1926. No progress.	Died - ? date.
14.	F.	Aug. 1925.		R. L1. L. L1. cav.(1) L.L. S+. T.B.+.	General.	Disch. Dec. 1925, Own request.	Nov. 1928. Did not keep up treatment.
15.	M.	Aug. 1925.	3 yrs.	R. L1. L. L2. cav.(2) U.L. S. T.B.+.	General.	Died, Jan. 1926,- haemorrhage.	
16.	M.	Sep. 1925.	25 yrs.	R. L1. L. L2. cav.(3) U.L. S. T.B.+.	General.	Disch. Mar. 1926, at own request.	? date.
17.	M.	Oct. 1925.	2 yrs.	R. L1. L. L1. cav.(2) U.L. S+. T.B.+.	General.	Died, Jan. 1926. No progress.	
18.	M.	Oct. 1925.	6 yrs.	R. L3. L. L2. cav.(3) U.L. T.B.+.	General.	Disch. May, 1926. Improved. T.B.+.	Oct. 1930.
19.	M.	Jan. 1926.	7 yrs.	R. L1. L. L1. cav.(3) U.L. T.B.+.	General. A.P. failed.	No progress. Died, July, 1926,- haemorrhage.	
20.	M.	Mar. 1926.	yrs.	R. L3. cav.(3) U.L. L. L1. S. T.B.+.	General.	Disch. Aug. 1926. No progress.	? date.

No.	Sex.	Date of Admission.	Duration of Illness.	Condition on Admission.	Treatment.	Immediate Result.	Death.
21.	M.	Mar. 1926.	13 yrs.	R. L3. cav.(3) U.L. L. Spont.pneum. S. T.B.+.	General.	No progress. Died, June, 1926.	
22.	F.	May, 1926.	6 mths.	R. L1. L. L2. cav.(2) U.L. S. T.B.+.	General. July, 1926. A.P.- effective.	Disch. Aug. 1927. Improved. T.B.+.	June, 1929. Spread to R.lung.
23.	F.	Oct. 1926.	3 yrs.	L. L2. cav.(1) U.L. S++. T.B.+.	General. A.P. failed.	Disch. Sept.1927. No progress.	Sept. 1928.
24.	F.	Dec. 1926.	6 mths.	R. L3. cav.(2) U.L. L. L2. cav.(2) U.L. S++. T.B.+.	General.	Disch. Aug. 1927. No progress.	Sept. 1927.
25.	M.	Feb. 1927.	10 yrs.	R. L1. cav.(3) U.L. L. L1. S+. T.B.+.	General.	No progress. Died, June,1927, haemorrhage.	
26.	F.	Feb. 1927.	yrs.	R. L1. cav.(3) U.L. S. T.B.+.	General. A.P. failed. Phrenic Ev.	Spread of disease L. lung. Died, Jan. 1928.	
27.	F.	Mar. 1927.	yrs.	R. L3. cav.(3) U.L. L. L2. cav.(3) S++. T.B.+.	Symptomatic.	Rapid deterioration. Died, Mar. 1927.	
28.	M.	May, 1927.	10 yrs.	R. L3. cavs.(3) U.L. & L.L. S++. T.B.+.	A.P. failed. Phrenic Ev. Thoracoplasty, June, 1928.	Died, June,1928, heart failure.	
29.	F.	June,1927.	yrs.	R. L3. cav.(3) L.L. L. L2. cav.(3) U.L. S++. T.B.+.	Symptomatic.	Rapid deterioration. Died, July,1927.	
30.	F.	July,1927.	6 yrs.	R. L3. cav.(3) U.L. L. L2. S+. T.B.+.	General.	No progress. Disch. Apr. 1928.	Died 1930.

No.	Sex.	Date of Admission.	Duration of Illness.	Condition on Admission.	Treatment.	Immediate Result.	Death.
31.	F.		6 mths.	L. L2. cav.(1) L.L. S+. T.B.+.	General.	Improved. T.B.+. Disch. at own request, Mar.1928.	Died, Sept.1928
32.	M.	Feb. 1928.	4 yrs.	R. L3. cav.(3) U.L. L. L2. T.B.+.	General.	Improved. T.B.+. Disch. Apr. 1928.	Died, Dec.1929.
33.	F.	Mar. 1928.	6 yrs.	R. L3. cav.(3) U.L. L. L2. S. T.B.+.	General.	No progress. Disch. May, 1928, at own request.	Died, Aug.1928.
34.	F.	Mar. 1928.	10 yrs.	R. L1. L. L2. cav.(3) L.L. Intest.Tub. S++. T.B.+.	Symptomatic.	Rapid deterioration. Died, Sept. 1928.	
35.	M.	Apr. 1928.	yrs.	R. L3. cav.(2) U.L. L. L2. S. T.B.+.	General.	Much improved. T.B.neg. Disch. Oct. 1928.	Died, Feb.1931. No details.
36.	M.	Apr. 1928.	9 mths.	R. L1. cav.(2) U.L. L. L1. S. T.B.+. Genito-urinary Tub. Diabetes.	General. A.P. failed.	No progress. Disch. Apr. 1929.	Died, Dec.1929.
37.	M.	Apr. 1928.	2 yrs.	R. L3. cav.(3) U.L. L. L2. S++. T.B.+.	General.	Rapid deterioration. Died, June, 1928.	
38.	F.	June,1928.	10 yrs.	R. L3.cav.(3) U.L. L. L2. T.B.+.	General.	No progress. Died, Apr. 1932.	
39.	F.	July,1928.	3 yrs.	R. L3. cav.(3) U.L. L. L2. S+. T.B.+.	General. R.A.P. 1929 - ineffective.	Broncho pleural fistula developed followed by empyema. Died. Nov. 1931.	

No.	Sex.	Date of Admission.	Duration of Illness.	Condition on Admission.	Treatment.	Immediate Result.	Death.
40.	F.	Sept.1928.	14 mths.	R. L2. cav.(3) L.L. L. L1. S++. T.B.+.	General. A.P. ineffective.	Steady deterioration. Spread in L.lung. Renal Tub. Died, May, 1929.	
41.	F.	Oct. 1928.	18 mths.	R. L3. cav.(2) U.L. L. L2. S++. T.B.+.	General.	Steady deterioration. Died, Dec. 1928.	
42.	F.	Jan. 1929.	4 yrs.	R. L1. cav.(1) U.L. S+. T.B.+.	General. Partial A.P. on admission.	Disease spread to L. side. Died, Jan. 1930.	
43.	F.	Apr. 1929.	2½ yrs.	R. L3. cav.(2) U.L. L. L1. S. T.B.+.	General.	Slight improvement. Disch. July,1929.	Died, Sept. 1929.
44.	F.	Apr. 1929.	6 mths.	R. L1. L. L2. cav.(1) U.L. S. T.B.+.	General. L.A.P. effective.	Spread to R.lung. Died, Sept. 1931.	
45.	M.	May, 1929.	3 yrs.	R. L3. L. L1. cav.(3) U.L. S+. T.B.+.	General.	No progress. Tub. enteritis. Died, Feb.1930.	
46.	M.	June,1929.	yrs.	R. L3. cav.(3) U.L. L. L1. cav.(3) U.L. S. T.B.+.	General.	Steady deterioration. Died, Mar. 1930, haemorrhage.	
47.	M.	June,1929.	18 mths.	R. L3. cav.(3) U.L. L. L2. S. T.B.+.	General.	Improved. Died, Jan. 1930, haemorrhage.	

No.	Sex.	Date of Admission.	Duration of Illness.	Condition on Admission.	Treatment.	Immediate Result.	Death.
48.	M.	June, 1929.	2 yrs.	R. L3. cav.(2) U.L. L. L2. cav.(2) L.L. S+. T.B.+.	General.	No progress. Died, Jan. 1931 - haemorrhage.	
49.	M.	July, 1929.	yrs.	R. L3. cav.(3) U.L. L. L2. cav.(3) U.L. S. T.B.+.	General.	Slight improvement. Disch. at own request, Aug. 1929.	Died, Sept. 1929.
50.	F.	Aug. 1929.	9 mths.	R. L1. L. L2. cav.(2) U.L. S. T.B.+.	A.P. ineffective. General.	Slight improvement. Died, Jan. 1931 - haemorrhage.	
51.	M.	Dec. 1929.	yrs.	L. L2. cav.(3) U.L. T.B.neg.	Thoracoplasty, Jan. 1930.	Good collapse, much improved. Disch. Mar.1930.	Died suddenly, Dec. 1930.

Of the hundred cases thus detailed it will be seen that at the end of 1932, 49 were alive and 51 were dead.

Taking the survivors first, those contained in Table A, we find that all except eight had bilateral disease while five had bilateral excavation. Excluding the five bilateral cavity cases the remaining 44 were equally divided as regards the side of the main lesion, 22 having left-sided cavities and 22 right-sided. In only five cases in Table A was the duration of the illness estimated at under one year prior to admission.

Treatment in all cases had as its basis rest in bed. This varied in strictness from complete typhoid rest in certain cases to others who were permitted to get up for toilet, the question of the degree of latitude allowed being dependent on the severity of the systemic disturbance, the acuteness and extent of the pulmonary damage and in certain instances, the temperament of the patient. The usual fresh air and dietary regime was followed, the latter being supplemented when necessary by Cod liver oil and kindred preparations. In a few cases Sanocrysin and Collosal Calcium injections were tried but as it has been impossible to estimate the benefit which ensued these drugs/

drugs have not been taken into consideration in calculating results. In no case was Tuberculin exhibited. Artificial pneumothorax was attempted in 21 cases with the following results:-

TABLE C.

Artificial pneumothorax attempted in 21 cases.

Result.	Type of Cavity.			
	1st stage.	2nd stage.	3rd stage.	
Effective.	2	1	4	7
Ineffective.	1	4	3	8
Failed.		2	4	6
	3	7	11	21

Thus out of 21 cases attempted, an effective collapse was only obtained in seven. The term "effective collapse" does not imply complete collapse but is used to describe those cases in which, as a result of the compression, toxaemia subsided, sputum disappeared or became T.B. negative, and the patient's general health showed definite improvement.

Of the 14 cases which were suitable for collapse therapy and in which Artificial pneumothorax failed, six proceeded to phrenic evulsion followed by thoracoplasty/

thoracoplasty, and one to thoracoplasty without a preliminary evulsion.

In no case was a Phrenic evulsion performed as a single method of collapse.

The results of this operative group are shown in Table D:-

TABLE D.

Seven cases where A.P. failed or was ineffective and which proceeded to thoracoplasty.

Result.	Type of Cavity.			
	1st stage.	2nd stage.	3rd stage.	Total
Arrested.			3	3
Improved.			1	1
Unimproved or Worse.		1	2	3
		1	6	7

The remaining seven cases in the attempted collapse group were treated along general lines without further collapse and the results are embodied in Table E.

TABLE/

TABLE E.

Seven cases where A.P. failed and which were treated by general measures without further collapse.

Result.	Type of Cavity.			
	1st stage.	2nd stage.	3rd stage.	Total.
Arrested.		2		2
Improved.		1		1
Unimproved or Worse.	1	2	1	4
	1	5	1	7

That now leaves us with 28 cases remaining in the original Table A which were unsuitable for collapse therapy and which were treated along general lines from the start supplemented in some instances by Sanocrysin or Collosal Calcium. The results in this group are shown in Table F:-

TABLE/

TABLE F.

28 cases receiving general treatment with or without gold therapy.

Result.	Type of Cavity.			
	1st stage.	2nd stage.	3rd stage.	Total.
Arrested.	5	4	4	13
Improved.		1	5	6
Unimproved or Worse.	2	1	6	9
	7	6	15	28

Taking the entire group of 49 patients who were alive at the end of 1932 the results of all forms of treatment are summarised in Table G:-

TABLE G.

~~29~~ 49 cases receiving all forms of Treatment.

Result.	Type of Cavity.			
	1st stage.	2nd stage.	3rd stage.	Total.
Arrested.	7	7	11	25
Improved.		2	6	8
Unimproved or Worse.	3	4	9	16
	10	13	26	49

In/

In assigning the cases to their various groups of "Arrested", "Improved", etc., the following criteria were utilised:-

"Arrested" -- this term is used solely in respect of those patients who, at the end of 1932, were able to live a reasonably normal life, carry out their full work and were either sputum-free or negative for Tubercle Bacilli. Provided that the working capacity was unimpaired and the sputum was T.B. negative, complete obliteration of the cavity as shown on the radiogram was not considered an essential qualification for admission to this group. No case, however excellent the general health, was included in which the sputum remained T.B. positive.

"Improved" -- this group includes those patients who were able for ordinary work but were still T.B. positive, those who were able for ordinary work but subject to occasional exacerbations of the pulmonary condition, and those who were able for light work.

"Unimproved or worse" -- this comprises the remainder who are either unable to work or are living a life of chronic invalidism.

As regards the side on which the cavity was located, the right sided group gave the following results:-/

results:-

Arrested 10

Improved 4

Unimproved or worse 8

while the left sided cases were:-

Arrested 12

Improved 3

Unimproved or worse 7

Of the five patients with bilateral excavation two secured arrest of the disease, one was improved and two were unimproved or worse.

In the two instances in which the cavity was situated in the lower lobe of the lung the patients were definitely worse at the end of 1932.

Taking now the contents of Table B and analysing them along similar lines, we find that all except five had bilateral disease, while bilateral excavation was present in nine instances. Excluding these nine cases the unilateral cavities were distributed thus: 25 on the right side and 17 on the left.

In only four instances in Table B was the duration of illness estimated at less than one year.

In addition to the usual regime of rest as previously described, Artificial pneumothorax was attempted/

attempted in 11 cases in Table B with the results appended in Table C1.

TABLE C1.

Artificial pneumothorax attempted in 11 cases.

Result.	Type of Cavity.			
	1st stage.	2nd stage.	3rd stage.	Total.
Effective.				
Ineffective.	2	2	2	6
Failed.	1	1	3	5
	3	3	5	11

Of these 11 cases in which Artificial pneumothorax was either ineffective or a failure 10 were treated along general lines with the following results:-

TABLE D1.

10 cases in which A.P. failed and which were treated along general lines without further collapse.

Result.	Type of Cavity.			
	1st stage.	2nd stage.	3rd stage.	Total.
Died in San.	3	2	4	9
Improved in San. Died later.		1		1
	3	3	4	10

The/

The remaining case proceeded to a Phrenic evulsion followed by a thoracoplasty, but died ten days after the latter operation from cardiac failure.

Case No. 51 in Table B had a thoracoplasty without a previous attempt at A.P. in January, 1930, and was discharged much improved in March of that year. Unfortunately he died suddenly in December, 1930, having been in good health previously; the cause of death was not reported.

The remaining 39 cases were treated by the general sanatorium routine without collapse and Table E1 is concerned with their fate.

TABLE E1.

39 cases under general treatment only.

Result.	Type of Cavity.			
	1st stage.	2nd stage.	3rd stage.	Total.
Died in San.		6	17	23
Improved in San. Died later.		2	6	8
UNCLASSIFIED.	2	1	5	8
	2	9	28	39

The "UNCLASSIFIED" column refers to those who were discharged at their own request before the completion of treatment and whose deaths were reported later.

The/

The results in the entire group of Table B are here summarised in Table F1.

TABLE F1.

51 cases dead. All forms of treatment included.

Result.	Type of Cavity.			
	1st stage.	2nd stage.	3rd stage.	Total.
Died in San.	3	8	22	33
Improved in San. Died later.		3	7	10
UNCLASSIFIED	2	1	5	8
	5	12	34	51

In eight instances in this group there were lower lobe cavities and in none of the nine cases with bilateral excavation was there any response to treatment.

Finally to summarise the results of treatment in all the hundred cases Table G is appended which shows the result of each form of treatment in each type of cavity. The only explanatory note necessary here concerns the column headed A.P. which includes all those cases in which pneumothorax was attempted. As shown previously the collapse was effective in only seven of these so that, strictly speaking, the remaining/

remaining cases in this column were treated by general measures only.

TABLE G.1.

The results of treatment in all cases, dead or alive, at the end of 1932.

Type of Cavity.	Result.	Form of Treatment.			Total.	Total of Type of Cavity.
		A.P.	Thoraco-plasty.	General.		
1st Stage.	Arrested.	2		5	7	15
	Improved.					
	Worse.	1		2	3	
	Dead.	3		2	5	
2nd Stage.	Arrested.	3		4	7	25
	Improved.	1		1	2	
	Worse.	2	1	1	4	
	Dead.	3		9	12	
3rd Stage.	Arrested.	4	3	4	11	60
	Improved.		1	5	6	
	Worse.	1	2	6	9	
	Dead.	4	2	28	34	
TOTAL.		24	9	67	100	

SUMMARY.

As a basis for investigation one hundred consecutive cases of pulmonary tuberculosis showing cavity formation were selected. These had been admitted to Tor-na-Dee Sanatorium between the years 1924 and 1930, and their subsequent progress was followed and recorded up to the end of 1932. At that time 51 of the original group were dead and 49 were alive.

Eighty-seven of the cases had bilateral disease and fourteen had bilateral excavation. Of this group two only secured arrest, one was improved, two were unimproved or worse and nine were dead.

As regards the situation of the lesion, excluding the bilateral cases, there were 47 with cavities on the right side and 39 with cavities on the left. Here the results were:-

	Arrested.	Improved.	Unimproved.	Dead.
Right side.	10 (21.3%)	4 (8.5%)	8 (17%)	25 (53.8%)
Left side.	12 (30.7%)	3 (7.6%)	7 (17.9%)	17 (43.5%)

In 10 cases there were cavities in the lower lobe and of these two only were alive and unimproved while the remaining eight were dead.

In/

In the matter of treatment artificial pneumothorax was attempted in 32 cases which were made up as follows:-

First stage cavities ... 6
Second stage cavities .. 10
Third stage cavities ... 16

An effective collapse was only obtained in seven instances, two first stage, one second stage, and four third stage cases securing arrest thereby.

Nine cases, made up of one second stage and eight third stage cavities, were treated by thoracoplasty. Three of these secured arrest, one was improved, three were unimproved or worse and two were dead.

Including the 17 cases where artificial pneumothorax failed and where further attempts at collapse were abandoned, 84 cases altogether were treated by general measures. They were made up as follows:-

First stage cavities ... 13
Second stage cavities .. 23
Third stage cavities ... 48

Of these 84, 15 (17.8 per cent.) secured arrest, seven (8.3 per cent.) were improved, 13 (15.4 per cent.) were unimproved or worse and 49 (58.3 per cent.) were dead.

The/

The sub-groups of these latter were made up thus:-

	First stage.	Second stage.	Third stage.
Arrested.	5 (37.6%)	6 (26.08%)	4 (8.3%)
Improved.		2 (8.6%)	5 (10.4%)
Unimproved or Worse.	3 (23.07%)	3 (13.04%)	7 (14.5%)
Dead.	5 (37.6%)	12 (51.7%)	32 (66.6%)

Altogether of the total one hundred cases there were 15 first stage cavities (15 per cent.), 25 second stage cavities (25 per cent.), and 60 third stage cavities (60 per cent.).

Of the first stage cases seven (46.6 per cent.) secured arrest, three (19.9 per cent.) were alive but unimproved, and five (33.3 per cent.) were dead.

Of the second stage seven (28 per cent.) secured arrest, two (8 per cent.) were improved, four (16 per cent.) were worse and twelve (48 per cent.) were dead.

Of the third stage group eleven (18.3 per cent.) secured arrest, six (10 per cent.) were improved, nine (15 per cent.) were unimproved or worse, and thirty-four (56.6 per cent.) were dead.

One/

One further point brought out by the investigation was that of the 51 cases who had died ten (19.6 per cent.) had had fatal haemorrhages. Of these ten eight were third stage cases and two were second stage.

C O N C L U S I O N S.

(1). Excavation occurring in the course of pulmonary tuberculosis is a serious complication as shown by the high mortality recorded. (51 per cent.).

(2). The question of prognosis in cases of cavity is closely related to the type of lesion, and the outlook in First stage cases is very much better than in the more chronic Third stage cavities ... 46.6 per cent arrested as opposed to 18.3 per cent. The Second stage group occupy an intermediate position with 28 per cent arrested.

(3). Left-sided cavities appear to have a rather better prognosis than those located in the right lung ... 30.7 per cent arrested as against 21.3 per cent.

(4). Bilateral excavation is of grave prognostic import.

(5). Cavities situated in the lower lobe offer very little hope of a successful result, none of those in the present series having secured arrest or even improvement.

(6)/

(6). Artificial pneumothorax as a method of treatment has been disappointing in its results, due mainly to adherent pleura preventing an adequate collapse. The results of this treatment might be improved by its application as soon as breaking down is detected, even in the absence of any gross systemic disturbance.

(7). In carefully selected Second and Third stage cases, particularly where there is evidence of fibrous reaction thoracoplasty is more likely to produce benefit than any of the other methods of collapse.

(8). Phrenicectomy is of limited value in cases of excavation as in none of these under review were the results of this operation alone sufficient to secure obliteration of the cavity.

(9). Under general treatment alone First stage lesions gave the best prognosis (37.6 per cent arrested), while the outlook in the Third stage group with a figure of only 8.3 per cent arrested is disappointing.

(10). An uncollapsed chronic cavity remains a potential source of severe haemoptysis and of the 51 deaths recorded in this series ten (19.6 per cent) were the result of a fatal haemorrhage.

BIBLIOGRAPHY.

(1). Laennec. Traite de l'auscultation mediate. Paris 1879.

(2). Jaccoud. Curabilite et traitement de la phthisie pulmonaire. Paris 1881.

(3). Wilson Fox. Diseases of the Lungs and Pleura.

(4). Jacquerod. Etude clinique et radiologique des cavernes tuberculeuses. Paris 1928.

(5). Wohlers. La guerison naturelle des cavernes pulmonaires tuberculeuses. Annales de Medicine. Nov. 1930.

(6). Sampson, Heise, Brown and Lawrason. A study of pulmonary pleural annular radiographic shadows. Amer. Rev. of Tuberc. 2. 1918-19.

(7). Amberson. Roentgenographic pleural annular shadows in pulmonary tuberculosis. Amer. Rev. of Tuberc. 5. 1921-22.

(8). Dahlstedt. Bietrage zur kenntnis der lokalisenten pneumothorax bei Lungentuberkulose. Beitrage Klin. Tuberk. 32. 1922.

(9). Assman. Der roentgendiagnostik der innern Erkrankingen. Leipzig. 1921.

(10). Graff and Kupferle. Die Lungenphthise: Ergelnisse vergleiche der roentgenologisch-anatomschr untersuchungen. Berlin. 1923.

(11). Morland. Quoted by Burrell in (12).

(12). Burrell. Tuberculous cavities of the lung. The Lancet. Feb. 1933.

(13). Burton Wood. Proceedings of the Tuberculosis Association. Tubercle. Jan. 1934.

(14). Sparks. ibid.

(15). Graff. Quoted by MacMahon and Kerper in (21).

(16)/

(16). Barnes and Barnes. The duration of life in pulmonary tuberculosis with cavity. Amer. Rev. of Tuberc. Oct. 1928.

(17). Fischel. Quoted by MacMahon and Kerper in (21).

(18). Fowler. Proceedings of the Tuberculosis Association. Tubercle. Jan. 1934.

(19). Watt. ibid.

(20). Forty-seventh Annual Report of the Trudeau Sanatorium.

(21). MacMahon and Kerper. Healing of tuberculous cavities: a clinical study. Amer. Journ. of Med. Sciences. Aug. 1933.

(22). Jacquerod. The natural processes of healing in pulmonary tuberculosis. Tubercle. July, 1931.

(23). Pottenger. Cavitation in Pulmonary Tuberculosis. Amer. Rev. of Tuberc. Sept. 1932.

(24). Edwards. Indications for phrenic evulsion and thoracoplasty. Tubercle. June, 1930.

(25). Leslie. Collapse measures for pulmonary tuberculosis. Journ. Amer. Med. Assoc. 100. 1933.

(26). Packard. The present status of one hundred pneumothorax patients after one to eighteen years expansion of the lung. Journ. Thoracic. Surgery. Aug. 1932.

(27). Pollock and Marvin. Bilateral artificial pneumothorax. Amer. Rev. of Tuberc. 26. 1932.

(28). Matson. Quoted by Morriston Davies in (46).

(29). Diehl and Kremer. Thorakoscopie und Thorakokaustic. Berlin. 1929.

(30). O'Brien. The suspended cavity in artificial pneumothorax. Journ. Thoracic Surg. Aug. 1932.

(31)/

(31). Morriston Davies. The after-effects of phrenicectomy. Tubercle. Aug. 1933.

(32). Watson. Analysis of immediate results of Phrenicectomy in pulmonary tuberculosis. Tubercle. Aug. 1933.

(33). Naegeli and Schulte-Tigges. Die radikale phrenicus operation und bedentung bie der chirurgischen behandlung der lungentuberkulose. Ztschr. Tuberk. 59. 1930.

(34). Bernard and Poix. La phrenicectomie dans la traitement de la tuberculose. Presse Medicale. Feb. 1931.

(35). Johns and Cole. Eight years of selective collapse for pulmonary tuberculosis. Journ. Thoracic Surg. II. 1933.

(36). Curti. Risultati a distanza della frenicotomia bilateral. Policlinico. 34. 1927.

(37). Gravesen. Selective lung collapse. The Lancet. Feb. 1933.

(38). Sachs and Sperle. Ueber die plomberung bei lungentuberkulose. Beitr. Klin. Tuberk. 74. 1930.

(39). Brit. and Scholz. Die behandlung der Lungenkavern. Ztschr. Tuberk. 61. 1931.

(40). Felix. Ueber die plomberung in der chirurgischen behandlung der lungentuberkulose. Ztschr. Tuberk. 59. 1931.

(41). Denk and Domanig. Chirurgie der lungentuberkulose. Beitr. Klin. Tuberk. May. 1931.

(42). Proust and Maurer. Radiographie D'apicolyse. Bull. et Mem. Soc. Nat. Chir. July, 1931.

(43). Behrens. The operation of plombage in pulmonary tuberculosis. Tubercle. Dec. 1933.

(44)/

(44). Schedtler. Statistik und Ergebris uber thoracoplastik. Deutsche. Med. Wchnschr. Mar. 1931.

(45). Fischel. Surgical treatment of tuberculous cavities. Amer. Rev. of Tuberc. Oct. 1933.

(46). Morrison Davies. Pulmonary Tuberculosis: Medical and Surgical Treatment. p. 393.

(47). Allen. Bilateral partial thoracoplasty for bilateral pulmonary tuberculosis. Journ. Thoracic. Surg. Aug. 1932.

APPENDIX.

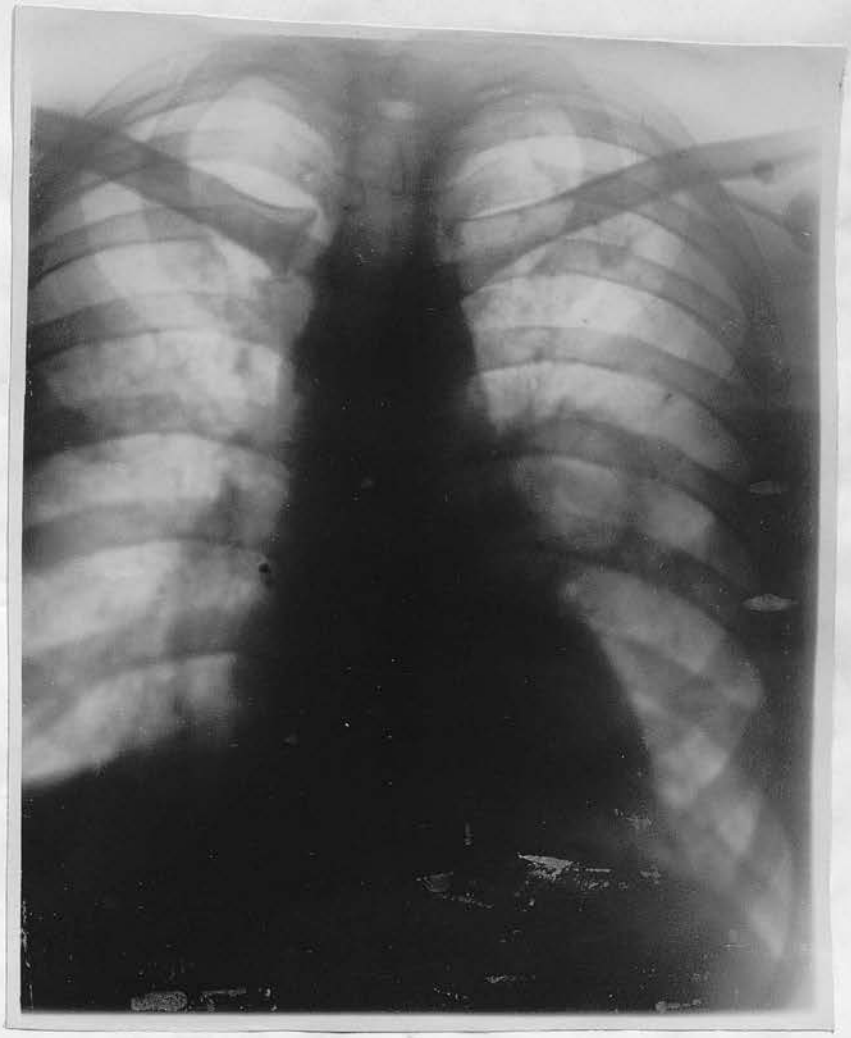

Fig. 1.

Case No. 47. (Table A).

Film taken on admission showing First Degree cavity at left hilar region.

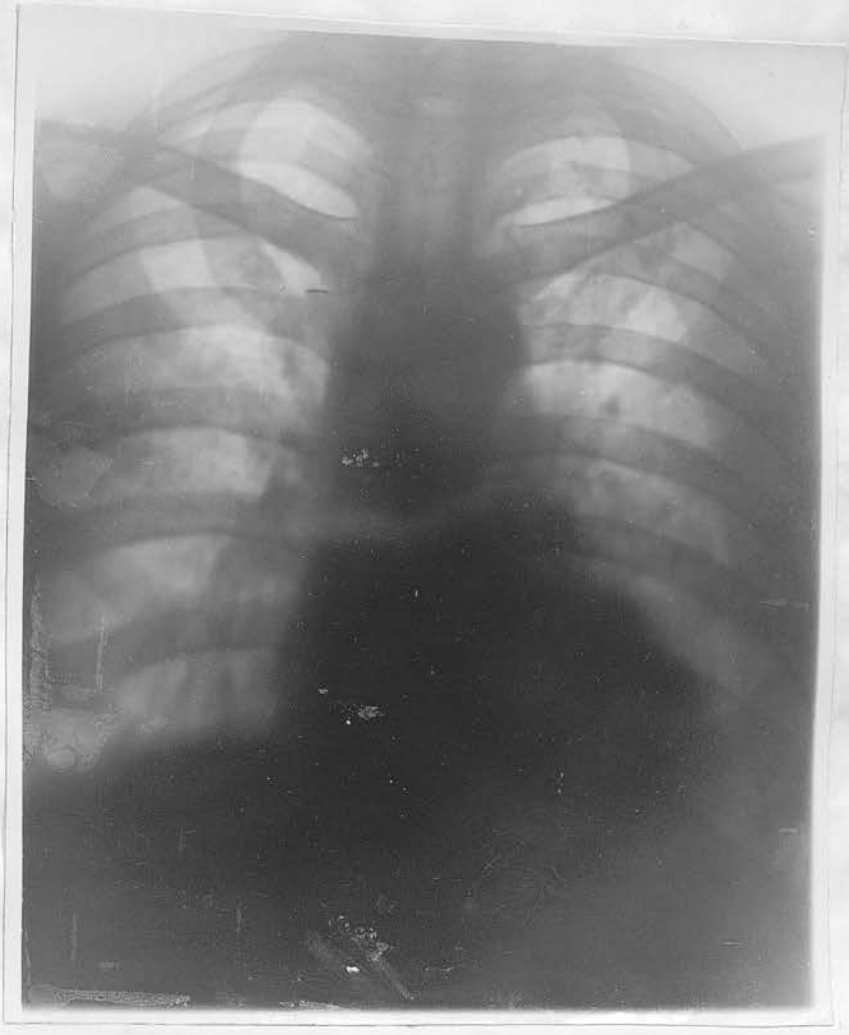

Fig. 2.

Same case.

Film taken after four months' general treatment. Cavity no longer visible.

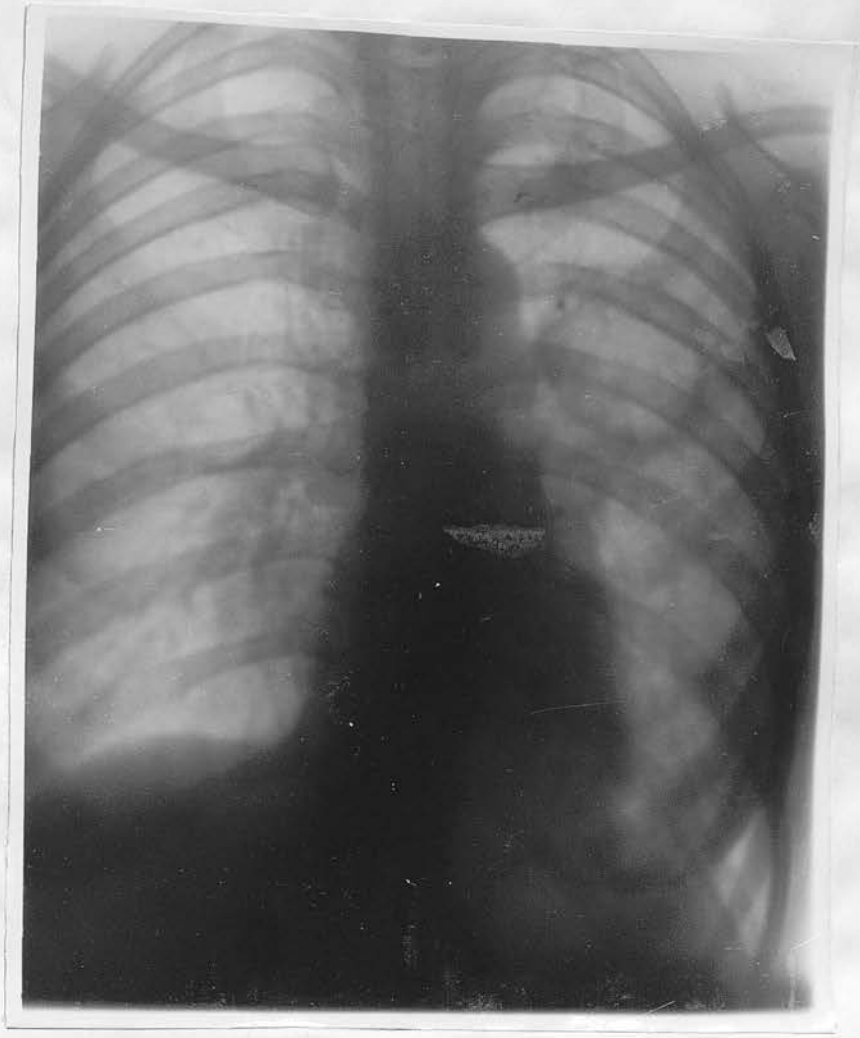

Fig. 3.

Case No. 8 (Table A).

Film taken on admission showing large First Degree cavity in the left upper lobe.

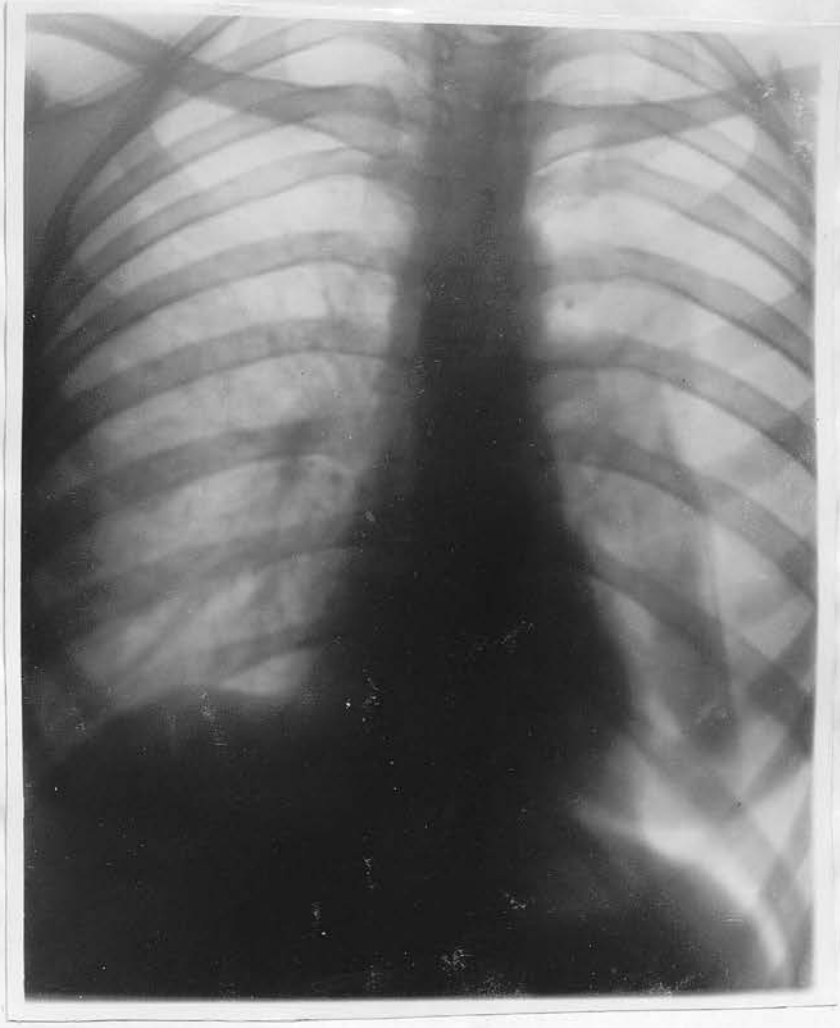

Fig. 4.

Same case.

Film taken after seven months showing artificial pneumothorax on the left side with obliteration of the cavity.

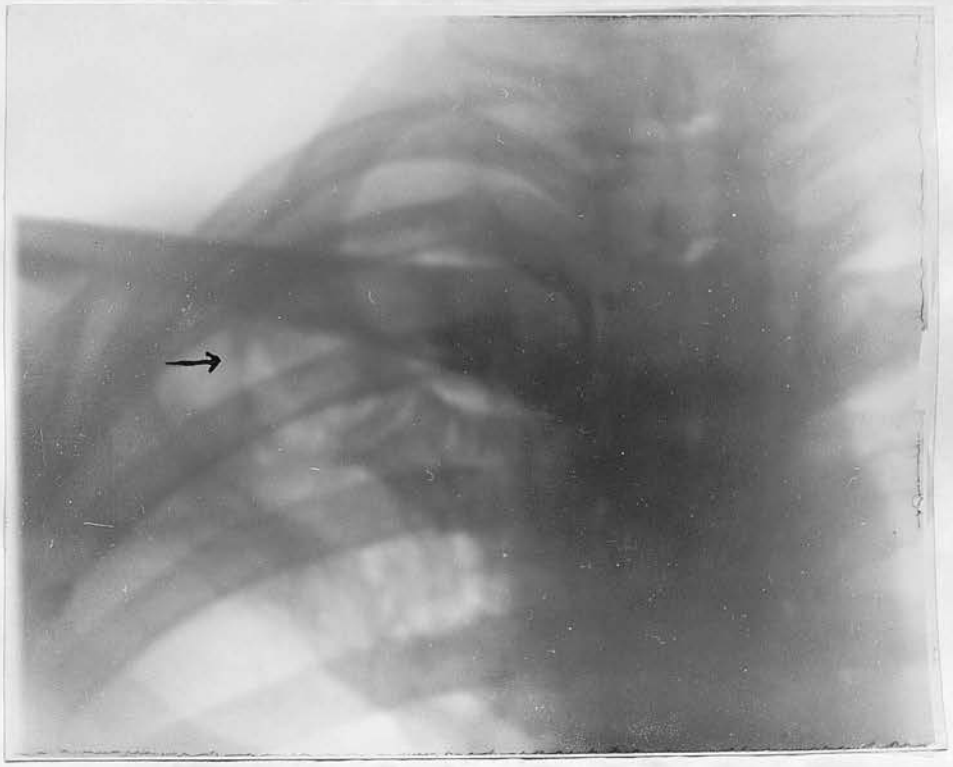

Fig. 6.

Same case (Table A).

Film taken after 18 months' general treatment. Cavity still patent.

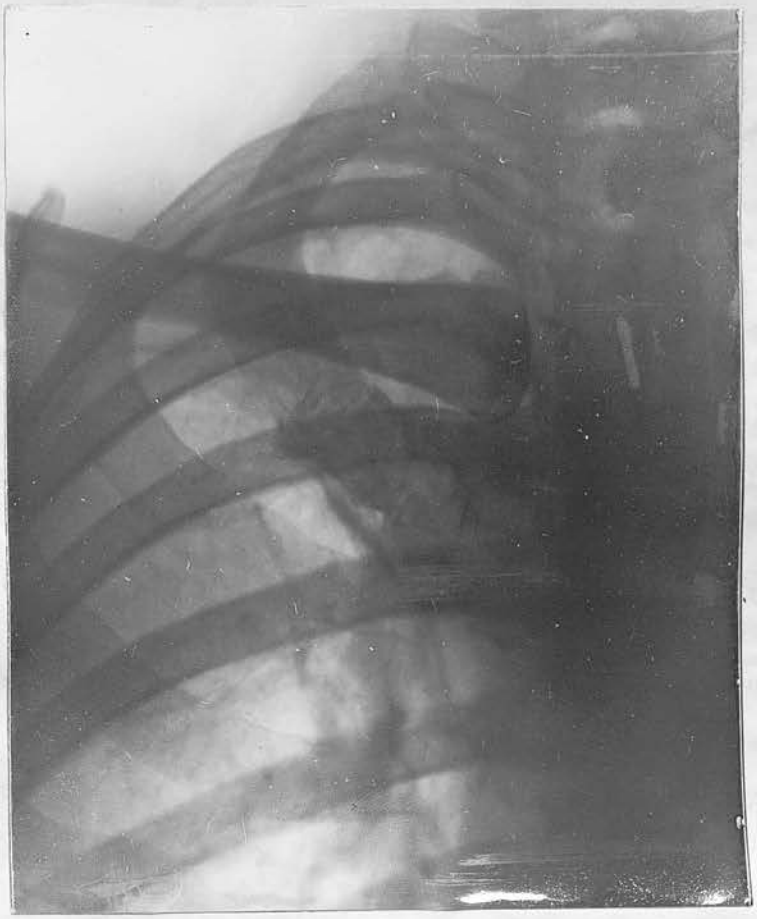

Fig. 7.

Same case.

Film taken four years after discharge. Cavity now obliterated.

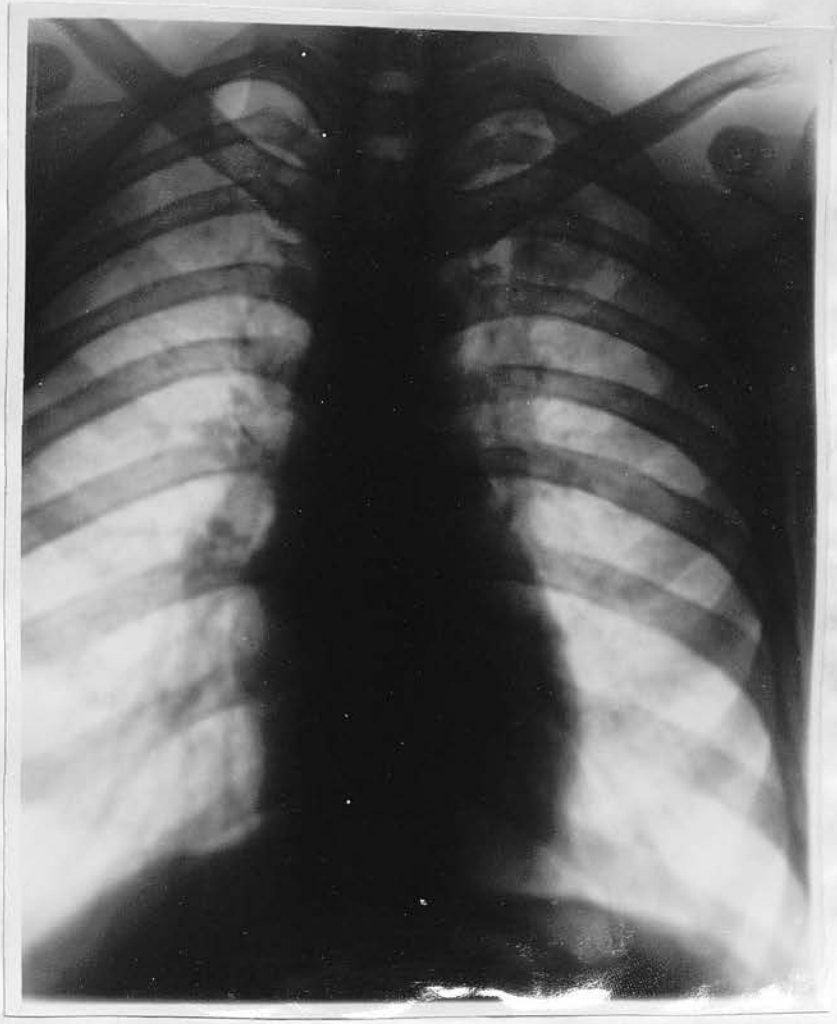

Fig. 8.

Case No. 48 (Table A).

Film taken on admission showing small Second degree cavity in the left upper lobe.

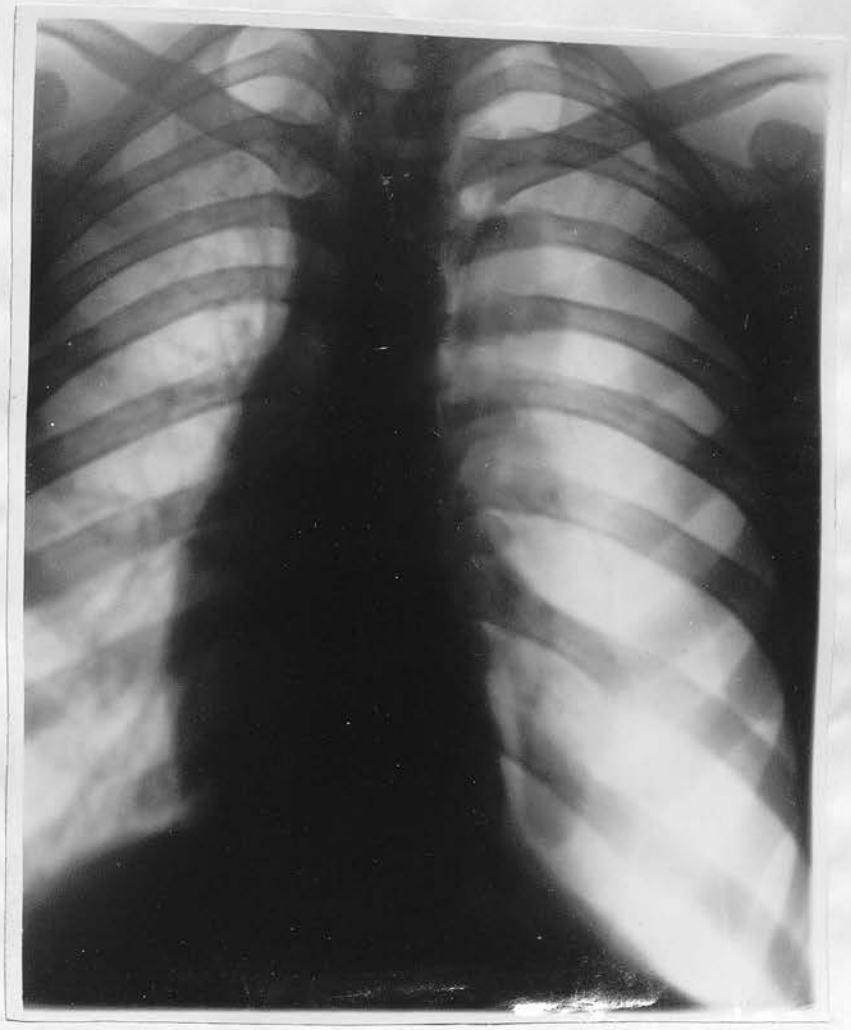

Fig. 9.

Same case.

Film taken four months after artificial pneumothorax induced on left side. Cavity obliterated.

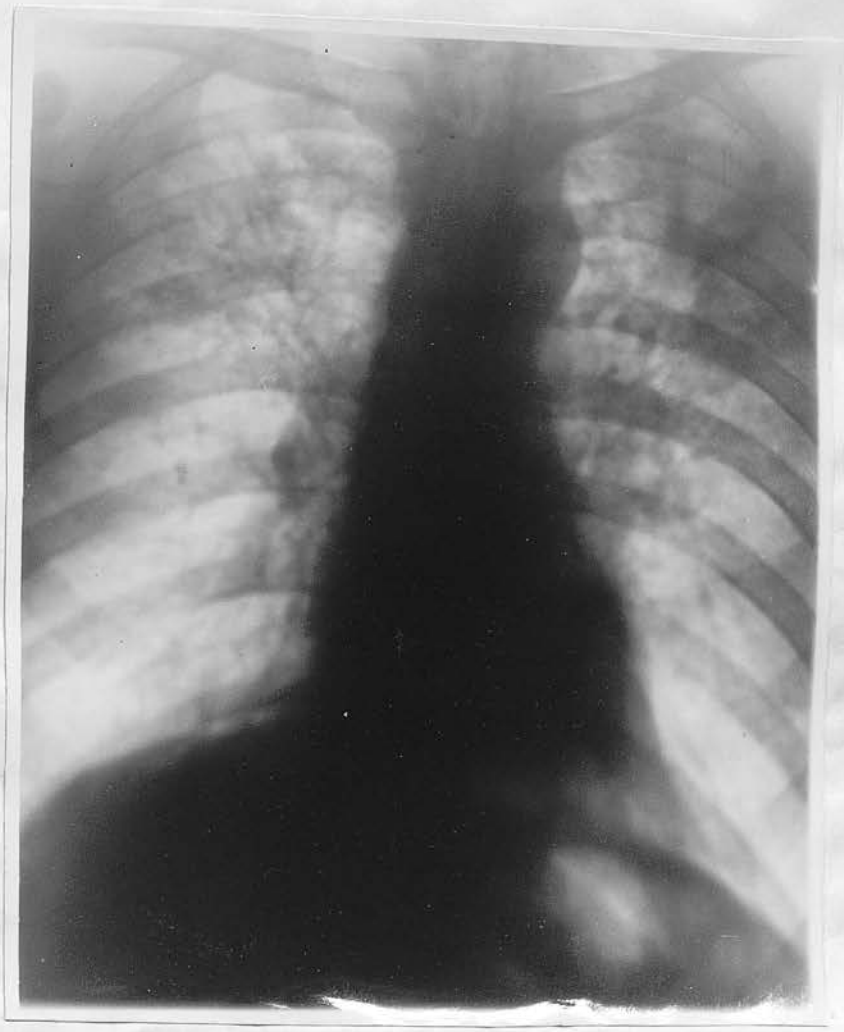

Fig. 10.

Case No. 41. (Table A).

Film taken on admission showing Third Degree cavity in the left upper lobe.

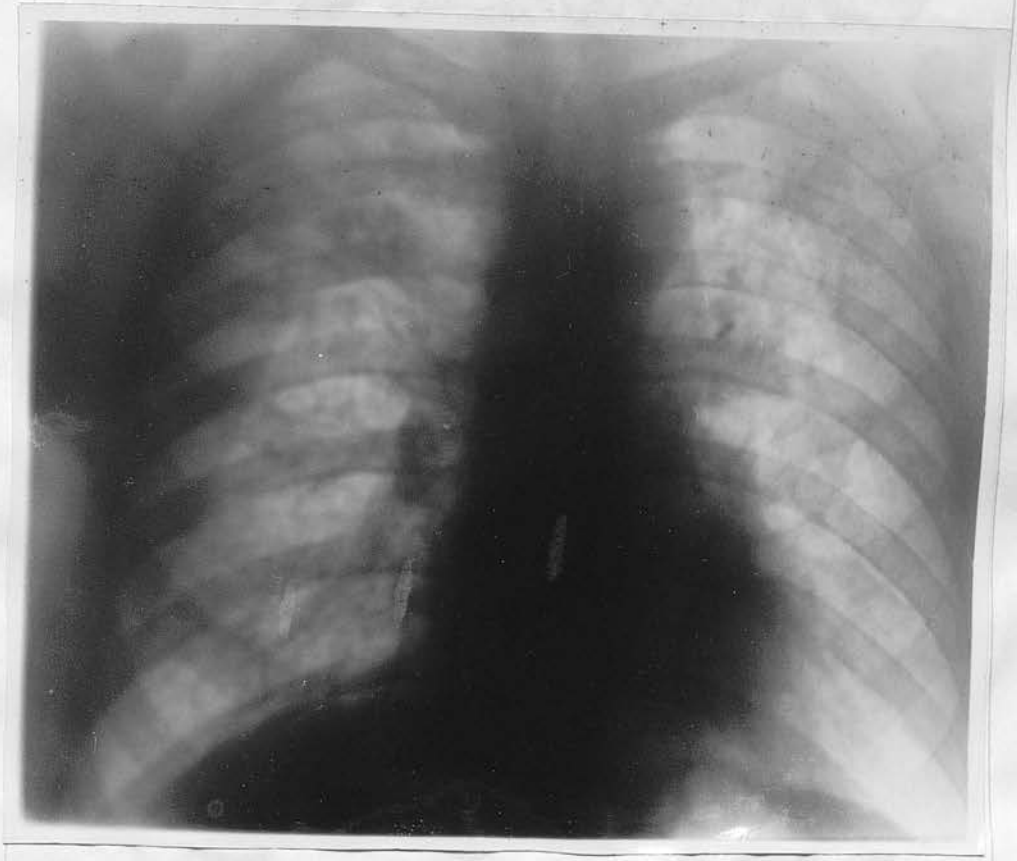

Fig. 11.

Same case.

Film taken seven months later showing cavity replaced by dense fibrosis.

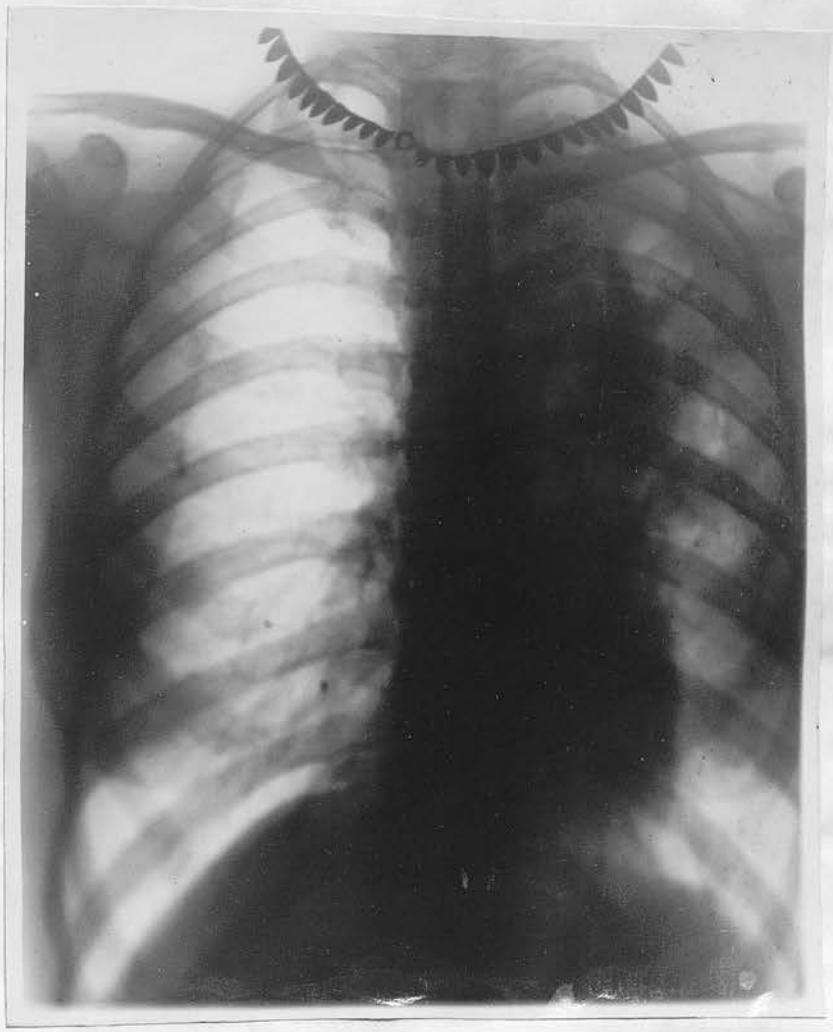

Fig. 12.

Case No. 31. (Table A).

Film taken on admission showing Third Degree cavity in the left upper lobe.

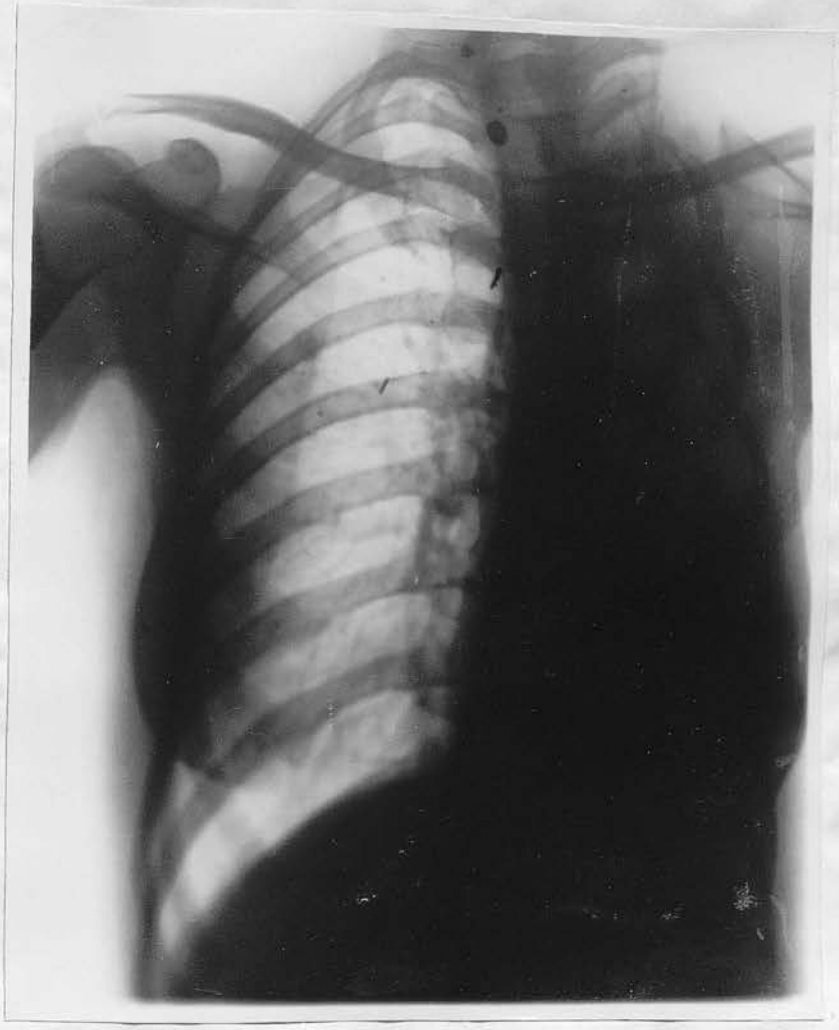

Fig. 13.

Same case.

Film taken three months later showing complete thoracoplasty on the left side with obliteration of the cavity.