An Experience with Segmental Resection in the Treatment of Pulmonary Tuberculosis

R. F. CORPE, J. L. SHEK and J. A. COPE

Dis Chest 1956;30;183-193
DOI 10.1378/chest.30.2.183

An Experience with Segmental Resection in the Treatment of Pulmonary Tuberculosis

R. F. CORPE, M.D., F.C.C.P., J. L. SHEK, M.D., F.C.C.P. and J. A. COPE, M.D.*
Rome, Georgia

The surgical treatment of pulmonary tuberculosis has occupied a progressively greater role in the therapeutic armamentarium. However, surgical intervention consisting of pulmonary resection is a relatively old concept. Block[1] in 1881 was aware of its possibilities. The concept of excision of diseased areas has been fostered by surgical prophets for many years. A few desperation cases were treated from time to time by pneumonectomy or lobectomy. Friedlander[2] in 1935 discussed the role of lobectomy in pulmonary tuberculosis. In 1939, Jones and Dolley[3] reported four cases treated by pneumonectomy or lobectomy. Some of these early results were good, but the overall results were discouraging.

Overholt[4] in 1945 reported the largest individual series of resections at that time. The following year, the same author[5] in a review of resection cases from 1934 to 1946 was able to find 192 patients having a total of 127 pneumonectomies and 73 lobectomies.

Strong impetus was given to pulmonary resection in tuberculosis by the general improvement in thoracic surgery techniques. Improvements in anesthesia, blood transfusions, and greater understanding of pulmonary physiology awakened new interest in the possibility of resection in this disease. With the advent of modern anti-tuberculous drugs, started by Waksman with streptomycin, resectional surgery was becoming increasingly common. With modern drug therapy, it was repeatedly demonstrated that morbidity and mortality rate in resectional surgery was held to an acceptable level.

Foremost in the minds of all advocates of resectional surgery has been the conservation of pulmonary tissue. Following the demonstration by Blades[6] and Churchill[7] of the technical feasibility of segmental resection, this procedure is now established on firm ground. After the demonstration of the feasibility of segmental resection in non-tuberculous conditions, it was but a short step to attempt to apply this measure in tuberculosis. Segmental resection is now a widely accepted procedure in minimal, moderate, and far advanced pulmonary tuberculosis. Wedge resection, still aiming at conservation of pulmonary tissue, is also a standard procedure either alone or combined with other forms of resection.

It is the purpose of this paper to present our experiences with 182 consecutive segmental resections in pulmonary tuberculosis from 1951 to 1954. In this paper, segmental resection may be the only procedure or it may be combined with other forms of resection, either lobe or wedge. By segmental resection, we mean an anatomical dissection based on the

*Department of Surgery, Battey State Hospital, Rome, Georgia.

Segmental Resections

TABLE I
AGE DISTRIBUTION

Age	Number	Per Cent
Under 20	16	9
20 to 40	116	64
40 or over	50	27
TOTAL	182	100

bronchovascular pattern. Wedge resection is an excision from the periphery with dissection toward the hilum without regard for anatomical landmarks.

The above table shows age distribution of patients in this review. Sixteen (9 per cent) were under the age of 20; 116 (64 per cent) were between 20 and 40; and 50 (27 per cent) were 40 or over.

TABLE II
SEX AND COLOR

	White	Colored	Total
Females	69	23	92
Males	64	26	90
TOTAL	133	49	182

The above table shows the sex and color distribution of the patients in this study. There were 69 white females and 23 colored females for a total of 92 females. There were 64 white males and 26 colored males for a total of 90 male patients.

TABLE III
EXTENT OF DISEASE

	Number	Per Cent
Minimal	1	00.3
Moderate	105	58.0
Far	76	41.7
TOTAL	182	100.0

The above table shows the extent of disease in this group of patients at the time of admission to the sanatorium. One (00.3 per cent) had minimal disease; 105 (58 per cent) had moderately advanced disease; 76 (41.7 per cent) had far advanced pulmonary tuberculosis. It is rarely that we see a case of minimal tuberculosis in this institution.

The following table shows the sputum status on admission to the sanatorium. One hundred sixty-one (89 per cent) were found to be positive and 21 (11 per cent) were negative.

TABLE IV
SPUTUM STATUS ON ADMISSION

	Number	Per Cent
Positive	161	89
Negative	21	11
TOTAL	182	100

Preoperative Therapy

Bed rest remains a constant factor and a basis for treatment of pulmonary tuberculosis. In addition to bed rest, collapse measures and antimicrobial drugs are used. Surgical resection is an additional adjunct that is employed in selected cases.

TABLE V
COLLAPSE MEASURES PRIOR TO SURGERY

	Number	Per Cent
Treatment with collapse	141	77
No collapse	41	23
TOTAL	182	100
Type of Collapse		
Pneumoperitoneum	116	
Pneumothorax	14	
Thoracoplasty	11	
Phrenic interruption	31	
	182	—Collapse procedures on 141 patients

A review of collapse measures used prior to surgery in these 182 consecutively treated patients shows that 141 (77 per cent) had been treated with, and 41 (23 per cent) without collapse. The type of collapse is also shown. One hundred sixteen received pneumoperitoneum; 14 pneumothorax; 11 thoracoplasty; and 31 phrenic interruption. One hundred eighty-two collapse procedures had been used on 141 patients, showing that some of them had received more than one type of collapse.

TABLE VI
ANTIMICROBIAL TREATMENT PREOPERATIVELY

	Number	Per Cent
Received treatment	161	89
None preoperatively	21	11
TOTAL	182	100

Antimicrobial therapy plays an important part in present day therapy of pulmonary tuberculosis. One hundred sixty-one (89 per cent) had received antimicrobial drugs preoperatively and 21 (11 per cent) had none. Those receiving no drugs preoperatively were in the early years of this study.

TABLE VII
DURATION OF ANTIMICROBIAL TREATMENT BEFORE SURGERY

Months	Patients	Months	Patients
None	21	6 to 12	53
Under 1	18	12 to 18	25
1 to 6	51	18 and over	14
TOTALS	90		92

The above table shows that 21 had received no antimicrobial drugs prior to surgery; 18 had been on drugs less than one month prior to surgery; 51 from one to six months; 53 for a period of six to 12 months; 25 for 12 to 18 months; and 14 for 18 months or longer, prior to the addition of surgery to the therapeutic regime. Ninety patients had received less than six months of antimicrobial drugs, while 92 had received them over six months.

TABLE VIII
IMMEDIATE PREOPERATIVE SPUTUM STATUS

	Number	Per Cent
Negative (always)	14	8
(+) Within 1 month	25	14
(+) Within 6 months	79	43
(—) More than 6 months since (+)	64	35
TOTALS	182	100

The above table reveals the preoperative sputum status on this group of 182 patients. Fourteen (8 per cent) had been negative during their entire preoperative hospital stay; 25 (14 per cent) had been positive within one month of the time they were operated; 79 (43 per cent) had been positive within the last six months; 64 (35 per cent) had been negative for six months or longer, prior to surgical intervention.

Indications for the Addition of Surgery

We are aware of the present-day controversy over long term drug administration alone versus long term use of drugs in conjunction with other accepted methods of treatment. A high percentage of patients have sputum conversion on drugs alone. We have felt that an open cavitary lesion, whether the sputum was positive or negative, was a clearcut indication for surgical intervention after failure of the cavity to close with accepted methods of treatment. We have felt that tuberculous fibrocaseous residue was another indication for surgery. The areas of tuberculous residue that have been resected have been either in the form of filled cavities or the end results of coalescence of exudative disease. We have leaned more toward resection of filled cavities than of coalescence of exudative disease, particularly when the filled cavity has measured more than 2 cm. in diameter. We have used bronchograms preoperatively to a

great degree, and the presence or absence of bronchiectasis has influenced us in many instances toward the use of excisional surgery.

Extensive bilateral disease or extrapulmonary diseases of various types may exclude patients from excisional surgery.

We have primarily operated on patients with disease localized in a lobe and one additional segment, or on those with disease localized in one or two segments of a particular lobe. Cavitary or fibrocaseous disease localized in the anatomical manner as mentioned above, with the remaining lung fields primarily stable, have been our main indications. It may be necessary to do lobectomy, such as the upper lobe, and then do segmental resection to remove foci of disease located in the superior segment of the lower lobe. All patients must be considered acceptable surgical material by general standards.

TABLE IX
EXTENT OF SURGERY

		Number	Per Cent
Wedge or subsegment	40		
One segment only	28		
More than 1 segment, less than 1 lobe	79		
		147	80
One lobe and segment or wedge	37		
Two lobes and segment or wedge	2		
		39	20
TOTAL		186	

The above table shows the extent of surgery that was carried out. Forty had a wedge or a subsegment removed; 28 had a segment only; 79 had more than one segment, but less than one lobe. One hundred forty-seven (80 per cent) had less than a lobe removed; 39 (20 per cent) had lobectomy plus smaller portions of an additional lobe removed. Many combinations have been used throughout this series. There were 186 surgical procedures on 182 patients, as four had bilateral resections.

TABLE X
PATHOLOGY

Open cavities	59
Tuberculous residue	162
Bronchiectasis	69

Three specimens were not examined pathologically or bacteriologically. A review of pathological reports on these 183 surgical specimens shows that the pathology was varied, as were the preoperative indications. In these pathological specimens there were 59 open cavities; 62 areas of

TABLE XI
BACTERIOLOGY ON RESECTED SPECIMENS

Year	(+) D.S.	(+) Culture	Total No. Specimens
1951	12	9	12
1952	44	23	57
1953	65	32	82
1954 (to 6/24)	27	3	32
	148 (80 per cent)	67 (36 per cent)	183

tuberculous residue of varying sizes, shapes, and manner of origin; and 69 specimens revealing bronchiectasis.

Bacteriology of resected specimens has been of great interest. In 1951 all 12 cases treated with this type of excisional surgery were positive to direct smear and nine were positive to culture. In 1952, 44 of the 57 specimens were positive to direct smear and 23 of the specimens revealed positive cultures. In 1953, 65 of 81 specimens were positive to direct smear and 32 were positive to culture. In 1954, 27 of the 32 specimens included were positive to direct smear and only three were positive to culture. Three specimens were not examined bacteriologically. Of the 183 surgical specimens from these 182 patients, 148 (80 per cent) were positive to direct smear and 67 (36 per cent) revealed positive cultures. There were some open cavitary lesions as well as closed lesions which failed to give positive cultures.

Morbidity and Mortality

In this group, a raw or potentially raw surface left behind by excisional surgery has been a common denominator. What are the morbidity and mortality rates associated with this type of therapy?

TABLE XII
MORBIDITY AND MORTALITY

	Number	Per Cent
1. Uncomplicated	146	80
2. Complicated	36	20
3. Deaths	2	01.1

One hundred forty-six (80 per cent) of these patients had an entirely uneventful postoperative course; 36 (20 per cent) had a complicated postoperative course; there were two (01.1 per cent) who died directly as a result of surgical therapy.

Three patients in this series had cardiac arrest, and two of them died on the operating table as a result of this complication. These two were the most distressing of the series as both were young and had had negative sputum to culture for more than six months preoperatively on drug therapy.

TABLE XIII
MORBIDITY AND COMPLICATIONS

Complication	No.	Treatment of Complication	End Result
1. Cardiac arrest	3	Cardiac massage (3)	2 deaths
2. Air leaks			
a. Prolonged	22	Catheter reinsertion (9)	Excellent
b. BPF	3	Thoracoplasty (12)	Excellent
c. Empyema	1		
3. Postop. hemorrhage	4	Thoracotomy (3)	Excellent
4. Transfusion reaction	1	Supportive	Excellent
5. Wound infection	4	Incision & drainage	Good
6. Pleurisy	1	Supportive	Excellent
7. Paralytic ileus	1	Decompression	Excellent
8. Retention of secretions	1	Bronchoscopy	Excellent
9. P.O. asthma	1	Medical treatment	Excellent
10. Atelectasis	2	Bronchoscopy (2)	Excellent
11. Dyspnea & cyanosis	1	Oxygen therapy	Good
TOTAL	45		

Both of them had had enough disease to warrant lobectomy plus segmental resection.

Air leaks in the postoperative period accounted for more than half the total number of complications. There were 22 who had residual air pockets that demanded further therapy; three had definitely demonstrated bronchopleural fistulae; and one had proved empyema. Catheter reinsertion was necessary on nine. Post-excisional thoracoplasty was necessary on 12. The end results were excellent in all, so that while complications added to the morbidity rate they presented few unsolved problems.

There were four who had severe postoperative hemorrhages; in three of them it was necessary to do exploratory thoracotomy in the immediate postoperative period to control bleeding within the hemithorax. The end results were excellent in all four.

The other complications were of less consequence. One had a transfusion reaction; four, wound infections; one, pleurisy; one, paralytic ileus; one, retention of secretions without atelectasis; one, postoperative asthma; two, postoperative atelectasis and one, rather severe dyspnea and cyanosis because of pulmonary insufficiency.

All these received antimicrobial therapy for at least three months postoperatively.

Post-Surgical Period

We would now like to present the follow-up on this group of patients after the immediate postoperative period.

The status in regard to hospitalization reveals that 130 have been discharged from the institution. One hundred twenty-five of them were inactive, three were active and two were dead, both from cardiac arrest. Of the three discharged with active disease, one (discharged against medical advice) had positive culture with a contralateral lesion for which

TABLE XIV

Hospital Status	Inactive	Active	Dead	Average Stay Postop.
130 Discharged	125	3	2	9.6 months
	Negative	Positive		
52 Hospitalized	49	3		8.5 months

surgery had been recommended and refused; the other two were discharged with consent and advice. One of them had 12 and the other had 28 consecutive negative cultures. Both of them returned one positive culture out of three submitted in the week prior to discharge from the hospital. They have had no further positive sputa.

Fifty-two are still hospitalized; 49 of them are negative to culture; three are positive. One has a contralateral lesion for which surgery has been approved. One has atypical acid fast organism and is a candidate for further surgery. The third, who has been through the gamut including long term drug therapy of over two years, pneumothorax, intrapleural pneumonolysis, thoracoplasty, and resection, left the hospital against medical advice and is back with positive sputum.

We found that the patients discharged remained for an average of 9.6 months following surgery. Of the 52 still in the hospital, the average time since surgery up to September of 1954 is 8.5 months.

Of the 130 discharged, follow-up is available on 107. These were followed up from the standpoint of (1) physical activity, (2) sputum status, and (3) x-ray studies.

TABLE XV
PRESENT STATUS OF DISCHARGED PATIENTS

Follow-up available	107
No follow-up	23
TOTAL	130

Activity		Sputum status		X-ray	
Full	56	Negative	96	Stationary	79
Daily rest periods	50	Positive	2	Better	16
Dead	1	Not done	8	Worse	1
				No x-ray	10
	107		106		106

Fifty-six have returned to full activity and 50 of them are still observing daily rest periods. One young, white male committed suicide, yet up to that time he was well and working full time. The sputum status study revealed that 96 were negative, two positive, and eight had only recently received medical discharges from the hospital and were negative at that time. Seventy-nine had stationary x-ray film shadows, 16 had shown roentgenological improvement, one was worse roentgenologically and 10 had not had x-ray films since discharge.

The average period of follow-up after hospitalization was 12.3 months.

Comment

We are enthusiastic in the use of segmental resection in the treatment of pulmonary tuberculosis. We feel that it is a safe procedure. Our mortality figures are low, and the morbidity rate is acceptable. We have had few serious complications. We feel that it is extremely useful in removing major foci of disease and open cavitary lesions and at the same time conserving the maximum amount of lung tissue.

SUMMARY

1. One hundred eighty-two consecutively treated patients, all having had segmental resections as well as other types of therapy, have been reviewed.

2. At the time of hospital admission 99.7 per cent had moderate or far advanced pulmonary tuberculosis. Eighty-nine per cent had positive sputum.

3. All had similar therapy—bed rest, antimicrobial drugs, and excisional surgery—and 77 per cent of them had received collapse therapy.

4. Fifty-seven per cent were positive within a six-month period prior to surgery. Ninety-two per cent had been positive during preoperative treatment.

5. The early mortality rate was 1.1 per cent. The morbidity rate was 20 per cent. All complications, except the two cardiac arrests leading to death, were otherwise amenable to further treatment.

6. At present, eight (4.3 per cent) of the 182 patients are treatment failures. There were three deaths, two in the hospital and one (suicide) in the post hospital follow-up. There are three in the hospital with positive sputum whose treatment has not been concluded. There are two on the outside with positive sputum, one of whom had positive sputum four months ago and has no evidence of relapse clinically or by x-ray shadows. The other has positive sputum and relapse shown by x-ray film.

7. Of the remaining 176 (95.7 per cent of the total), there are 49 who remain in the hospital with an average post surgical stay to date of 8.5 months, and their therapy is successful to date. The other 127 discharged patients have an average follow-up since surgery of 22 months. We are certain of the status of 106 (85 per cent of the total). We have so far been unable to secure information on 23 (10.7 per cent of the total).

RESUMEN

1. Se hizo una revisión de 182 enfermos consecutivos tratados con resección segmentaria así como con otras formas de tratamiento.

2. Al ingresar al hospital, 99.7 por ciento estaban clasificados como moderados o muy avanzados tuberculosos pulmonares. Ochenta y nueve por ciento tenían esputos positivos.

3. Todos se sujetaron a un tratamiento similar: reposo en cama. drogas antimicrobianas, cirugía de excisión, y 77 por ciento de ellos habían tenido colapsoterapia.

4. Cincuenta y siete por ciento eran positivos dentro de los seis meses

anteriores a la cirugía. Noventa y dos por ciento habían sido positivos durante el período preoperatorio.

5. La mortalidad inmediata fué de 1.1 por ciento. La morbilidad fué de 20 por ciento. Todas las complicaciones con excepción de dos paros cardiacos que produjeron la muerte, fueron susceptibles de tratarse.

6. En la actualidad, ocho (4.3 por ciento) de los 182 enfermos son fracasos. Hubo tres muertes, dos en el hospital y una (suicidio) durante el seguimiento posthospitalario.

Hay tres enfermos en el hospital con esputo positivo cuyo tratamiento no ha concluído. Hay dos entre los externos con esputo positivo, uno que ha tenido esputo positivo desde hace cuatro meses y notiene evidencia clínica ni radiológica. El otro es positivo con recaída aparente a los rayos X.

7. De los restantes 176, 95.9 por ciento del total, hay 49 que permanecen en el hospital con una estancia postoperatoria de 8.5 meses y su tratamiento es satisfactorio hasta ahora.

Los otros 127 que han salido se han seguido por término medio durante 22 meses. Estamos seguros de las condiciones de 106 (85 por ciento del total). No hemos podido tener información de 23 (10.7 por ciento del total).

RESUME

1. L'auteur a passé en revue 182 malades traités successivement par résections segmentaires plus ou moins associées à d'autres types de traitement.

2. Au moment de leur entrée à l'Hôpital, 99,7% de ces malades étaient porteurs de tuberculose pulmonaire modérée ou sérieuse. 89% avaient une expectoration positive.

3. Tous les malades reçurent un traitement semblable (repos intégral au lit, chimiothérapie, exérèse chirurgicale) et 77% d'entre eux subirent une collapsothérapie.

4. 57% des malades eurent des expectorations positives au cours des six mois qui précédèrent l'acte chirurgical. 92% avaient été positifs pendant la phase de traitement préopératoire.

5. Le taux de la mortalité post-opératoire fut de 1,1%. Le taux de la morbidité fut de 20%. Toutes les complications, à l'exception de deux arrêts cardiaques ayant provoqué la mort, purent être l'objet d'un traitement ultérieur.

6. Actuellement, 8 des 182 malades (4,3%) constituent des échecs au traitement. Il y eut trois décè, deux à l'hôpital et un (suicide)) pendant la période de contrôle après la sortie de l'Hôpital. Il y a trois malades à l'Hôpital qui ont encore leur expectoration positive, et dont le traitement n'est pas terminé. Deux malades sortis de l'Hôpital ont encore leur expectoration positive, l'un d'eux avait une expectoration positive quatre mois auparavant, et ne présente aucun signe clinique ou radiologique de rechute, l'autre a une expectoration positive et présente une rechute visible radiologiquement.

7. Parmi le reste des 176 malades (95,7%) il y en a 49 qui restent hospitalisés, avec un séjour moyen de 8 mois et demis, et leur traitement

est actuellement satisfaisant. Les 127 autres malades sortis de l'Hôpital ont été suivis depuis l'intervention pendant une moyenne de 22 mois. L'état pulmonaire de 106 malades (85% du total) est satisfaisant. Jusqu'à présent, l'auteur n'a pu obtenir aucune indication au sujet de 27 malades (10,7% du total).

ZUSAMMENFASSUNG

1. Es wurden 182 fortlaufend behandelte Kranke geprüft, die alle sowohl Segmentresektionen als auch anderen Behandlungsarten unterzogen wurden.

2. Zum Zeitpunkt der Aufnahme ins Krankenhaus hatten 99,7% mässig oder weit fortgeschrittene Lungentuberkulose. 89% hatten Tuberkalbakterien im Auswurf.

3. Alle wurden ähnlich behandelt: Bettruhe, tuberkulostatische Medikamente und Resektionstherapie; 77% von ihnen erhielten Kollaps-Therapie.

4. 57% waren 6 Monate lang vor der Operation TB-positiv. 92% waren während der praeoperativen Behandlung überhaupt positiv gewesen.

5. Die Frühmortalität betrug 1,1%. Die Morbiditätsquote belief sich auf 20%. Alle Komplikationen—mit Ausnahme von 2 Fällen tödlichen Herzstillstandes—konnten durch entsprechende Behandlung beherrscht werden.

6. Zur Zeit stellen 8 (= 4,3%) von den 182 Kranken Behandlungs-Misserfolge dar. Es ereigneten sich 3 Todesfälle: davon 2 im Krankenhaus und ein Selbstmord nach der Entlassung. 3 Patienten, deren Behandlung noch nicht beendet ist, sind weiterhin positiv. 2 Patienten behielten nach der Entlassung positives Sputum: der eine von ihnen hatte vor vier Monaten Tuberkelbakterien im Auswurf, ohne dass klinisch oder röntgenologisch ein Rückfall nachweisbar war; bei dem anderen war sowohl positiver Auswurf als auch röntgenologisch ein Rezidix nachweisbar.

7. Von den restlichen 176 Kranken (=95,7%) aller beobachteten Patienten verblieben 49 Kranke durchschnittlich 8,5 Monate nach dem operativen Eingriff im Krankenhaus, und ihre Behandlung ist bis heute erfolgreich. Die anderen 122 entlassenen Patienten sind durchschnittlich über 22 Monate nach dem operativen Eingriff beobachtet worden. Bei 106 Kranken (= 85%) ist der Befund genau bekannt. Über 23 Patienten (= 10,7%) konnte bisher nichts Sicheres in Erfahrung gebracht werden.

REFERENCES

1 Block: "Verhandl. d. deutsch," *Gesselsch. f. Chir. Eilfter Congress*, 77, 1882.
2 Friedlander, S. O.: "Lobectomy in Pulmonary Tuberculosis," *J. Thor. Surg.*, 5:132, 1935.
3 Jones, J. C. and Dolley, F. S.: "Lobectomy and Pneumonectomy in Pulmonary Tuberculosis," *J. Thor. Surg.*, 8:351, 1939.
4 Overholt, R. H. and Wilson, N. J.: "Pulmonary Resection in the Treatment of Tuberculosis," *J. Thor. Surg.*, 14:55, 1945.
5 Overholt, R. H., Langer, L., Szypulski, J. T. and Wilson, N. J.: "Pulmonary Resection in the Treatment of Tuberculosis," *J. Thor. Surg.*, 15:384, 1946.
6 Blades, B.: "Conservation of Lung Tissue by Partial Lobectomy," *Ann. Surg.*, 118: 353, 1943.
7 Churchill, E. D. and Belsey, R.: "Segmental Pneumonectomy in Bronchiectasis," *Ann. Surg.*, 109:481, 1939.

An Experience with Segmental Resection in the Treatment of Pulmonary Tuberculosis

R. F. CORPE, J. L. SHEK and J. A. COPE

Dis Chest 1956;30; 183-193
DOI 10.1378/chest.30.2.183