Thorax (1970), **25**, 285.

Clinical and physiological associations of some physical signs observed in patients with chronic airways obstruction

S. GODFREY[1], R. H. T. EDWARDS, E. J. M. CAMPBELL, and J. NEWTON-HOWES

The Department of Medicine, Royal Postgradute Medical School, Du Cane Road, London, W.12

A study of the relation between physical signs and the clinical and physiological pattern of chronic lung disease with obstruction has been carried out on 24 patients with varying degrees of airways obstruction. One sign (the forced expiratory time) was a direct reflection of the obstruction, but a number of other signs which also correlated significantly with the specific airway conductance were probably related to secondary effects on lung volume (increased resonance), disordered pattern of muscle action (tracheal tug and use of accessory muscles) or to excessive swings of intrathoracic pressure (excavation of supraclavicular fossae). Other signs which are regularly present but which did not correlate significantly with the severity of the airways obstruction were often related to other factors such as age or duration of symptoms (tracheal length). The difficulties in deciding the origin of other signs such as wheezes (rhonchi) or costal paradox are discussed.

In previous publications we have described certain physical signs which were felt to be of use in assessing airways obstruction (Campbell, 1969) and we have shown that these signs possess a degree of observer variation similar to that of other physical signs (Godfrey, Edwards, Campbell, Armitage, and Oppenheimer, 1969). We have now studied the clinical and physiological associations of these signs.

METHODS

Observations were made on 24 patients in either the wards or out-patient clinics at Hammersmith Hospital. All the patients were known to have stable airways obstruction from previous tests of pulmonary function and there was a wide variation of severity as judged by clinical and physiological criteria. The patients were examined while lying on a couch with the back rest raised to 45°. Two of us (R. H. T. E. and E. J. M. C.) examined them independently in the manner described previously (Campbell, 1969; Godfrey *et al.*, 1969). The findings of the two observers were then compared and, if any differences arose, the observers were invited to examine the patient together to reach an agreed conclusion, with S. G. acting as arbitrator.

[1]Correspondence to: Dr. S. Godfrey, Institute of Diseases of the Chest, Brompton, London, S.W.3

A series of pulmonary function tests was performed on the same day as the examination. The forced expiratory volume in one second ($FEV_{1.0}$) and the relaxed vital capacity (VC) were determined by the method of Freedman and Prowse (1966) using a dry spirometer. Lung volumes, airways resistance and specific conductance were determined in the body plethysmograph by the method of Briscoe and Dubois (1958). The specific conductance (SGaw) is airway conductance divided by thoracic gas volume. This procedure is to standardize changes in airway conductance due to changes in thoracic gas volume (Guyatt, Alpers, Hill, and Bramley, 1967).

THE SIGNS

The physical signs which were investigated are briefly listed below, and for a fuller description the reader is referred to our previous publications:

1. External jugular filling on expiration
2. Increased resonance to percussion
3. Diminished breath sounds
4. Wheezes (rhonchi) at bases
5. Crepitations (discontinuous rales) at bases
6. Accessory muscle activity (scaleni and sternomastoids)
7. Excavation (recession) of supraclavicular fossae on inspiration
8. Tracheal tug (downwards) on inspiration
9. Costal paradox with decrease in lateral diameter of costal margin on inspiration

10. Upper chest movement forwards and upwards without normal 'bucket handle' lateral rise of ribs
11. Tracheal length from lower border of cricoid to sternal notch during expiration
12. Forced expiratory time (Lal, Ferguson, and Campbell, 1964)

RESULTS

The measurements of $FEV_{1\cdot0}$ and SGaw were very highly correlated (r=0·82) and the SGaw alone is used as the index of airways obstruction. For each of the signs 1 to 10, the 24 subjects were divided into two groups, those who showed the sign and those who failed to do so, and the mean SGaw for each group was calculated. The results are shown in Table I, from which it can be seen that

TABLE I

Sign	Sign Present		Sign Absent		Difference in mean SGaw	t
	No. of Patients	Mean SGaw	No. of Patients	Mean SGaw		
1	6	0·08	18	0·16	0·08	1·66
2	9	0·07	15	0·18	0·11	2·56[1]
3	9	0·09	15	0·17	0·08	1·86
4	10	0·12	14	0·16	0·04	0·95
5	8	0·10	16	0·16	0·06	1·36
6	12	0·09	12	0·19	0·10	2·40[1]
7	11	0·06	13	0·20	0·14	3·35[1]
8	10	0·07	14	0·19	0·12	2·84[1]
9	8	0·14	16	0·14	0	0
10	10	0·13	14	0·15	0·02	0·47
	Regression coefficient of SGaw on sign					
11	0·0465					1·84
12	−0·0452					2·83[1]

[1] Significant at 5% level

higher values for SGaw, indicating more normal airways, were usually seen in patients who did not have the physical signs. For the two signs (11 and 12) which gave a continuous measurement, the regression of SGaw on the sign was calculated and the slope of the regression is shown in Table I. Inspection of this table shows that with the following signs there was a significant difference (5% level) in SGaw between patients in whom the sign was present and those in whom it was absent.

2. Increased resonance
6. Accessory muscle activity
7. Excavation of supraclavicular fossae
8. Tracheal tug
12. Forced expiratory time

Using a similar approach, we considered the correlations of the signs with other factors, such as age, height and duration of symptoms. This was particularly interesting for these signs which correlated poorly with the physiological measurement of airways obstruction and yet are frequently observed in patients with this condition. Wheezes and costal paradox correlated significantly with the duration of symptoms and tracheal length with age. No correlations were found for upper chest movement. Most of the signs which did correlate with the severity of airways obstruction as judged by the SGaw also corelated with the duration of the illness (Table II).

TABLE II

CORRELATION COEFFICIENT

Sign	Age	Duration
1	0·2057	0·1902[3]
2	0·2579	0·5374
3	0·3302	0·0394[1]
4	0·2932	0·5420[3]
5	0·2726	0·3921
6	0·6950[4]	0·2009
7	0·0132	0·5402[3]
8	−0·2340	0·4198[1]
9	0·4832[2]	0·5882[3]
10	0·2340	0·1182
11	−0·4699[3]	0·2709
12	0·3939	0·4605[2]

[1] Significant at 5% level; [2] Significant at 2·5% level
[3] Significant at 1·0% level; [4] Significant at 0·1% level

DISCUSSION

The only physical sign which is in any sense a measure of airway resistance is the forced expiratory time, which stands in a similar relationship to SGaw as does the $FEV_{1\cdot0}$ or peak expiratory flow rate. All the other signs discussed here depend upon the secondary effects of the airways obstruction and it is little wonder that a number of these were correlated with age or duration of symptoms.

The physical signs which were most closely associated with the airways obstruction seemed to be related to such secondary effects as lung volume (increased resonance), the disordered pattern of muscular activity (tracheal tug, accessory muscles) or to excessive swings of intrathoracic pressure (excavations of supraclavicular fossae). We confirmed the finding of Lal *et al* (1964) of a good correlation between forced expiratory time and airways obstruction. Two of the remaining signs, diminished breath sounds and external jugular filling, are probably also related to lung volume and excessive intrathoracic pressure swings, but although more common in subjects with a low SGaw, the association did not reach statistically significant levels.

The poor correlation between the presence of wheezes and the SGaw does not, of course, mean

that this sign does not occur in patients with airways obstruction, but rather that it does not reflect the severity of obstruction. It is quite likely that the more severely affected patient has such a low gas flow rate that the wheezes tend to disappear. This sign and a number of others, such as costal paradox and tracheal length, were part of the clinical picture of chronic airways obstruction but were more closely related to age or duration of symptoms than to the narrowing of the air passages. However, some of these conclusions may depend on the group of patients studied, because Connolly and Godfrey (1969) have demonstrated in children that costal paradox occurs in asthma, probably as a secondary effect of a large lung volume. It is likely that this association could be more easily demonstrated in children with more pliable chest cages than in our group of elderly adults with relatively fixed chests.

There is a considerable degree of observer variation in the detection of physical signs (Fletcher, 1964; Armitage, Blendis, and Smyllie, 1966), but the ones studied here were no less reliable than other signs (Godfrey *et al.*, 1969). From our study it appears that many signs associated with the clinical picture of chronic airways obstruction can be correlated with the severity of the basic disturbance of physiology, but others may be more related to associated factors such as age or duration of symptoms.

We should like to thank Miss H. Hogford and Dr. M. Hills, of the Department of Medical Statistics, London School of Hygiene and Tropical Medicine, for their very considerable contribution to the interpretation of our data.

REFERENCES

Armitage, P., Blendis, L. M., and Smyllie, H. C. (1966). The measurement of observer disagreement in the recording of signs. *J. roy. Statist. Soc.*, **129**, 98.

Briscoe, W. A., and Dubois, A. B. (1958). The relationship between airway resistance, airway conductance and lung volume in subjects of different age and body size. *J. clin. Invest.*, **37**, 1279.

Campbell, E. J. M. (1969). Physical signs of diffuse airways obstruction and lung distension. *Thorax*, **24**, 1.

Connolly, N. M., and Godfrey, S. (1969). Changes of chest configuration during breathing in children with reversible airways obstruction. *Clin Sci.*, **37**, 567.

Fletcher, C. M. (1964). The problem of observer variation in medical diagnosis with special reference to chest diseases. *Meth. Inform. Med.*, **3**, 98.

Freedman, S., and Prowse, K. (1966). How many blows make an $F.E.V._{1.0}$? *Lancet*, **2**, 618.

Godfrey, S., Edwards, R. H. T., Campbell, E. J. M., Armitage, P., and Oppenheimer, E. A. (1969). Repeatability of physical signs in airways obstruction. *Thorax*, **24**, 4.

Guyatt, A. R., Alpers, J. H., Hill, I. D., and Bramley, A. C. (1967). Variability of plethysmographic measurements of airways resistance in man. *J. appl. Physiol.*, **22**, 383.

Lal, S., Ferguson, A. D., and Campbell, E. J. M. (1964). Forced expiratory time: a simple test for airways obstruction. *Brit. med. J.*, **1**, 814.