

THE LATE RESULTS OF THORACOPLASTY IN THE TREATMENT OF PULMONARY TUBERCULOSIS

B. NOLAND CARTER, M.D.

CINCINNATI, OHIO

FROM THE DEPARTMENT OF SURGERY OF THE COLLEGE OF MEDICINE OF THE UNIVERSITY OF CINCINNATI AND THE CINCINNATI GENERAL HOSPITAL

THE operation of extrapleural thoracoplasty is well established as the method of treating certain types of pulmonary tuberculosis. However, the technic of the operation has changed considerably in recent years. Formerly, relatively short segments of the first 10 or 11 ribs were removed in all cases, usually in two stages, beginning with the lower ribs. At present, the tendency is toward a partial thoracoplasty involving the removal of very long segments of a few ribs over the diseased portion of the lung, thus preserving the function of the non-diseased areas. The partial thoracoplasty is begun at the upper limits of the thorax and continued downward until the desired amount of compression has been obtained. Sufficient time has not elapsed since the advent of the partial operation to compare the permanency of the results accomplished by it with those of the earlier complete operation. It would seem advisable, therefore, to record the late results in as large a number of cases as possible which have been operated upon according to the earlier technic, in order that a satisfactory comparison can subsequently be made with those resulting from the present procedure. A further reason for making such a report is to attempt to answer the questions: "What are the late results which can be obtained by complete thoracoplasty?" and "How lasting are such results?"

A partial thoracoplasty is commonly defined as consisting of the removal of segments of seven ribs or less. According to this standard, all of the cases in this report have been subjected to a complete thoracoplasty. They have all been operated upon by a technic the details of which have been described elsewhere,¹ and the principles of which are meticulous hemostasis, gentle handling of tissues, local anesthesia, the use of silk for ligatures and sutures and closure of the wound without drainage. In the earlier cases in this series, the operation was performed from below upwards, but beginning in 1932 the upper portion of the thorax was attacked first. In the later cases in the series much longer segments of ribs were removed, over the most diseased portions of the lung, than had been the case in the earlier ones, as it was becoming apparent that many of the cavities had not been closed by the resection of short portions of the ribs. By far the majority of the operations were performed in two stages, with a two week interval between them. At each stage, segments of at least four and frequently of five or six ribs were removed. At present never more than three ribs are removed at a stage, but practically the entire length of each of the first three ribs is resected.

It has been the experience of many surgeons that the resection of short rib segments is ineffectual in closing cavities and is directly responsible for many of the deaths and unsatisfactory results in their earlier cases. Even if a complete thoracoplasty is proposed, it is essential to remove long enough segments of ribs to completely close the cavity. In the 103 cases embodied in this report from two to eleven years have elapsed since the operations. Most of the patients had been ill with pulmonary tuberculosis for from three to five years; the shortest duration of the disease prior to operation was one year, and the longest 12 years. All of the patients had had unsuccessful attempts at sanatorial care and at artificial pneumothorax, and many had had a phrenicectomy performed.

Several different methods of classifying cases in order to indicate the results of thoracoplasty have been used. Probably the simplest is that of Bull² of Oslo, who in 1930 reported on 401 cases, some of which were collected. His classification was Group I.—Alive, able to work, practically symptom free, negative sputum; Group II.—Alive, able to do some work but not symptom free, positive sputum; Group III.—Unable to do any work, positive sputum; Group IV.—Results not evident; Group V.—Unable to be traced; and Group VI.—Dead at various time intervals. This classification was used by Hedblom and Van Hazel³ in their comprehensive report published in 1934, and is the one I propose to use. However, there are a few cases which cannot be fitted into the above classification and I have placed them in a Group I-A.—Alive, not entirely symptom free, able to do very little work but with negative sputum.

The results of thoracoplasty will vary with several factors. The more important ones of these are: (1) the care with which patients are selected for operation; (2) the type of operation performed, and (3) the type of convalescence which follows operation. The more strictly the indications for operation are adhered to, the better are the results. Thus Archibald⁴ found that among "good chronics" his operative mortality was 4.3 per cent; in the group of doubtful risks it was 4.2 per cent, whereas among the unfavorable cases it was 26 per cent. Brunner,⁵ reporting on 117 cases performed in Sauerbruch's Clinic, obtained 40 per cent cures in a group of cases with favorable indications, 14 per cent cures in cases with less favorable indications and no cures in the desperately ill cases. Table I indicates our experience in this regard.

TABLE I

TYPES OF PATIENTS OPERATED UPON

"Good risks."—62 cases, 59.6% are apparently well—22.6% have died.

"Doubtful risks."—27 cases, 40.7% are apparently well—29.5% have died.

"Unfavorable risks."—14 cases, 30% are apparently well—35.2% have died.

However, it must be remembered that if only the most favorable cases are selected for operation, the benefits of the operation will be denied to many patients, a considerable number of whom can be cured. It is advisable,

on the other hand, not to accept hopeless cases for operation on the plea that it gives them their only chance, for that type of patient will practically always die as a result of the operation. Several of the cases reported in this paper should never have been operated upon, and in the light of our experience would not now be thought suitable for operation. Careful observation by a competent internist, the use of blood transfusions and graded exercise may do a good deal towards converting a seemingly hopeless risk into a moderately good one.

Mention has been made above as to the type of operation which is considered most effective at the present time. Many of the early operations in this series were quite inadequate. As evidence of this are the 13 cases that had to have "supplementary" operations for cavities not closed by their original operation. The time to close the cavity completely is at the first series of operations. Supplementary operations have proved rather unsatisfactory in our experience. It is most important to bear in mind that the operation of thoracoplasty does not cure the patient at once, but that it makes conditions such that nature can more readily heal the cavities and other lesions in the lung. Consequently a sufficiently long and properly managed convalescence is essential following operation. All of the patients included in this report were kept at absolute bed rest for at least six months after operation. If the sputum was still positive at the end of that time, the bed rest was continued up to one year before additional collapse therapy was advised.

In considering the results obtained by thoracoplasty, it should be borne in mind that the patients upon whom the operation is performed are chronically ill and have been so for years, that they are frequently very poor risks and that without the benefits of operation the outlook for all of them is practically a hopeless one.

Table II shows the late results in the patients that fall into Group I, *viz.*, those that are living, are able to work, are symptom free and have a negative sputum.

TABLE II

GROUP I:—ALIVE, ABLE TO WORK, PRACTICALLY SYMPTOM FREE, NEGATIVE SPUTUM													
No. of Cases	Years after Operation											Total	Per Cent
103	2½	3	3½	4	5	6	7	8	9	10	11		
	2	6	3	3	7	6	5	10	7	8	1	58	56.3

In Hedblom's report³ in 1934 of 200 cases of his own, 41 per cent fell into Group I. He also collected 1,235 from the reports of eight authors and of these found that 35.4 per cent were in this group. At least two years had elapsed since operation in each instance. Graham⁶ reports that 29.3 per cent of his 75 cases, in which the operation had been performed for at least two years, were able to resume normal activities and had negative sputum. Due to the fact that a more complete collapse of cavities in the

lung is being obtained with the present operation, I believe that an increasing number of patients will be found in this group. The occupations of the patients in Group I are shown in Table III, together with any other data of interest since operation. Table IV shows the number of patients falling into Group I-A, *i.e.*, alive, able to do some work, not symptom free, negative sputum.

TABLE III

PRESENT OCCUPATIONS OF PATIENTS IN GROUP I

Housewife—29	Maid—2	Unemployed—5	Engineer—1
Salesgirl—1	Nurse—1	Elevator operator—1	Clerk—4
Stenographer—1	Technician—1	Houseman—1	Orderly—2
Telephone oper.—1	R. R. attendant—1	Gen'l light labor—3	Bookkeeper—1
	Taxi driver—1	Car checker—1	Merchant—1

Eight of the female patients have married since operation; four of them have had children who are at present 6 months, 4 years, 5 years, and 7 years old.

TABLE IV

GROUP I-A:—ALIVE, NOT SYMPTOM FREE, ABLE TO DO VERY LITTLE WORK,
NEGATIVE SPUTUM

No. of Cases	Time Elapsed Since Operation				Total	Percentage
103	3 yrs.	6 yrs.	7 yrs.	10 yrs.		
	I	I	I	I	4	3.9%

One patient has a severe bronchiectasis.

Two patients have marked emphysema.

One patient has moderate cardiac involvement and some emphysema.

The number of patients in Group II, *viz.*, alive, able to do some work, not symptom free, positive sputum, is given in Table V.

TABLE V

GROUP II:—ALIVE, ABLE TO DO SOME WORK, NOT SYMPTOM FREE, POSITIVE SPUTUM

No. of Cases	Years after Operation				Total	Per Cent
103	3	5	9	11		
	2	I	I	I	5	4.8

Occupations: Lithograph artist—1. Housekeeping—4.

In comparison with the figures in Table V are those of Bull's² which are 11.6 per cent; of Hedblom's³ which are 5 per cent and of Hedblom's collected series of 1,235 cases which are 10.9 per cent.

The number of patients that fall into Group III, *i.e.*, alive, unable to work, not symptom free, positive sputum, is shown in Table VI.

TABLE VI

GROUP III:—ALIVE, UNABLE TO WORK, NOT SYMPTOM FREE, POSITIVE SPUTUM

No. of Cases	Years after Operation						—Total	Per Cent
103	2½	3	4	5	6	9		
	I	2	I	3	I	I	9	

The 27 deaths among the 103 patients upon whom this report is based fall naturally into two groups, *i.e.*, the early and the late. The confusion as to what constitutes an operative mortality can be avoided if the deaths are reported with the time interval after operation at which they occurred, since practically all of the deaths within eight weeks are directly due to operation. The large number of early deaths and the fact that they constitute nearly one-half of the total deaths is one of the striking features of all reports. Graham, Singer and Ballou⁶ in 1935 reported an operative mortality of 13 per cent in a series of 2,642 collected cases and one of 8.5 per cent in the first four weeks in a series of 140 cases of their own. Hedblom³ in 1934 in a compilation of 3,811 cases occurring in 24 series, stated that the mortality in the first eight weeks was 10.5 per cent with individual variations from 3 to 21 per cent. His own eight week mortality in 161 patients was 10.5 per cent. Table VII shows the time at which the early deaths in our series occurred with the cause of death in each instance.

TABLE VII

GROUP IV:—PATIENTS THAT HAVE DIED EARLY DEATHS

Of the 27 deaths 9 (8.7% of the total number of patients) occurred within the first six weeks as follows:

2 days	3 days	4 days	7 days	9 days	14 days	35 days
2	1	1	2	1	1	1
<i>Causes of Death</i>						
Mediastinal Flutter	Wound Infection	Acute tbc. Pneumonia in Good Lung	Cardiac	Lobar Pneumonia	Pulmonary Hemorrhage	Acute Autotuberculinization
1	1	3	1	1	1	1

Except for more careful selection of cases there is little that can be done to decrease the number of late deaths most of which are due to tuberculosis in some form. It should be possible, however, to lower the mortality which occurs in the first eight weeks. In a combined series of 319 early deaths recently reported,³ it was found that wound infection was responsible for 8.3 per cent, shock for 8.3 per cent, heart failure for 21.3 per cent, mediastinal flutter for 2.3 per cent and pulmonary complications for 38 per cent. The number of deaths occurring from shock can certainly be decreased by an operative technic that demands careful hemostasis and lack of trauma; and by dividing the operation into many stages, no one of which is of enough magnitude to cause a dangerous degree of shock. No patient in our series died from shock following operation. The resection of not more than three ribs at a single stage will do much to prevent shock and abolish mediastinal flutter.

I am in accord with Graham⁶ in believing that there are relatively few true cardiac deaths following thoracoplasty and that many patients whose deaths are ascribed to heart failure really die of autotuberculinization and acute

tuberculous pneumonia of the good lung. Allen⁷ believes that the anoxemia due to an insufficient vital capacity remaining after collapsing one lung is frequently confused with heart failure—a feeling which I likewise share. A careful preoperative study of the lung volume as advocated by McIntosh⁸ after the method of Christie,⁹ is a definite aid in determining the reserve upon which a patient can rely after operation. The highest percentage of early deaths is due to pulmonary complications, the chief one of which is an acute tuberculous pneumonia involving the good side. Undoubtedly some of these follow a reactivation of a supposedly healed focus in the good lung. The added “strain” thrown upon the sound lung was commonly thought to be responsible for this but Churchill¹⁰ feels that this factor may be greatly discounted. He has shown that if a harmful strain is ever thrown on the collateral lung, it is most likely through the increase in the rate or depth of breathing which results from the increased carbon dioxide content of the blood entering the general circulation from the collapsed, but actively circulated lung. A large percentage of the cases of acute tuberculous pneumonia in the good lung is due to the aspiration into it of the contents of cavities which are compressed when the diseased lung is collapsed. The mechanism by which this occurs has been well described by McCordock and Ballou.¹¹ They state that the development of acute tuberculous pneumonia in the good lung in many cases depends upon the amount of compression obtained and upon the location of such compression. It is the squeezing out into the bronchial tree of the infected contents of tuberculous cavities and the aspiration of such contents into the already sensitized good lung that produced the tuberculous pneumonia. The experimental work of Rich and McCordock¹² has shown that such a mechanism does exist and that by it massive tuberculous pneumonia may be produced within a few days. The latter authors also have shown that the severity of the pneumonia is dependent upon the number of bacilli which are aspirated into the good lung—a fact that explains the recovery of some patients and the rapid death of others. A considerable amount of edema accompanies this type of pneumonia and on this account many cases are unrecognized and death is attributed to edema of the lungs. In this connection the experience of Allen⁷ is interesting. In one of the hospitals in which he operated, he had not for seven years had a single instance of acute tuberculous pneumonia following a thoracoplasty operation. He ascribed this to the fact that he had to operate at that particular hospital only in the afternoon and by that hour the patients had cleaned their lungs during their morning coughing even better than they could have by postural drainage. It is largely for fear of aspiration during operation that I have performed all of my operations under local anesthesia. Hedblom quotes Denk³ as believing that postoperative mortality is influenced by the season of the year at which the operation is performed and states that between October and March his mortality was 13.8 per cent in 165 operations, whereas between April and September, it was only 4.5 per cent. Hedblom's³ own experience, however, was just the opposite with a mortality of 2.1 per

cent for winter and 6.2 per cent during the summer. Our series shows 4.3 per cent from October to March and 4.4 per cent from April to September.

Apparently there is little uniformity of opinion as to the relationship between sex and mortality rate or between the side operated upon and the early mortality. This series shows a higher mortality rate for females (9.5 per cent) than for males (7.5 per cent) and a higher rate (10.1 per cent) for left-sided than for right-sided operations (9 per cent); a higher rate for the left side in males (5 per cent as compared to 2.5 per cent for the right side); and for the left side also in females (6.2 per cent as against 3.1 per cent for the right side).

TABLE VIII

GROUP IV:—PATIENTS THAT HAVE DIED LATE DEATHS

Of the 27 deaths 18 (17.4% of the total number of patients) occurred after 3 months following operation as follows:

3 mos.	4 mos.	1 yr.	1½ yrs.	2 yrs.	3 yrs.	3½ yrs.	4½ yrs.	6½ yrs.	8 yrs.	9½ yrs.
1	3	3	1	1	3	1	2	1	1	1
<i>Causes of Death</i>										
Tuberculosis of the Good Lung	Generalized Tuberculosis	Peritonitis Following a Ruptured Cecal Ulcer	Cardiac	Cerebral Hemorrhage	Mediastinal Lymphosarcoma					
9	5	1	1	1	1					

It will be noted in Table VIII that 83.3 per cent of the late deaths were due to tuberculosis in some form, usually more often a spread of the disease to the good lung. This has been the experience of other authors. Three of the late deaths in this study were due to causes unrelated to operation or to the disease and occurred in patients who were alive, with negative sputum and working nine and one-half, three, and three and one-half years after operation.

SUMMARY

(1) A series of 103 cases of pulmonary tuberculosis which were treated by thoracoplasty is reported.

(2) At least two and one-half years have elapsed since operation in every case and as much as 11 years in some of them.

(3) Of the 103 patients—58 are working and have negative sputum; four others have negative sputum, but are unable to work; five are able to do some work but still have a positive sputum; nine are unable to do any work and have positive sputum; and 27 are dead.

(4) The causes of the deaths have been analyzed. Emphasis is laid on the large number of early deaths following operation.

(5) Nearly all of the late deaths were due to tuberculosis in some form.

REFERENCES

- ¹ Carter, B. N.: *Surg., Gynec., and Obst.*, **57**, 353, 1933.
- ² Bull, P.: *Seventh Conference de l'union contre la Tuberculose*, 261, 1930.
- ³ Hedblom, Carl A., and Van Hazel, Willard: *Jour. Thoracic Surg.*, **4**, 55, 1934.
- ⁴ Archibald, E. W.: *Surg., Gynec., and Obst.*, **50**, 146, 1930.
- ⁵ Brunner, A.: *Die chirurgische Behandlung der Lungentuberkulose*. Leipzig, J. A. Barth, 1924.
- ⁶ Graham, E. A., Singer, J. J., and Ballou, H. C.: *Surgical Diseases of the Chest*. Lea & Febiger, 1935.
- ⁷ Allen, Duff: *Jour. Thoracic Surg.*, **4**, 76, 1935 (discussion).
- ⁸ McIntosh, C. A.: *ANNALS OF SURGERY*, **102**, 961, 1935.
- ⁹ Christie, R. V.: *Jour. Clin. Invest.*, **11**, 1099, 1932.
- ¹⁰ Churchill, E. D.: *Arch. Surg.*, **18**, 553, 1929.
- ¹¹ McCordock, H. A., and Ballou, H.: *Jour. Thoracic Surg.*, **2**, 24, 1932.
- ¹² Rich, A. R., and McCordock, H. A.: *Bull. Johns Hopkins Hosp.*, **44**, 273, 1929.