

Surgical treatment of emphysematous bullae: late outcome

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ABSTRACT From 1967 to 1972 12 patients were operated on for emphysematous bullae in the Liverpool regional cardiothoracic centre. The patient with the poorest lung function died in the immediate postoperative period but the remainder survived for more than five years. All but one of the survivors showed evidence of benefit three to six months after surgery and all those not retired returned to full-time employment for at least five years. Nine patients were reviewed 5-10 years after surgery. These all reported a gradual return of dyspnoea, which was matched by a falling one-second forced expiratory volume (FEV₁) (mean fall 82 ml a year); but five were still maintaining some of their postoperative improvement. When mean preoperative lung function values were compared with the values obtained 5-10 years later there was still a significant improvement in forced vital capacity; but FEV₁, residual volume, transfer coefficient, and arterial oxygen and carbon dioxide tensions were unchanged. Chest radiographs showed no new bullae or (except in one case) any increase in size of pre-existing bullae.

We conclude that the removal of large emphysematous bullae did not hasten the progress of the underlying emphysema and that in most patients some benefit lasted for more than five years after the operation. Patients treated by lobectomy fared at least as well as those treated by bullectomy alone. It may be relevant to the relatively good progress of patients in this series that only three had suffered from chronic bronchitis before operation or smoked after operation, and but two had bullae occupying half or more of one hemithorax, and none had hypercapnia.

The indications for resection of bullae and the immediate benefits of the procedure are well known.^{1,2} Information about the long-term outcome is more scanty and conflicting. This report describes the outcome in a small group of patients operated on in the Liverpool regional cardiothoracic centre during a five-year period and followed up for 5-10 years.

Patients and methods

From 1967 to 1972 13 operations for the removal of emphysematous bullae were carried out on 12 patients in this unit. The clinical details of these patients are shown in table 1. The patients were all men, with a mean age of 54 years. All smoked cigarettes but only three had evidence of chronic bronchitis. All were dyspnoeic (grade 3 or more in

nine patients), with a reduced forced expiratory volume in one second (FEV₁) (mean 1.19 l, 40% predicted). Mean preoperative values for forced vital capacity (FVC), FEV₁, and dyspnoea grade are shown in table 2 and values for residual volume (RV), transfer coefficient for carbon monoxide (KCO), and arterial gas tensions (PaO₂ and PaCO₂) in table 3. In most patients the RV was increased and the KCO and PaO₂ were reduced, but the PaCO₂ was normal in every patient.

The preoperative and postoperative investigations were all carried out in the same laboratory and by the same techniques. These included clinical examination, dyspnoea grading on a five-point scale, chest radiographs taken in inspiration and expiration, FVC and FEV₁ measured by a standard low resistance water spirometer, subdivisions of the lung volume determined by the helium-dilution technique and KCO by the single-breath carbon monoxide method, and arterial blood gas tensions measured with an IL 403 Blood Gas analyser. Statistical comparisons were made with the paired Student's *t* test.

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Table 1 Clinical features of the 12 patients and operative findings

Patient No	Age	Smoking before operation	Smoking after operation	Chronic bronchitis	Dyspnoea grade	Bulla size as % hemithorax	Operative findings	Operation
1	52	+	+	+	2	20	15 cm bulla LLL, several smaller bullae LUL	Bullectomy over-sewing
2	58	+			2	80	Large bulla in LUL, rest of lung emphysematous	Bullectomy
3	58	+			3	50	Large multilocular bulla in LLL, LUL compressed, small bullae in LUL	Bullectomy over-sewing
4	49	+			3	50	Large bulla LUL anteriorly, rest of lung emphysematous	Bullectomy
5	44	+			2	70	One large and many small bullae RUL, RLL emphysematous	Upper lobectomy
6	52	+	+	+	5	75	LLL replaced by one large bulla, LUL emphysematous	Lower lobectomy
7	68	+		+	5	50	Large bulla replacing LLL, LUL of poor texture	Lower lobectomy
8	43	+			4	50	LUL many large bullae, LLL emphysematous, RUL huge tense bulla, RLL and RML emphysematous	Staged upper lobectomies
9	43	+			3	60	RLL one large and many small bullae, RML cystic, RUL no bullae but emphysematous	Middle and lower lobectomy
10	57	+			3	60	Two large bullae RLL, RML and RUL collapsed except for few bullae	Lower lobectomy
11	70	+			5	40	Multiple bullae RLL compressing RUL and RML, which were emphysematous	Lower lobectomy
12	51	+			5	50	Large bullae LUL, multiple smaller bullae LLL	Bullectomy over-sewing

LLL, LUL — left lower and upper lobe; RLL, RML, RUL — right lower, middle, and upper lobe.

Results

All 12 patients were traced and nine returned for review from five to 10 years after the operation. Of the remaining three, one (No 12) had died of bronchopneumonia in the immediate postoperative

period, one (No 5) was alive and working 10 years after surgery but refused to attend for review, and the third (No 10) died of a myocardial infarct eight years after the operation. This last patient had been followed up regularly at another hospital and was recorded as being well and free of dyspnoea only one month before his death.

Table 2 Changes mean (± 1 SD) in FVC, FEV₁, and dyspnoea grade of the 11 survivors

	Before operation	After operation	
		3–6 m	5–10 y
FVC (l)	2.29 \pm 0.68	2.84 \pm 0.37*	2.81 \pm 0.45*
FEV ₁ (l)	1.19 \pm 0.55	1.77 \pm 0.33**	1.33 \pm 0.67 NS
Dyspnoea grade	3.45 \pm 1.2	1.60 \pm 0.7**	2.80 \pm 1.8 NS

Improvement over preoperative value: * $p < 0.01$; ** $p < 0.001$.

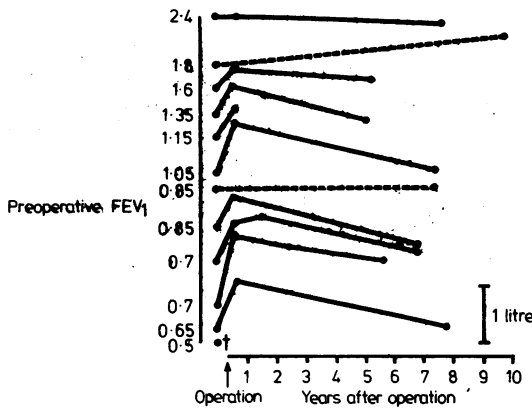
Table 3 Changes in mean (± 1 SD) residual volume (RV), transfer coefficient (Kco), and arterial gas tensions

	Before operation	5–10 y after operation
RV (l) (% predicted)	2.8 \pm 1.1 (142)	2.8 \pm 0.7 (132)
Kco (ml min ⁻¹ mmHg ⁻¹ l ⁻¹)	3.5 \pm 1.5	3.1 \pm 1.6
Pao ₂ (kPa)	10.1 \pm 0.9	10.2 \pm 1.3
Paco ₂ (kPa)	4.9 \pm 0.5	5.2 \pm 0.2

Conversion: SI to traditional units — Blood gases: 1 kPa = 7.5 mm Hg.

Apart from the patient who died in the postoperative period, all patients survived for at least five years after the operation (mean survival at time of follow up 7.3 years). All but one reported symptomatic benefit when seen three to six months after surgery and this was reflected in the improved FVC and FEV₁ (table 2). Apart from the two patients already retired and the one who died, all patients returned to work and remained in full-time employment for at least five years.

Over the years dyspnoea tended to return and the FEV₁ to fall; at the time of follow-up four of the nine were virtually back to their preoperative level, though five were still maintaining some of their postoperative improvement (fig). The mean decline in the FEV₁ was 82 ml a year. On the other hand the postoperative improvement in FVC was well sustained. The mean values for FVC, FEV₁, and dyspnoea grading before and after surgery are shown in table 2. There was significant improvement in all three measurements in the early postoperative period, but at 5–10 years only the FVC improvement is significant. Linear regression analysis shows



Serial changes in FEV₁ for the 12 patients in descending order of preoperative FEV₁ (same order as table 1).

Table 4 Changes in residual volume (l) in three patients

Patient No	Before operation	After operation	
		3-6 m	5-10 y
3	1.75	1.4	2.35
4	3.5	2.25	3.35
8	3.75	2.4	3.0
Mean % predicted	159	106	146

an inverse correlation between FEV₁ and dyspnoea grade ($r = -0.79$, $p < 0.01$).

RV, Kco, and blood gases were measured before surgery and at follow up 5-10 years later in eight patients. There was no significant difference between the values obtained on these two occasions (table 3). RV fell, however, in the early postoperative period in the three patients for whom measurements were available (table 4).

Chest radiographs were available for 10 patients 5-10 years after the operation. None showed new bullae on the operated side and only one (No 4) showed an increase in size of a pre-existing contralateral bulla.

Discussion

Previous authors have agreed that early postoperative results are good when large bullae are removed,^{1,2} and the FEV₁ has been regarded as the most reliable guide to postoperative progress.⁴⁻⁶ The present study supports these observations. The one patient with a bulla occupying less than a third of the hemithorax was the only one to show no symptomatic or objective improvement, and in the series as a whole there was a highly significant

inverse correlation between dyspnoea grade and FEV₁.

There are few published accounts of the longer term outcome of surgery. Fitzgerald and others present spirometric data on 15 similar patients followed for more than three years (eight for more than five years) and found a pattern similar to the one we describe but with an annual decline in FEV₁ of 101 ml.⁵ Wesley and others reported three five-year survivors but three of the 11 followed for shorter periods had already died.⁶ Pride and others found evidence of benefit two to three years after surgery in only three of their 10 patients.⁴ The mean preoperative FEV₁ in this last series was lower than in any of the others and the mean postoperative increase in FEV₁ (1.04 l to 1.24 l) was considerably less than in our series (1.19-1.77 l).

The mean annual decline in FEV₁ of 82 ml in our patients is similar to that reported in large series of patients with chronic obstructive airways disease (80-90 ml a year).^{7,8} This suggests that removal of large bullae does not hasten the progression of emphysema in the remaining lung, a view supported by the fact that no new bullae appeared in the postoperative radiographs.

The relatively good postoperative progress of our patients, with all but three of the survivors still showing objective evidence of benefit (in FVC or FEV₁) more than five years after surgery, may of course relate to preoperative selection and to operative procedure. With regard to selection only three patients had significant sputum production, none had a raised PaCO₂, and all but two had bullae occupying one half or more of the hemithorax. Two of the three with no objective evidence of benefit five to ten years after operation were the only patients who had chronic bronchitis before operation and smoked after it (Nos 1 and 6). Half the patients had a preoperative FEV₁ of less than a litre but the only patient with an FEV₁ of less than 0.5 litres died in the immediate postoperative period.

Seven patients were treated by lobectomy and five by bullectomy. It has been suggested¹⁵ that patients with disease extensive enough to require lobectomy do not fare so well as those in whom bullectomy is performed. The seven patients treated by lobectomy in this series all had more extensive disease and poorer preoperative lung function than four of the five treated by bullectomy but there was no difference in the long-term outcome of the two groups. Indeed, the only death was in the bullectomy group, which also contained two of the three survivors showing no objective evidence of benefit at follow up.

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References

- ¹ Potgieter PD, Benator SR, Hewitson RP, Ferguson AD. Surgical treatment of bullous lung disease. *Thorax* 1981;**36**:885–90.
- ² Hugh-Jones P, Whimster W. The etiology and management of disabling emphysema. *Am Rev Respir Dis* 1978;**117**:343–78.
- ³ Fletcher CM, Elmes PC, Fairburn AS, Wood CH. The significance of respiratory symptoms and the diagnosis of chronic bronchitis in a working population. *Br Med J* 1959;**4**:257–66.
- ⁴ Pride NB, Hugh-Jones P, O'Brien EN, Smith LA. Changes in lung function following the surgical treatment of bullous emphysema. *Q J Med* 1970;**153**:49–69.
- ⁵ Fitzgerald MX, Keelan PJ, Gaensler EA. Long-term results of surgery for bullous emphysema. *J Thorac Cardiovasc Surg* 1974;**68**:566–87.
- ⁶ Wesley JR, Macleod WM, Mullard KS. Evaluation of surgery in bullous emphysema. *J Thorac Cardiovasc Surg* 1972;**63**:945–55.
- ⁷ Jones NL, Burrows B, Fletcher CM. Serial studies of 100 patients with chronic obstructive lung disease in London and Chicago. *Thorax* 1967;**22**:327–35.
- ⁸ Burrows B, Earle RH. Course and prognosis of chronic obstructive lung disease. *N Eng J Med* 1969;**280**:397–404.