

Radiological abnormalities in children with asthma and their relation to the clinical findings and some respiratory function tests

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Criteria are put forward for the recognition and assessment of radiographic abnormalities in childhood asthma. Using these criteria, radiographs of the chest in 218 children with asthma are compared with those of 162 normal children. In 73% of the asthmatic children the radiograph appeared to be normal, 15% presented a simple overinflation pattern with long narrow lungs and a narrow vertical heart (0-1 pattern), and 12% showed the same pattern together with enlargement of the hilar vessels relative to the lung vessels (0-2 pattern). Those children with the most marked radiographic abnormalities (0-2 pattern) were, without exception, suffering from severe or moderately severe *constant* asthma. Those with *intermittent* symptoms usually had radiographs which appeared to be normal even during their asthmatic episodes.

The radiological appearances in childhood asthma are somewhat elusive. Different observers often cannot agree whether a particular chest radiograph does or does not show an abnormality. Moreover, when abnormalities are agreed to be present they are difficult to relate to the clinical state of the patient. For example, one child with asthma may have a radiograph which clearly shows evidence of overinflation, while another child with equally severe symptoms may have a radiograph which looks normal in all respects (Figs. 1, 2, and 3).

In this paper an attempt has been made to define these appearances more precisely by specifying some criteria for their recognition. A study is presented of 218 asthmatic children in whom the relationship of the abnormalities to some clinical features of the disease and to certain respiratory function tests is investigated. The radiographs of a group of normal children are used for comparison.

PATIENTS

The patients studied were 73 children from the paediatric department of the Brompton Hospital and 145 from the asthma and allergy clinic of University College Hospital. All were suffering from asthma which was severe enough for them to be referred to hospital as outpatients but not severe enough for them to need hospital admission at that time. In all other respects they were an unselected group. Their ages ranged from 6 to 14

years and in every case their asthma was of at least six months' duration.

The normal children were a series in which a radiograph had been taken at yearly intervals between the ages of 6 and 19 years as contacts of adult tuberculous patients. These children did not present any evidence of chest disease during the period of follow-up, and from their radiographs percentile charts for lung measurements were available. These charts give boundaries for the 97th, 90th, 75th, 50th, 25th, 10th, and 3rd percentiles (Simon *et al.*, 1972).

They were for the most part radiographed during the period 1945-65, that is, some 10 to 25 years before the asthmatic children, but there is no evidence that children are growing much taller than during this relatively recent period. In any case, asthmatics tend to be shorter than healthy subjects so that tallness is unlikely to account for greater lung length. Most normal children still have a lung length around the 50th percentile of the control group used, as did 75% of the asthmatics.

METHODS

For the purpose of this study radiographs of the asthmatic children were taken and respiratory function tests were performed on the same day, at or near their first attendance at hospital.

All the radiographs were assessed by the same observer (G.S.), who, at that time, was unaware of the clinical details of the patients.

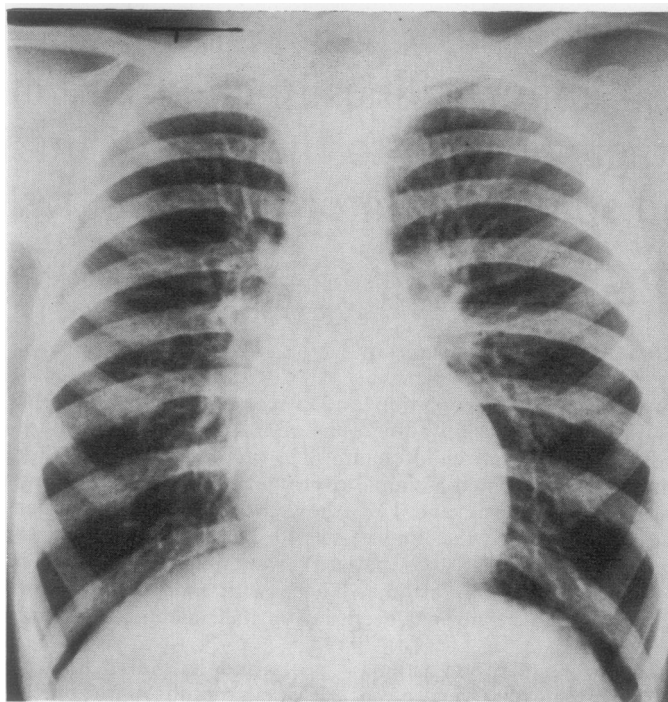


FIG. 1. Normal radiograph. Boy aged 6 years. Continuous asthma. Onset age 6 months. PEFR 48% predicted. (See also monthly readings in Fig. 8.) Diaphragm at level of rib 6. Lung width greater than lung length. Heart width on 50th percentile. (Retrosternal space was small.) Vessels normal.

RADIOGRAPHIC TECHNIQUE A standard postero-anterior view was taken at a tube film distance of 6 feet during deep suspended inspiration with the patient standing. A left lateral view was taken in a similar manner in 96 patients.

VENTILATORY FUNCTION TESTS Estimations of peak expiratory flow rate (PEFR) were made with the Wright peak flow meter and the best of three readings was recorded. Spirometry readings were made several times until no further improvement occurred, and the best values were recorded. Either or both these tests were made within one hour of the chest radiograph. In a number of patients ventilatory function tests were also made on many other occasions.

The result of each test was expressed as a percentage of the predicted normal for that child (nomograms based on body height from Godfrey *et al.*, 1970).

CLINICAL ASSESSMENT The children were classified into two groups as follows:

Intermittent asthma Attacks of asthma at variable intervals but patient leading a normal life without daily bronchodilator drugs; including those with a history of one or more attacks of status asthmaticus

which had needed treatment with corticosteroids and/or hospital admission.

Constant asthma Never completely free of symptoms. Using daily bronchodilator drugs in order to lead a normal life; including all patients on long-term treatment with disodium cromoglycate, corticosteroids or ACTH.

RADIOLOGICAL ANALYSIS Measurements were made of the diaphragm level, the lung length, the lung width, and the heart width. These measurements were plotted for each child on the appropriate normal percentile chart and the nearest percentile boundary was recorded.

Less precise measurements were made of the retrosternal transradiant zone and of the size of the hilar vessels relative to the lung vessels.

The presence of any additional shadows was noted.

DIAPHRAGM LEVEL This was recorded by noting the level of the top of the right dome of the diaphragm in the mid lung field in relation to the anterior inferior angle of the rib, that is the lowest part of the rib. For example, if the level of the diaphragm was nearer to the 6th than the 7th rib, it was recorded as 'rib 6' and if about midway, as 'rib 6½'.

The diaphragm level in relation to the anterior part of the ribs will depend partly on the downward slope of the ribs and partly on the length of the ribs. A short rib with a long costal cartilage will lie somewhat higher than a long rib if both slope slightly downwards. It is, therefore, possible for the diaphragm to be at only the 6-6½ rib, and yet the lung length may be near the 90th percentile. Hence not every case allocated to the 0-1 group had a diaphragm below rib 6½.

It is remarkable how constant the level of the diaphragm was in serial radiographs of the same person. This is a tribute to the radiographers and the whole team who managed to rouse the interest of the children to a pitch which ensured their co-operation in the various procedures.

Lung length Because there is frequently lack of definition of the lung apex, measurement was made from a line drawn horizontally from the tubercle on the upper margin of the right first rib. A line was then drawn vertically from this to the top of the dome of the right diaphragm in the mid lung field (Fig. 2). This adds about 1 cm to the radiographic lung length, but as the same method was used for measuring the length of the lungs in the control group, the error is systematic.

Lung width This was measured by drawing a horizontal line at the level of the top of the right dome of the diaphragm to the internal aspects of the ribs on both sides (Fig. 2).

In none of the control group or the asthmatic

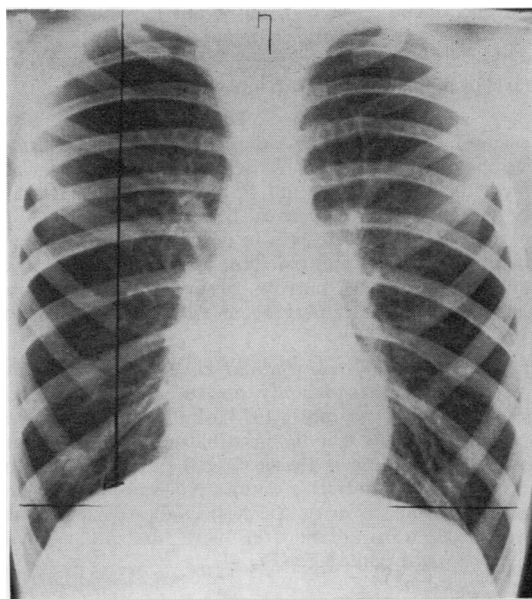


FIG. 2. 0-1 pattern. Boy aged 7 years. Intermittent asthma. Onset age 3. PEFR 69% predicted. (See monthly readings in Fig. 9.) Diaphragm rib 7. Lung length=lung width. Heart 3rd percentile. (Retrosternal space was large, see Fig. 5.) Vessels normal. Vertical and horizontal lines indicate method of measurement.

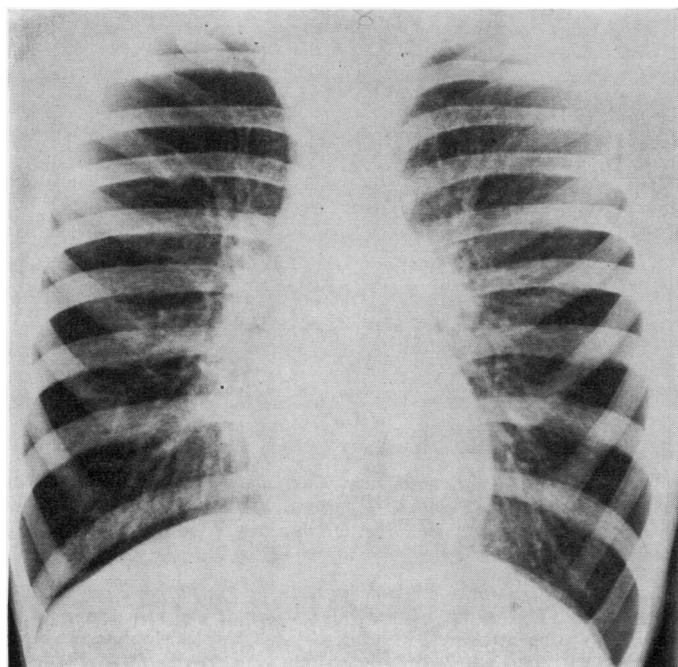


FIG. 3. 0-2 pattern. Boy aged 8 years. Continuous asthma. Onset age 1 year. PEFR 49% predicted. (See monthly readings in Fig. 10.) Diaphragm rib 7½. Lung length=lung width. Heart 3rd percentile. (Retrosternal transradiant area was large at times, at others normal, but sternum displaced forwards, see Fig. 6.) Hilar vessels larger than normal; lung vessels smaller than normal.

children did the chest wall bulge out locally, and the lung width was thus the maximal lung width, and it did not alter the measurement if it was made 1 cm above or below the top of the diaphragm.

Heart width and shape The heart width was measured as the transverse diameter (TD) in the conventional manner. Also, if the left heart border was almost as near to the mid line as the right, it was recorded as a 'narrow vertical heart' (Fig. 3).

A narrow vertical heart is in part the result of a low position of the diaphragm. Not all cases with a low diaphragm have a narrow vertical heart, and a narrow vertical heart may occur with a diaphragm at average level.

Size of retrosternal transradiant zone. In adults this zone can often be precisely measured in the lateral chest radiograph (Simon, 1970), but in children the ascending aorta is usually invisible and the posterior margin of the zone is therefore difficult to define. In this series of children a subjective assessment was made by comparison of the approximate size of the retrosternal transradiant area with that of normal children of the same age (Fig. 4).

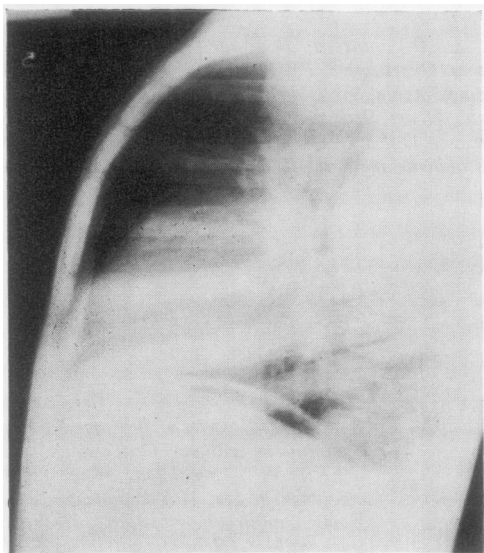


FIG. 4. Lateral view. Normal child from control series, showing upper limit of size of retrosternal transradiant zone. Most are smaller than this.

Sometimes the whole sternum is seen to be anteriorly displaced. This may or may not be associated with enlargement of the retrosternal transradiant zone and does not interfere with the assessment of its size (Figs 5 and 6). However, a marked anterior bowing of the sternum, often due to a growth defect, can cause an enlargement of the retrosternal transradiant zone unrelated to the presence of asthma. In such persons measurement of the zone is of no value in assessing whether it is large or not.

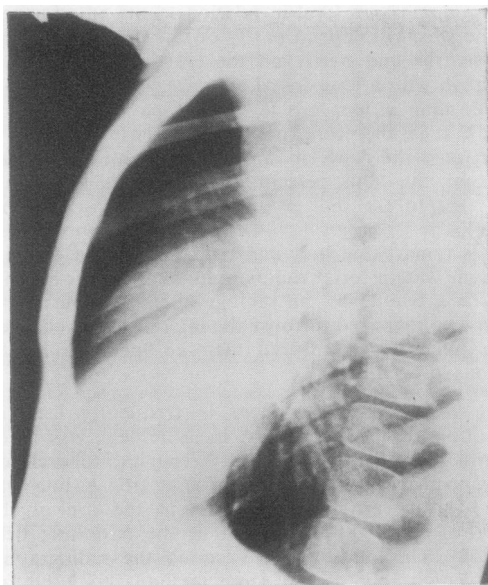


FIG. 5. Lateral view. Intermittent asthma, same case as in Fig. 2 with 0-1 pattern. Retrosternal transradiant zone about the same as upper limit of normal.

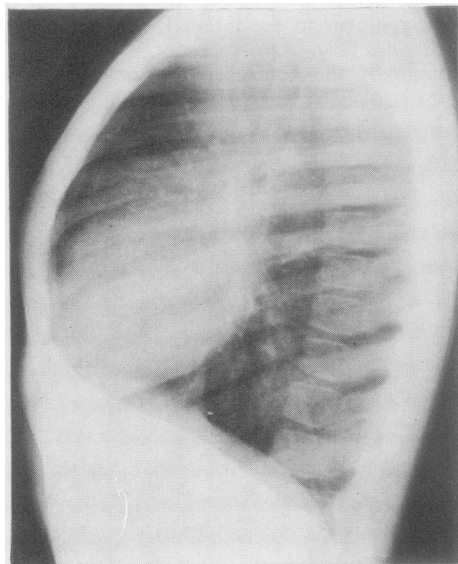


FIG. 6. Lateral view. Continuous asthma, same case as in Fig. 3 with 0-2 pattern. Sternum displaced forwards but space not large. (It was larger on another occasion.)

Size ratio of hilar vessels to peripheral lung vessels The width of the hilar vascular shadow can readily be measured in adults by defining the points on both sides where the upper lobe vein crosses the lower lobe

artery (basal artery) and measuring the distance between them. The width of the lower lobe artery can also be determined with considerable accuracy. In children, similar measurements can often be made, but sometimes the vascular shadows are rather blurred and the measuring points are thus ill defined.

Over a large series it is, therefore, not possible to record precise measurements of the vascular shadows. However, a subjective impression of the relative sizes of the vessels can be formed by comparing radiographs of asthmatic children with those of normals. In radiographs of normal children, large-looking hilar vessels are associated with lung vessels of a large size and small hilar vessels with small lung vessels. It is, therefore, possible to record an abnormal appearance in other radiographs consisting of 'large hilar vessels associated with small lung vessels' without defining the actual size of the vessels. This type of vascular abnormality may be seen in asthmatic children, and an example is shown (Fig. 3).

Additional shadows An abnormal shadow sometimes seen in the radiographs of asthmatic subjects was described by Hodson and Trickey (1960) and was designated a 'tramline shadow'. It is a tubular hair-line opacity lying in the direction of the bronchus, the width being appropriate for a normal bronchus at that level. These shadows are usually seen just beyond the

level of the segmented bronchi in either the upper or the lower zones, but they are more readily recognized in the upper half of the lung since in this area there are fewer confusing shadows (Fig. 7).

Other abnormal shadows are occasionally seen in asthmatic children. These consist of areas of consolidation, wider tubular or ring shadows suggesting bronchiectasis, or circular and bandlike shadows suggesting intrabronchial plugs of mucus. These appearances may indicate the presence of complicating bronchopulmonary aspergillosis and are similar to those described in adults by McCarthy, Simon, and Hargreave (1970). Cases showing such shadows had serological evidence of aspergillosis and are excluded from this analysis.

Interpretation of radiological appearances. Using the criteria set out above, we have classified the radiographs of the asthmatic children into three types.

Normal pattern (Fig. 1) Presenting two or more of the following features:

1. Diaphragm at or above the anterior rib level of '6½'
2. Lung width greater than lung length
3. Heart width on or above the 3rd percentile.

0-1 Pattern (simple overinflation) (Fig. 2) Presenting two or more of the following abnormalities:

1. Diaphragm below anterior rib level of '6½'
2. Lung length the same or greater than the lung width
3. Heart width on or below the 3rd percentile. (A large retrosternal transradiant area in the lateral film is also an indication of overinflation.)

0-2 Pattern (complicated overinflation) (Fig. 3) Similar to the 0-1 pattern above, but with hilar vessels which appear large relative to the lung vessels which appear small.

RESULTS

The two series of asthmatic children were com-

TABLE I

INITIAL COMPARABILITY OF THE TWO SERIES OF ASTHMATIC CHILDREN

	Brompton	U.C.H.	P (by <i>t</i> test or χ^2)
Total	73	145	
Male	51 (70%)	87 (60%)	> 0.1
Female	22 (30%)	58 (40%)	
Mean age (yr) .. .	9.3 (SD2.1)	9.81 (SD2.3)	> 0.1
Mean age of onset (yr)	4.0 (SD2.6)	3.6 (SD2.8)	> 0.25
Mean body height percentile	49 (SD30)	49 (SD26)	> 0.25
No. with intermittent asthma	21 (29%)	31 (21%)	> 0.1
No. with constant asthma	52 (71%)	114 (79%)	> 0.1
No. with 'normal' radiograph	51 (70%)	109 (75%)	
No. with 0-1 radiograph	12 (16%)	20 (14%)	
No. with 0-2 radiograph	10 (14%)	16 (11%)	

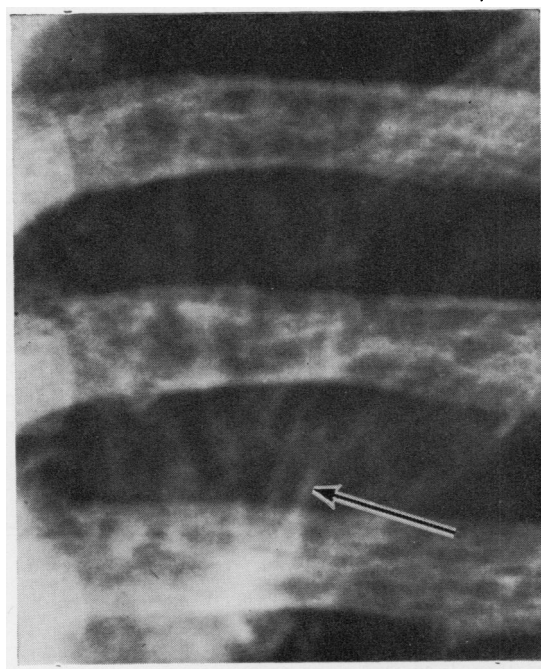


FIG. 7. Parallel line (tramline) shadow. This is seen in left upper zone. Boy aged 9 years. Continuous asthma. Onset age 2. PEFR 44% predicted. Later, lines disappeared.

pared for age, sex, body height percentile, age of onset, and duration of the asthma and for respiratory function (Table I). The findings in these respects were almost identical, as shown by significance tests (Student's *t* test or χ^2). When the radiographic measurements were examined, it was found that the frequency of abnormalities was also remarkably similar in the two series. These findings indicate that the two hospital populations of asthmatic children were comparable and also that there was a consistent radiographic assessment of the less precise measurements.

The results from the two sources are hereafter combined and analysed as a single group, and as such are compared with the normal control series (Tables II, III, IV).

Frequency of the different radiographic patterns (Table II) Seventy-three per cent of the children had 'normal' chest radiographs, 15% showed the 0-1 pattern, and 12% showed the 0-2 pattern.

Level of the diaphragm (Table II) This was low (below 'rib 6½') in 40 (25%) of the asthmatic children with a 'normal' radiograph while it was as low as this in only 15% of the control non-asthmatic children. In the 0-1 and 0-2 types of radiograph, the diaphragm was low in 81% and 88% respectively. It was curved in shape in all the patients and was not flat even in the lateral view in any of the children for whom these films were available.

Size of the lungs and heart Table II sets out the numbers of children who were found to have radiographic measurements outside the normal range. For this purpose the normal is defined as being between the 3rd and 97th age percentile boundaries. From this analysis it can be seen that the proportion of children in each radiographic category who had abnormally long or narrow lungs, enlarged retrosternal transradiant zones, and abnormally narrow hearts increased

progressively from those with normal radiographs through those with 0-1 to those with 0-2 radiographs.

It is, of course, true that patients were allocated to the 0-1 and 0-2 groups because they had a low diaphragm and long lungs, and these features will therefore be present and are recorded in the tables in each group. The diaphragm levels and lung lengths were put in the tables partly to show that the selection was more or less correct and also in order to compare these features with the normal control group and those asthmatics with a normal chest radiograph, and to relate the lung length to the other parameters such as the lung width, body height, and expiratory flow rate.

Table III shows the actual radiological measurements of the lungs and heart expressed as percentiles. The mean lung length increases to a maximum in the 0-2 category and the mean lung width decreases to a minimum in the 0-2 category, as would be expected from the method of selection. The lung area, derived from length \times width for each patient individually, does not differ from normal in any of the radiographic patterns.

The width of the heart is the most sensitive indicator of abnormality and is decreased even in those children with a 'normal' radiograph (mean TD percentile 30).

Additional shadows (Table II) Tubular ('tram-line') shadows, as described above, were found in 58 children (27%). The incidence was lowest (17%) in those children with an otherwise normal radiograph and highest in those with a 0-2 pattern (61%). Such shadows were usually transient, and the figures refer to their presence in any one of a series of radiographs of the same patient.

Relationship of body height to radiographic appearances (Table III) The mean height of all the children with asthma falls near the median percentile for normal children. Those children

TABLE II
RADIOLOGICAL ANALYSIS OF 218 ASTHMATIC CHILDREN COMPARED WITH 162 NORMAL CONTROLS

	Total	No. with Diaphragm below Ant. Rib Level 6½	No. with Lung Length \geq 97th Percentile	No. with Lung Width \leq 3rd Percentile	No. with Heart Transverse Diameter \leq 3rd Percentile	No. with Enlarged Retrosternal Area (96 patients)	No. with 'Tramline' Shadows
Normal controls	162	15%	3%	3%	3%	—	Nil
Asthmatic children (all)	218	89 (40%)	34 (16%)	28 (13%)	70 (32%)	24 (24%)	58 (27%)
Asthmatic children							
'Normal' radiograph	160 (73%)	40 (25%)	12 (7.5%)	13 (8%)	32 (21%)	4 (5%)	28 (17%)
0-1 radiograph	32 (15%)	26 (81%)	14 (44%)	5 (16%)	18 (56%)	10 (77%)	14 (44%)
0-2 radiograph	26 (12%)	23 (88%)	8 (31%)	10 (38%)	19 (73%)	10 (100%)	16 (61%)

TABLE III

RADIOLOGICAL ANALYSIS OF 218 ASTHMATIC CHILDREN GROUPED BY RADIOLOGICAL PATTERN

	Mean Age (yr)	Mean Age of Onset of Asthma	Mean Lung Length Percentile	Mean Lung Width Percentile	Mean Lung Area Percentile	Mean Heart Transverse Diameter Percentile	Mean Body Height Percentile	Mean PEFR or FEV ₁ as % of Predicted
Asthmatic children								
'Normal' radiograph (160)	9.3 (2.3) ¹	3.7 (2.8)	58.4 (31.5)	45.6 (30.6)	55.6 (30.2)	30.0 (25.4)	49.7 (28.2)	69.6 (18.9)
0-1 radiograph (32)	10.0 (2.1)	4.1 (3.0)	80 (24.9)	24.7 (19.4)	64.3 (28.5)	8.7 (10.1)	52.3 (26.3)	60.8 (19.4)
0-2 radiograph (26)	11.0 (2.4)	3.3 (2.3)	81.7 (24.6)	21.9 (26.9)	56.7 (26.5)	4.9 (3.1)	41.9 (29.5)	47.1 (24.0)
Significance of difference between means (Students' <i>t</i> test)								
N × 0-1	<i>t</i> = 1.54 P NS	NS	<i>t</i> = 3.71 P < 0.001	<i>t</i> = 3.66 P < 0.001	NS	<i>t</i> = 4.21 P < 0.001	NS	<i>t</i> = 2.39 P < 0.02
N × 0-2	<i>t</i> = 3.5 P < 0.001	NS	<i>t</i> = 3.72 P < 0.001	<i>t</i> = 3.59 P < 0.001	NS	<i>t</i> = 4.62 P < 0.001	NS	<i>t</i> = 5.39 P < 0.001
0-1 × 0-2	<i>t</i> = 1.74 P NS	NS	<i>t</i> = 0.25 P NS	<i>t</i> = 0.45 P NS	NS	<i>t</i> = 1.85 P < 0.10 NS	NS	<i>t</i> = 2.39 P < 0.001

NS = not significant (*P* > 0.05)¹ Standard deviations in parentheses.

TABLE IV

CLINICAL FEATURES COMPARED WITH RADIOLOGICAL PATTERNS IN 218 ASTHMATIC CHILDREN

	No. with PEFR or FEV ₁ < 75 % Predicted	No. with 'Normal' Radiograph	No. with 0-1 Radiograph	No. with 0-2 Radiograph	No. with 'Tramline' Shadows	No. with Diaphragm Rib '6½'
Intermittent asthma (52 patients)	23 (44%)	50 (95%)	2 (5%)	Nil	4 (8%)	12 (23%)
Constant asthma (166 patients)	118 (71%)	110 (67%)	30 (18%)	26 (15%)	49 (30%)	72 (44%)
Significance of distribution (χ ²)	χ ² = 11.4 df = 1 P < 0.001		χ ² = 18.4 df = 2 P < 0.001		χ ² = 9.1 df = 1 P < 0.005	χ ² = 6.1 df = 1 P < 0.025

with long narrow lungs (0-1 and 0-2 patterns) were not above the normal height for their age, and the long lungs were, therefore, not due to an overall long body measurement. On the other hand, those children with a 0-2 pattern were slightly, but not significantly, shorter than the median normal. Only one child in the whole series was below the 3rd percentile for body height.

Relationship of age and duration of asthma to radiographic appearances (Table III) The mean age of children with 'normal' radiographs was 9.3 years and was not significantly different from those with a 0-1 pattern. The children with 0-2 radiographs were a little older (mean age 11.0 years), the difference from the 'normal' group being significant (*P* < 0.001). The age of onset of the asthma was virtually the same (mean 4 years, SD 2.6) in the three radiological groups. The children with 0-2 radiographs therefore had a slightly longer duration of disease (mean difference less than 2 years).

Relationship of clinical features to radiographic appearances (Table IV) The differences between

the children with intermittent asthma and those with constant asthma were reflected in the distribution of the radiological abnormalities.

In 50 out of 52 (95%) of those with *intermittent* symptoms the radiograph was normal, even when the respiratory function was persistently abnormal. There were eight children with a history of previous status asthmaticus in this clinical category and all of them had 'normal' radiographs, even though their attacks had been severe enough in some cases to lead to unconsciousness. The mean PEFR or forced expired volume in one second (FEV₁) of all the children with intermittent asthma was 61.6% (SD 21.7) of the predicted normal.

Of the children with *constant* asthma, 110 out of 166 (66%) also had 'normal' radiographs, but it was from this clinical category that *all* the children with 0-2 radiographs were derived. The mean PEFR or FEV₁ of all the children with constant asthma was 57.8% of predicted (SD 19.5) which was slightly, but significantly, less than that of those with intermittent asthma (*P* < 0.001).

'Tramline' shadows were seen in 49 (30%) children with constant asthma, but in only 4

(8%) of those with intermittent symptoms ($P < 0.005$).

The heart TD was at or below the 3rd percentile in 62 (37%) children with constant asthma and 8 (15%) of those with intermittent asthma.

Relationship of ventilatory function to radiological pattern (Table III) The PEF_R or FEV₁ was below 75% of the predicted normal in 101 (63%) children with 'normal' radiographs, in 25 (78%) of those with 0-1, and in 22 (85%) of those with 0-2 radiographs.

The mean PEF_R or FEV₁ was 69.6% of predicted (SD 18.9) in children with 'normal' radiographs, 60.8% (SD 19.4) in those with 0-1, and 47.1% (SD 24.0) in those with 0-2 radiographs. These differences were significant ($P < 0.02$).

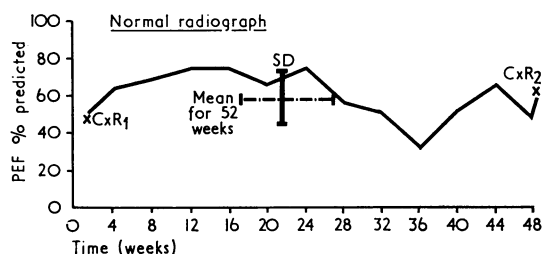


FIG. 8. Monthly readings of PEF_R expressed as a percentage of predicted figure. Continuous asthma, same case as in Fig. 1. Mean value shown by horizontal line.

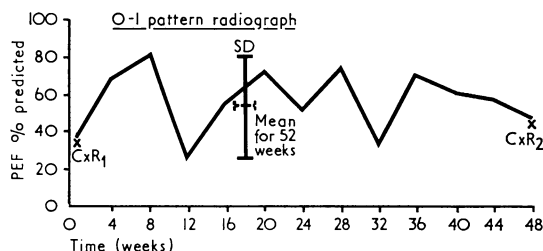


FIG. 9. Monthly readings of PEF_R. Intermittent asthma. Same child as in Fig. 2.

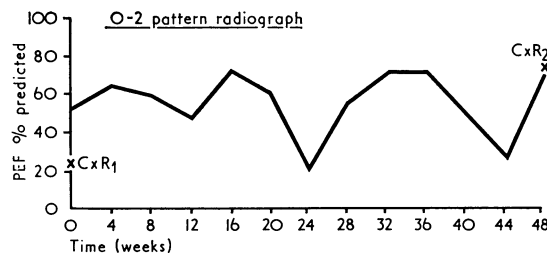


FIG. 10. Monthly readings of PEF_R. Continuous asthma. Same child as in Fig. 3.

Figure 8 shows the peak flow readings taken at monthly intervals in one of the asthmatic children with a 'normal' radiograph (the same child as in Fig. 1). Although there are considerable variations, no reading is above 75% of the predicted normal. Figure 9 is an example of the monthly readings in a child with a 0-1 pattern (the same child as in Fig. 2). Figure 10 is from a child with a 0-2 pattern and shows a variable PEF_R which never rises to above 60% of the predicted normal and sometimes falls as low as 20% (the same child as in Fig. 3).

DISCUSSION

It would appear that nearly all the children whose asthma was *intermittent* had a normal chest radiograph, even if at the time that the radiograph was taken, or a few hours earlier, there was evidence of moderately severe airways obstruction.

On the other hand, some 33% of the children with *constant* asthma of variable severity showed either a radiograph which is unusual in a normal child, that is a 0-1 pattern (as in Fig. 2), or a definitely abnormal appearance (the 0-2 pattern, as in Fig. 3).

Children showing the 0-2 pattern tended to be a little older and to have had their asthma a little longer than the others, but the development of the radiographic abnormality is not dependent on the age of onset of the disease. Children with the 0-1 pattern do not differ in these respects from asthmatic children whose radiographs appear to be normal.

The radiographic appearances are not related to body height.

The mechanism of the decrease in lung width in some of the asthmatics is uncertain. This decrease may be the result of the low position of the diaphragm. A similar decrease in lung width was reported by Campbell (1969) in adult patients with severe emphysema. In an adult patient seen by one of us (G.S.) the lung appeared normal in a radiograph taken many years before the onset of symptoms. Later, this patient developed clinical and radiographic evidence of widespread emphysema. Measurements from the two radiographs showed that the lung length had increased from 28 cm to 36 cm but the lung width had decreased from 30.5 cm to 28.5 cm and the ratio of lung length to lung width had therefore increased from 0.8 to 1.2.

Although on average the airways obstruction was more severe in those showing the 0-2 pattern than in those with a normal radiograph (Table III), in all groups there were some cases in whom

the PEFR or FEV_1 was reduced to about 50% of predicted normal, so that the degree of obstruction to the larger airways is probably not the only factor responsible for the 0-2 pattern. This is in keeping with the observations of Woolcock and Read (1966), who showed that overinflation as measured by lung volumes bears no constant relationship to the FEV_1 .

As regards the apparent change in the vessels characteristic of the 0-2 pattern, namely dilatation of the hilar arteries and relative narrowing of the lung vessels, the haemodynamic basis of this change is unknown. It is reversible in some cases, and is not associated with clinical evidence of pulmonary hypertension or changes in the electrocardiogram.

There were some statistical differences between the asthmatic children with radiographs considered to be normal and the normal control group. The asthmatic children with a 'normal' radiographic pattern had, on average, longer lungs and narrower heart shadows than the control children. Until a rapid cure for asthma can be found, it is not possible to see if such children change their lung length or heart size when recovered.

The overinflation pattern, whether 1 or 2, may be reversible, as was found in some cases which were followed up, but how and when such children convert to a normal radiograph is as yet unknown. From a personal observation of 100 un-

selected cases (G.S.), it is apparent that such radiological overinflation patterns are rarely seen in adults and are certainly very uncommon in adult intrinsic asthma of late onset, however constant and severe the disease may be.

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