A Plea for Increased Caution in the Use of Surgical Collapse Therapy for Pulmonary Tuberculosis

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Not many years ago—within the lifetime of some of us—pulmonary tuberculosis was considered an almost hopeless disease. Patients were advised to "go out West and rough it," and those who did recover did it in spite of this advice rather than because of it. Examples of the fatalistic attitude prevalent in those days are too well known to all of you to merit discussion at this time. In 1877, what we consider to be the most significant advance in therapy in the recent history of the disease—the systematized sanatorium rest treatment—was popularized in this country by Trudeau, a few years after having been introduced abroad by Brehmer and Dettweiler.

Artificial pneumothorax, which had been suggested centuries before,7 was introduced in Milan by Forlanini and about 1900 began to be used in this country. Other means of collapse therapy were introduced in rapid succession.

ARTIFICIAL PNEUMOTHORAX

It has been recommended, and has been, with some, a regular practice, to institute pneumothorax as soon as there is radiographic evidence of any tuberculous pulmonary lesion. While it is obviously better to heal a minor lesion by means of a minor operation than later to arrest a severe lesion by a major operation, we think that operations should be reserved for occasions in which they are indicated, and to us the presence in the lung of an area of increased density compatible with pulmonary tuberculosis is far from being an indication for collapse treatment.

Furthermore, we do not approve of the early institution of artificial pneumothorax in non-cavernous lesions confined to a small part of one lung even if they are undoubtedly tuberculous. Such lesions improve and heal as a rule on sanatorium regimen, and if the patient in years to come has a recurrence of his tuberculosis, the pneumothorax is then available. If the lesions progress or fail to improve on rest in bed, the collapse may then be instituted.
It must also be considered that there are certain dangers inherent in any procedure which involves entering a body cavity. With due precautions illness resulting from artificial pneumothorax is rare and death rarer, but rare as they are, they must be considered when deciding on the type of therapy. Of course, in many cases the dangers to be expected from not collapsing the lung far outweigh those inherent in a pneumothorax. In certain instances, however, there are additional and special dangers to be considered. We agree that pneumothorax should be attempted even though it appears that adhesions between the visceral and parietal pleurae may reasonably be expected to prevent a satisfactory collapse. It is well known that such "expected adhesions" are frequently not present, or are of such nature that intrapleural pneumonolysis may be easily performed. If the adhesions are apparently unsuitable for intrapleural pneumonolysis, we feel that they should, nevertheless, be inspected by means of a thoracoscope, for it is not unusual for an intrapleural pneumonolysis which from x-ray appearance had presented little hope, to be successful. If satisfactory severing of adhesions is seen to be too dangerous, we think that it is, in most cases, even more dangerous to try to stretch the adhesion or tear it from the chest wall by the use of positive pressures. There are various degrees of this danger. If the adhesion is thin and the underlying lung is in fairly good condition, cautious attempts to free or stretch the adhesions are as safe as the nature of the procedure permits. Such adhesions, on the other hand, may be severed with a still greater degree of safety. If the adhesion is thick, sufficient strain on the tissues may tear the pleura and produce a traumatic pneumothorax. This may occur either at the base of the adhesion or at a more distant point. In cases in which the underlying lung is considerably diseased, the application of high positive pressures is exceedingly dangerous. Especially is this true when, as is often the case, the adhesion is over a large or moderately large cavity which is close to the periphery of the lung. The underlying diseased and friable lung may tear and produce the dreaded complication of mixed or tuberculous empyema. Partial cutting of adhesions unsatisfactory for complete lysis, in the expectation that weakening at one point will result in their lengthening or complete separation, has been recommended. We think that this should never be attempted, as the incidence of empyema following this procedure is quite high.

The same principles may be applied to the introduction of air into small pockets. No great good can be expected from the amount of collapse obtainable by such means, and every refill presents grave dangers. We have all seen cases in which the introduction of 50 or 100 cc. of air converted a negative pressure into a highly
positive one. In pneumothorax therapy our objective is to reduce the elastic tension and thereby reduce the strain on the lesion. Certainly 50 cc. of air cannot reduce elastic tension to any great degree, and the production of high positive pressures may lead to catastrophe. In such a case, the pneumothorax should be abandoned and other means of collapse therapy considered if it is deemed indispensable.

The danger of producing injury by the introduction of air under high pressure can be minimized by the use of an apparatus which is incapable of delivering air at high pressures without special adjustment. The type of pneumothorax machine which we have found most satisfactory ordinarily delivers air at a pressure of about twenty centimeters of water, and may be adjusted to deliver it at atmospheric pressure, negative pressure, or high positive pressure. Such a machine is in our opinion the safest type, especially for initial pneumothoraces. Other machines which we have seen in use always deliver the air at a relatively high pressure, the pressure being produced by the use of a pump or by the weight of a column of mercury. These machines make it possible inadvertently to produce pressures which may do irreparable damage.

The advantages of short-bevelled needles in pneumothorax administration are well established, but sharp needles are still too frequently in use. If everyone who used a sharp needle reminded himself as he picked it up that Alexander reported a three inch gash in a lung as the result of the lung's brushing against the tip of a needle, there would soon be few in use. The danger of laceration of the lung is greater at the lower lateral portion of the lung than elsewhere, for the motion of the visceral pleura relative to the chest wall increases from above downward, being relatively small at the apex. Unfortunately the most satisfactory place to introduce a needle is usually near the mid-axillary line.

There are some few types of tuberculosis of the lungs which inherently contraindicate even an attempt at pneumothorax. In acute pneumatic tuberculosis the danger of empyema complicating the pneumothorax is very great. In such a case collapse should not be attempted until the acute process has subsided, and then only if the lesions appear to be amenable to temporary collapse therapy. Likewise, if there is extensive cavitation throughout one lung or huge cavities in any area, attempts at pneumothorax are likely to be without any beneficial effect.

As has already been indicated, we think that after pneumothorax is instituted, adhesions which are attached to the lung in such a way as to interfere with the collapse of cavities should be severed by means of closed intrapleural pneumonolysis if possible. If they are making traction upon a diseased portion of the lung and there-
by interfere with satisfactory healing, intrapleural pneumonolysis should be performed. The fact that collapse should be as limited as is compatible with healing should be considered when deciding this. For a time one of us was convinced that all visible adhesions should be cut if their nature permitted it, but we have abandoned this view. We are not unaware that there have been reports indicating that activation of lesions at or near the site of attachment of adhesions sometimes occurs. Whether this happens because the tug of the adhesion prevents complete healing of the lesion, or because the adhesion is evidence of an underlying area of diseased tissue, we are not prepared to state dogmatically; we incline to the latter idea. The question of an adhesion's being detrimental to the ultimate prognosis of an arrested lesion after the lung has been allowed to re-expand seems academic, in view of the fact that multiple adhesions may be expected to form when the visceral and parietal pleurae are allowed to contact one another after pneumothorax is abandoned. Probably most cases of reactivation of apparently arrested lesions are caused by failure to persist in treatment long enough.

Moreover, attempts at pneumonolysis do not always result in an improvement in the anatomical factors affecting the success of pulmonary collapse. We have seen many pneumonolyses performed under what in retrospect seem to us to be rather dubious indications which ultimately resulted in considerably worse conditions than were present before the operation, in some cases so much so that the pneumothorax had to be abandoned. Such un-
foreseen misfortunes occur also in pneumolyisss performed with
the best of indications, but in such cases the probability of benefit
outweighs the possibility of harm. On the other hand in cases in
which continued improvement might reasonably be expected with-
out the severance of adhesions, we believe that the possibility of
harm outweighs the possibility of benefit, since complications may
occur even when the greatest care is taken to avoid them.
If adhesions interfere with satisfactory collapse in such a man-
er as to render healing of the lesion unlikely, and cannot safely
be severed, other means of obtaining the desired collapse or of
augmenting the collapse already present must be considered.
Revokable operations naturally come first to our minds.

PHRENIC NERVE INTERRUPTION

Phrenic nerve operations used alone have in our experience
shown such meagre results that we have abandoned their use
except in very extraordinary cases. The use of phrenic interrup-
tion in conjunction with other procedures will be discussed as
those procedures are considered.

PNEUMOPERITONEUM

The problem of decreasing the volume of the thoracic cage may
also be approached from below rather than from above the dia-
aphragm. The idea of raising the diaphragm by injecting air into
the peritoneal cavity is not new but has recently attracted more
attention. Some authors have stated that there is less rise of the

Figure 3

Figure 4
diaphragm when the patient is lying down than when he is sitting or standing. There is, independent of other factors, an increase in residual air which results in a decrease in vital capacity, when the patient assumes the supine position. When he is prone, the residual air is reduced and the vital capacity even less than in the supine position. These changes are the result of changes in the position of the vertebral column, but it may be that their presence has influenced those who advocate the sitting position. If diminution of vital capacity is the end desired, the patient is better off lying down. One of us (W.W.C.) has measured the vital capacity of two patients receiving pneumoperitoneum and found that the vital capacity was 600 cc. greater in the erect than in the supine position in one case and 150 cc. greater in the other. The vital capacity in the erect position in one was 450 cc. less than before pneumoperitoneum was begun, and in the other 100 cc. more. Both of these patients had phrenic nerve interruptions.

1. Before pneumoperitoneum standing ........................................ 2300 cc.
   After pneumoperitoneum and phrenic standing .................. 2400 cc.
   After pneumoperitoneum and phrenic supine ..................... 1800 cc.

2. Before pneumoperitoneum standing ........................................ 1900 cc.
   After pneumoperitoneum and phrenic standing .................. 1450 cc.
   After pneumoperitoneum and phrenic supine ..................... 1300 cc.

If the phrenic nerve is interrupted, there is some rise in the diaphragm. It must be borne in mind that pneumoperitoneum is a procedure which should be done with the greatest caution and care, preferably by one experienced in its use. Its greatest value
lies in its ability to enhance the diaphragmatic rise following phrenic nerve operation and this may sometimes be done in order to prepare a patient for surgery in less time than would be possible by rest in bed alone.

EXTRAPLEURAL PNEUMONOLYSIS

Extrapleural pneumonolysis, first performed by Tuffier in 1891, has had an extensive trial both in this country and elsewhere. Some of the results have been most discouraging. Sputum conversion is obtained in only about 50 per cent of cases with extrapleural pneumothorax, and complications are numerous and grave.\textsuperscript{6,11,12} In several series that have been reported, about one third of the patients developed extrapleural empyema. Of these empyemas approximately two thirds were tuberculous and one third mixed.\textsuperscript{6,11,12} Some of the substances used to fill the space have proved unsatisfactory. Although early results from extrapleural pneumothorax are sometimes reasonably good, as the postoperative period increases so also do the complications. Furthermore, extrapleural pneumothorax, although theoretically revokable, actually is in most cases irrevokable, since expansion does not easily occur when refills are discontinued. A thoracoplasty may finally be needed to close the space, and is then more difficult than the usual primary thoracoplasty.\textsuperscript{6} The operative risk, the frequency of complications, and the uncertainty of the end results indicate that extrapleural pneumothorax should probably be used only in cases in which the prognosis is very poor without surgery, and other surgical procedures including thoracoplasty cannot be employed. Occasionally an extrapleural pneumothorax may be used to prepare a patient for thoracoplasty. Alarcon\textsuperscript{1} has recently published a rather enthusiastic article concerning extrapleural pneumothorax.

THORACOPLASTY

Properly performed thoracoplasty is, in suitable cases, one of the most useful operations in our armamentarium. Reports of good results from bilateral thoracoplasty are not at all rare, and we have had the good fortune to see some of our own patients benefited by it. Innumerable persons owe their lives to unilateral thoracoplasty.

The excellence of the operation should not lead us to disregard contraindications or prescribe its use too freely. We must remember that it is a dangerous and mutilating operation, so much so that patients not infrequently refuse it because of the deformity produced. Improvement in surgical methods has reduced the disfigurement, but it is still enough to be most unwelcome to the patient,
particularly if a woman. Every effort should be made to avoid the necessity of thoracoplasty, and then if it is finally apparent that cure is impossible without it, we can go ahead with a clear conscience. Too much delay, of course, may be fatal. The moment must be seized. In nearly every fatal case a review of the records will reveal a time when an operation might have been done and the patient cured—but tuberculosis, like the tide, waits for no man.

Once thoracoplasty is decided on we must carefully consider the lesions not only on the side to be operated but also in the contralateral lung. Irreversible surgical collapse in the presence of an unstable lesion in the opposite lung is fraught with hazards; a patient with a large cavity on one side and a thoracoplasty on the other, while not necessarily hopeless, certainly is no welcome sight to most physicians. It is almost always better to delay the operation until the contralateral lesion is stable than to try to cure the opposite lung after the operation. Incidentally, paralyzing the diaphragm on the contralateral side in an effort to hasten healing so that surgery can be performed sooner is likely to turn out quite badly. If an appreciable collapse is expected, there must also be expected a concomitant decrease in vital capacity. If this decrease in vital capacity happens to be enough to make thoracoplasty impracticable, we have removed one contraindication only to substitute another.

Intrabronchial spread of the disease to the contralateral lung or to other portions of the same lung during or after thoracoplasty may occur in spite of all precautions, but much may be done by the internist, surgeon, and anesthetist working as a team to lessen its incidence. The patient should empty his cavities and bronchial tree as well as he can before the operation by means of cough and postural drainage. If preoperative bronchoscopy is to be employed, the bronchi may be aspirated by means of a tube. Preservation of the cough reflex is important. Narcotics and sedatives should therefore be employed sparingly, and the anesthetic be such that the patient reacts quickly. If large amounts of infective material are present in the bronchial tree, coughing is as likely to further the spread as it is to rid the lung of the material, so that the initial step of cleaning out the bronchial tree and cavities is very important. The anesthetist can aid greatly by keeping the bronchial tree as dry as possible throughout the operation. Passive movement should be instituted and active movement encouraged very early.

**RESECTION OF PULMONARY TISSUE**

Pneumonectomy and lobectomy for pulmonary tuberculosis we have had little experience with. Excepting those who had complete
blockage of a large bronchus by an endobronchial tuberculous lesion, such patients as we have had who might have been benefited by resection of pulmonary tissue seemed curable by less heroic means. Further advances in surgery may well make this the operation of choice in many cases.\textsuperscript{413} Theoretically it is ideal; the diseased tissue is removed, there is no possibility of a breakdown of the old lesion, and the patient is not disfigured. It has been shown many times that the absence of one lung is compatible with health and longevity. We now think that tension cavities which do not respond to other treatment and tuberculomas which produce positive sputum should be treated by resection if the condition of the contralateral lung is satisfactory. Resection should probably not be used in any case in which another form of treatment is likely to be successful.

**OPERATIVE CAVITY DRAINAGE**

Cavity drainage by means of the Monaldi operation is in some cases a valuable adjunct to other treatment. We have not had the good fortune with the operation that Monaldi had, nor have we seen such good results in the hands of others. Successful drainage in some of our cases has produced considerable temporary benefit but always had to be supplemented by more permanent procedures, inasmuch as cavities which had apparently closed, promptly re-opened when the tube was removed. The dangers of the Monaldi procedure are obvious, but accidents occur less frequently than might be expected. If other procedures are at the time impractical, this operation may be resorted to in an effort to put the patient in shape for further surgery but should not be expected to produce permanent results when used alone.

**SUMMARY**

Surgical collapse of the diseased lung is an important adjunct to rest and supportive therapy in the treatment of tuberculosis. The excellent results obtained in many cases by means of surgical collapse have, however, led many persons to prescribe its use too freely, or, having successfully collapsed a lung, to fail to continue a regimen of rest and supportive therapy. The success of some methods of collapse (f.i. artificial pneumothorax, thoracoplasty) has perhaps led to excessive use of less desirable methods such as extrapleural pneumothorax.

Whenever surgery is considered in a case of tuberculosis, the following questions must be answered. First, in what way will the patient be benefited by this operation? Second, do the hazards and complications, both immediate and remote, of the operation present a lesser danger than a decision to defer or abandon the
operation? It is readily apparent that no blanket answers to these questions are possible. Each case must be decided on its individual merits. In tuberculosis as in other diseases the potential dangers of any operation must be weighed against the expected benefits. Above all, operations should never be done simply because they are possible, or in an effort to "do something". A haphazard approach will subject the patient to consequences which he can survive only with the greatest good luck.

RESUMEN

El colapso quirúrgico del pulmón afectado es un auxiliar importante al reposo y a la terapia sustentante en el tratamiento de la tuberculosis. Los excelentes resultados obtenidos en muchos casos mediante el colapso quirúrgico, sin embargo, han inducido a muchas personas a prescribir muy liberalmente su empleo o, después de haber colapsado eficazmente un pulmón, a no continuar el régimen del reposo y de la terapia sustentante. La eficacia de algunos métodos de colapso (vg. el neumotórax artificial, la toracoplastia) quizás ha conducido al uso excesivo de otros métodos menos deseables, tales como el neumotórax extrapleural.

Cuando quiera que se considere la intervención quirúrgica en un caso de tuberculosis, deben contestarse las preguntas siguientes: Primero: En qué forma beneficiará la operación al paciente? Segundo: Presentan los riesgos y complicaciones de la operación, tanto inmediatos como remotos, un menor peligro que la decisión de aplazar o abandonar la operación? Es claro, evidentemente, que no se les puede dar contestaciones generales a estas preguntas. Debe decidirse cada caso a base de sus méritos individuales. En la tuberculosis, así como en otras enfermedades, deben compararse los peligros potenciales de cualquiera operación con los beneficios esperados. Sobre todo, nunca se debe llevar a cabo una operación simplemente porque es posible su ejecución, o con el fin de "hacer algo." Esta actitud aventurada expone al paciente a tales consecuencias que si no pierde la vida es porque tiene muy buena suerte.

REFERENCIAS

7 Gilchrist: "About the Value of Sea Travel," 1850