Long term changes in lung function after surgical treatment of bullous emphysema in smokers and ex-smokers

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ABSTRACT Eleven patients who had received surgical treatment for bullous emphysema had regular assessment of lung function for a minimum of four years (mean 8.8, range 4-20 years). For each patient we estimated the annual rate of change in FEV₁ and "relaxed" vital capacity (before and after bronchodilator aerosol) and in carbon monoxide transfer factor (TLco), transfer coefficient (Kco), and arterial carbon dioxide and oxygen tensions (Paco₂ and Pao₂).

Among the 11 who had undergone operation, all lung function variables declined at a faster rate in those who continued to smoke than in ex-smokers, the difference in rate being significant ($p < 0.05$) for FEV₁ (before bronchodilator), TLco and Kco. In ex-smokers the rate of change in most lung function indices was not significantly different from zero—that is, no change; in smokers all lung function indices except Paco₂ declined at a rate significantly greater than zero. These findings suggest that long term results of surgical treatment for bullous emphysema are likely to be greatly improved if patients abandon smoking.

After surgical treatment of bullous emphysema improvement in lung function has been found in several studies.¹⁻⁴ Beneficial effects on symptoms have also been reported,⁵⁻⁸ though such effects may be poorly correlated with objective changes in lung function.^{6,7}

Improvement in both symptoms and lung function values may be maintained over a long period,^{2,6-8} though patients who have undergone lobectomy have been reported to fare less well.^{3,5} We have estimated the annual rate of change of lung function in a group of patients who received surgical treatment for bullous emphysema.

Methods

Eleven men who had undergone surgical treatment of bullous emphysema have been assessed regularly for a minimum of four years (mean 8.8, range 4-20 years). Details are shown in table 1. All patients were or had been cigarette smokers. Five patients continued to smoke after their operation, while six

abandoned the habit before or immediately after surgery and did not smoke thereafter. There was no significant age difference between smokers and ex-smokers.

Forced expiratory volume in one second (FEV₁) and vital capacity (VC) before and after inhalation of 200 µg salbutamol from an aerosol, transfer factor (TLco), transfer coefficient (Kco), and arterial oxygen and carbon dioxide tensions (Pao₂ and Paco₂) were measured at each visit as described previously.⁹ Eight patients had lung function assessment before and after surgery.

Results

FEV₁, VC, and Pao₂ improved significantly after operation, whereas TLco and Kco remained unchanged (table 2). There was no significant difference between the smokers and ex-smokers with respect to postoperative lung function except for Paco₂, which was significantly higher in the ex-smokers ($p < 0.025$).

In the smokers all lung function values apart from Paco₂ declined with time and the regression coefficients of all the indices except Paco₂ against time were significantly different from zero. In the ex-smokers only the postbronchodilator FEV₁ and

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Table 1 Data on the patients

Patient No	Age at operation (y)	Age stopped smoking (y)	Dyspnoea grade		Chest radiographic zone affected	Type of operation	Years since operation at last assessment	No of post-operative visits	Chronic bronchitis grade	
			Before	After					Before	After
			operation						operation	
1	58	(C)	3	1	Upper	Monaldi	5	6	2	2
2	41	(C)			Upper	Lobectomy	20	12		2
3	69	(C)	4	3	Lower	Lobectomy	6	8	2	2
4	38	(C)	3		Upper	Lobectomy	8	6	2	
5	54	(C)	3	2	Lower	Lobectomy	12	8	1	1
6*	45, 51	46	3	2	Upper	Lobectomy	5	6	0	0
7	44	44	3	3	Upper	Lobectomy	13	10	1	1
8	44	44		2	Lower	Lobectomy	6	8	2	2
9*	49, 50	48	3	1	Upper	Lobectomy	8	6	2	
10	63	45	3	1	Upper	Monaldi	4	5	2	2
11	46	46	2		Upper	Bullae oversewn	9	6	0	0
Mean	50.7						8.7	7.4		
SD	9.6						4.7	2.1		

*Lung function data obtained before and after second operation.
C—continues to smoke.

Pao₂ declined at a rate significantly different from zero ($p < 0.005$) (table 2).

All lung function variables declined at a faster rate in the smokers than in the ex-smokers, although the differences were significant only for FEV₁ (before bronchodilator), TLCO, and Kco (table 2).

The mean changes in FEV₁ and VC (before bronchodilator) were 14 and 19 ml a year in the ex-

smokers and 34 and 37 ml a year in the patients who continued to smoke.

Discussion

Studies on surgically treated patients with emphysema are inevitably biased in the selection of patients, making comparison with other groups

Table 2 Initial postoperative lung function and annual change in smokers and ex-smokers

		Age (y)	FEV ₁ (ml)		VC (ml)		TLCO (mmol kPa ⁻¹ min ⁻¹)	Kco (mmol kPa ⁻¹ min ⁻¹ l ⁻¹)	Pao ₂ (kPa)	Paco ₂ (kPa)
			Before	After	Before	After				
			bronchodilator		bronchodilator					
EX-SMOKERS (n = 6) Initial postoperative assessment Annual change in lung function (regression coefficient of variable on time (units per annum))	Mean	50	1450	1700	3170	3430	6.55	1.37	9.8	5.2
	SD	7	790	770	690	660	2.08	0.39	0.9	0.45
	Mean		-14.2	-30.6	-19.4	-16.6	-0.08	+0.01	-0.26	0.0
	SEM		10.0	10.1	16.9	16.1	0.05	0.02	0.07	0.005
	p ¹		NS	<0.005	NS	NS	NS	NS	<0.005	NS
SMOKERS (n = 5) Initial postoperative assessment Annual change in lung function (regression coefficients of variable on time (units per annum))	Mean	52	2120	2180	3900	3980	5.30	1.12	10.2	4.5
	SD	13	650	760	620	650	1.98	0.29	1.6	0.4
	Mean		-34.2	-44.0	-37.6	-45.1	-0.18	-0.04	-0.30	0.001
	SEM		9.5	8.8	16.3	46.6	0.04	0.01	0.09	0.004
	p ¹		<0.001	<0.001	<0.05	<0.001	<0.001	<0.001	<0.01	NS
	p ²	NS	NS	NS	NS	NS	NS	NS	NS	<0.025
	p ³		<0.05	NS	NS	NS	<0.025	<0.001	NS	NS

p¹—comparison of mean regression coefficient with zero (that is, no change of lung function variables with time)

p²—comparison of age and initial lung function indices between smokers and ex-smokers

p³—comparison of regression coefficients of ex-smokers and smokers.

NS—not significant; FEV₁—forced expiratory volume in one second; VC—vital capacity; TLCO—transfer factor; Kco—transfer coefficient; Pao₂, Paco₂—arterial oxygen and carbon dioxide tensions.

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

difficult. We followed only patients who survived for four years, thereby excluding those who died before this. In those who survived for four years lung function variables declined at a faster rate in those who continued to smoke after surgery than in those who abandoned the habit. This result is in keeping with the findings of an earlier study from this department on patients with pulmonary emphysema who did not undergo surgery⁹ and the more favourable post-operative outcome for ex-smokers found by Stone *et al.*² In ex-smokers the rate of change in most indices was not significantly different from zero—that is, there was no change. Patients who continued to smoke fared less well. All lung function indices except Paco₂ declined at a significant rate.

Several studies¹⁻⁸ have shown both short and long term benefit after surgical treatment of bullous emphysema. Fitzgerald *et al.*,³ however, found a reduction in FEV₁ of 101 ml a year in 15 patients treated surgically, which is much more than we observed even in our group of smokers. One obvious difference is in the type of operation; most of our patients had had a lobectomy as opposed to bullectomy, though lobectomy is said to give less favourable results.^{3,5}

In a recent study⁴ the rate of decline of FEV₁ in postoperative patients was 82 ml a year, which is again a higher rate than was found in the present study. Few of the former group, however, continued to smoke, and five of the 11 patients had a bullectomy.

In a group of emphysematous patients not undergoing surgery⁹ the rate of decline in FEV₁ and FVC was 16 and 15 ml a year in ex-smokers and 53 ml for both in smokers. The decline in lung function was faster in patients with upper lobe emphysema than it was in those with generalised or lower lobe emphysema.¹⁰ Most patients in this study had had upper lobe bullae before surgery and, interestingly, in the non-operated patients with upper zone emphysema FEV₁ declined at a mean rate of 46 ml a year for ex-smokers and 86 ml a year for smokers—though the two groups were not strictly comparable.

Our study was concerned only with patients who survived for four years or more after operation. It is

clear that certain patients may live for many years after surgical treatment, even when their initial lung function was poor. Those who continue to smoke appear to deteriorate at a faster rate than those who stop smoking. In some patients the threat of operation or the procedure itself may provide sufficient stimulus for them to abandon the habit.

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