A study of lung function in coalworkers' pneumoconiosis

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Simple lung function and maximal expiratory flow volume curves (MEFV) were measured in 101 patients with simple and complicated coalworkers' pneumoconiosis (CWP) and compared with the data from healthy subjects and from miners exposed to dust. The purpose of the study was to show pulmonary functional deficits in these patients and to help determine their degree of disability.

Subjects and methods

The study included 65 patients with simple CWP, 36 patients with complicated CWP, and 30 miners exposed to coal dust in coalmines. All were men with 10-20 years underground. Their ages ranged from 32 to 63, the average ages being 52.3, 51.2, and 48.4 years, respectively. Thirty healthy male workers with no dust exposure served as controls. Their average age was 44.3 (range 26-55). The mean age was not significantly different in these groups ($p > 0.05$).

A Discom-15 spirometer, produced by Japanese CHEST cooperation, was used to measure vital capacity (VC), forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), the FEV_1/FVC , and the $FEV_1/VCPR$. The forced mid-expiratory flow ($FEF_{25-75\%}$) was calculated from the obtained spirogram. In addition, the group mean values of VC and FVC were expressed as the

percentage of the predicted level according to Baldwin's formula. From the maximal expiratory flow volume curves (MEFV) obtained, the mean values of the peak expiratory flow rate (PEFR) and the maximal expiratory flow rate at 75%, 50%, and 25% of the average vital capacity ($\dot{V}_{75}$, $\dot{V}_{50}$, $\dot{V}_{25}$, respectively), were determined. These values were standardised for height (m).

Results

The data obtained for the four groups are summarised in tables 1 and 2 and the results of significance testing shown in table 3.

To show the impairment patterns of lung function we used the percentage of the predicted VC and $FEV_1/FVC\%$ as indices. When the percentage of the predicted VC was lower than 80% we considered it to be a restrictive defect; when the $FEV_1/FVC\%$ was lower than 70% we considered it as an obstructive defect. The results are shown in table 4. The major impairments in CWP were obstructive and mixed.

Comment

There have been several studies of lung function in coalworkers' pneumoconiosis,¹⁻³ but the real effects of coal dust on lung function are still the subject of debate. According to the data presented here, the mean values of VC, FVC, $FEF_{25-75\%}$, PEFR/H, $\dot{V}_{50}/H$, $FEV_1/FVC\%$, and the percentage of pre-

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Table 1 Results of the simple lung function measurements (mean $\pm$ SD)

Parameter	(A) Controls (n = 30)	(B) Miners exposed to dust (n = 30)	(C) Patients with simple CWP (n = 56)	(D) Patients with complicated CWP (n = 36)
VC (l)	4.20 $\pm$ 0.54	3.94 $\pm$ 0.68	3.67 $\pm$ 0.65	3.11 $\pm$ 0.46
VC (% of pred)	106.12 $\pm$ 14.82	104.16 $\pm$ 14.73	96.32 $\pm$ 16.12	85.33 $\pm$ 15.79
FVC (l)	4.12 $\pm$ 0.58	3.87 $\pm$ 0.78	3.54 $\pm$ 0.28	3.01 $\pm$ 0.52
FVC (% of pred)	102.32 $\pm$ 18.10	99.10 $\pm$ 16.70	98.32 $\pm$ 16.68	86.12 $\pm$ 15.76
FEV_1 (l)	3.58 $\pm$ 0.54	3.27 $\pm$ 0.66	2.89 $\pm$ 0.43	2.23 $\pm$ 0.52
$FEF_{25-75\%}$ (l/s)	3.31 $\pm$ 0.86	2.89 $\pm$ 0.95	2.46 $\pm$ 1.10	1.82 $\pm$ 1.23
$FEV_1/FVC(\%)$	86.91 $\pm$ 10.10	84.47 $\pm$ 6.15	81.63 $\pm$ 8.33	76.25 $\pm$ 7.20
$FEV_1/VCPR(\%)$	85.14 $\pm$ 12.64	84.13 $\pm$ 14.42	82.35 $\pm$ 12.38	78.24 $\pm$ 17.32

Table 2 Results of MEFV measurement (mean $\pm$ SD)

Parameter	(A) Controls (n = 30)	(B) Miners exposed to dust (n = 30)	(C) Patients with simple CWP(C) (n = 56)	(D) Patients with complicated CWP (n = 36)
PEFR/H(L/S/M)	4.08 $\pm$ 1.23	3.90 $\pm$ 1.03	3.71 $\pm$ 1.22	3.12 $\pm$ 1.24
V ₇₅ /H(L/S/M)	3.58 $\pm$ 0.68	3.34 $\pm$ 0.79	2.77 $\pm$ 1.13	2.47 $\pm$ 0.78
V ₅₀ /H(L/S/M)	2.32 $\pm$ 0.58	2.29 $\pm$ 0.66	1.46 $\pm$ 0.82	1.26 $\pm$ 0.56
V ₂₅ /H(L/S/M)	0.88 $\pm$ 0.32	0.86 $\pm$ 0.34	0.66 $\pm$ 0.63	0.51 $\pm$ 0.37
V ₅₀ /V ₂₅ (%)	2.56 $\pm$ 0.62	2.48 $\pm$ 0.53	2.43 $\pm$ 0.67	2.54 $\pm$ 0.79

Table 3 Statistical significance of differences among groups (p value)

	A v B	A v C	A v D	B v C	B v D	C v D
VC	NS	<0.05	<0.01	NS	<0.01	NS
VC (% of pred)	NS	<0.05	<0.01	<0.05	<0.01	<0.01
FVC	NS	NS	<0.01	NS	<0.05	NS
FVC (% of pred)	NS	NS	<0.01	NS	<0.01	<0.01
FEV ₁	NS	<0.05	<0.01	NS	<0.01	<0.05
FEF ₂₅₋₇₅ %	NS	<0.05	<0.01	NS	<0.01	<0.05
FEV ₁ /FVC	NS	<0.05	<0.01	NS	<0.01	<0.05
FEV ₁ /VCPR	NS	NS	<0.05	NS	<0.05	NS
PEFR/H	NS	NS	<0.01	NS	<0.05	<0.05
V ₇₅ /H	NS	NS	<0.01	NS	<0.01	NS
V ₅₀ /H	NS	<0.01	<0.01	<0.05	<0.01	NS
V ₂₅ /H	NS	NS	<0.05	NS	<0.05	NS
V ₅₀ /V ₂₅	NS	NS	NS	NS	NS	NS

*NS = Difference between groups not significant (p > 0.05, paired t test)

Table 4 Impairment patterns of lung function

Pattern	Controls (n = 30)		Miners exposed to dust (n = 30)		Patients with simple CWP (n = 65)		Patients with complicated CWP (n = 36)	
	No	%	No	%	No	%	No	%
Obstructive	0	0	3	10.0	10	15.4	9	25.0
Restrictive	0	0	0	0	2	3.1	3	8.3
Mixed	0	0	1	3.3	5	7.7	6	16.7
Normal	30	100	26	86.7	48	73.8	18	50.0

dicted VC and FVC in patients with complicated CWP are much lower than those in healthy controls and in miners exposed to coal dust (p < 0.01). These parameters in patients with simple CWP were lower than those in healthy controls (p < 0.05), but there were no significant differences between the patients with simple CWP and miners exposed to coal dust (p > 0.05). Lung function, including small airways function, in these patients with CWP was definitely impaired, but the extent of the impairment and the reduction in lung function was related to the severity of the CWP; the changes in complicated CWP were more severe than in simple CWP. The major impairments in lung function were of an obstructive and a mixed type. There were no significant differences between the patients with simple CWP and the miners exposed to coal dust, or between the miners exposed to coal dust and the healthy controls (p > 0.05).

It has been suggested that the disparate findings of some reports may be attributable to the various geographical locations of the studies^{2,4} and cigarette smoking must be considered as a major factor in the

in the impairment of lung function in coalminers.²

In the present study all the subjects came from one region and about 38–45% of the subjects in all four groups were smokers. Cigarette smoking may have played a part in the deterioration in lung function but the impairment was also inversely related to exposure to coal dust. There may have been a synergic or additive effect between smoking and coal dust on the lung function in these subjects.

References

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