The Central African
Journal of Medicine

Volume 2 OCTOBER, 1956 Number 10

Pulmonary Schistosomiasis

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Several observers have described specific radiological changes in pulmonary schistosomiasis, notably Day (1937) and Mainzer (1938). These authors have described various radiological appearances, including discrete nodulation, multiple calcified foci, bilateral enlargement of the hilar prominences and general increase in the pulmonary linear striations. More recently Gelfand (1950) has written a comprehensive account of schistosomiasis, including pulmonary schistosomiasis. He found no specific radiological changes in the lungs of his African patients infected with schistosomiasis.

My impression, based on an experience of interpreting over 200,000 chest skiagrams of Africans during the past eight years, supports the view of Gelfand that there are no such specific radiological changes. As impressions, however, can be erroneous, it was decided to institute a controlled investigation, the main object of which would be to determine whether these changes did occur in the lungs of patients infected with schistosomiasis with special reference to the incidence of increased linear striation. This is important to us in that in our radiological classification of pneumoconiosis a recruit presenting himself for initial examination with a Category 1 degree of increase in linear striation (Fig. B) is not granted an initial certificate for employment in the copper mining industry of Northern Rhodesia. Although this was the primary object of the investigation, it was extended to include haematological and other findings and generally to assess the suitability of these cases for acceptance into the mining industry.

For the purpose of the investigation 300 African recruits infected with *S. haematobium* were chosen at random, the criterion of diagnosis being the finding of the ova of *S. haematobium* in a centrifuged specimen of urine. The majority of the recruits were from Northern Rhodesia and the remainder from Nyasaland and Tanganyika, where infection is mainly by *S. haematobium*. It was noted that all positive cases had an albuminuria. Control cases consisted of 300 similarly chosen African recruits free from schistosomial infection. The results of the investigation are detailed below.

I. Haematology

(a) *Leucocytes.*—The average total leucocyte count of the 300 cases was 8,270 c.mm. No case showed a leucopenia; 47 cases (15.7 per cent.) had a leucocytosis. A leucocytosis was accepted where the leucocyte count was 11,000 c.mm. or more; 253 cases (84.3 per cent.) had a normal leucocyte count of less than 11,000 c.mm. There were no significant features in the differential count apart from an eosinophilia.

(b) *Eosinophils.*—Fifty-four (18 per cent.) of the 300 cases had a normal eosinophil count. The eosinophil count was accepted as normal where it was 4 per cent. or less; 246 (82 per cent.) had an eosinophilia of more than 4 per cent. The distribution of the eosinophil count is shown in Table I.

Table I.—Eosinophil Count

	NORMAL 18%	EOSINOPHILIA 82%					
Eosinophilia count	0—4	5—10	11—15	16—20	21—25	26—30	31—35	36—40
No. of cases	54	154	60	20	6	5	0	1

(c) *Erythrocytes.*—The average erythrocyte count for the 300 cases was exactly 5 million c.mm. Only three cases had an anaemia and all three cases had a count of 3.2 million c.mm.

(d) *Haemoglobin.*—The average haemoglobin estimation of the 300 cases was 99 per cent. Sahli.

(e) *E.S.R.*—The E.S.R. (Westergren method) was estimated in each case. One hundred and seven (35.7 per cent.) had a normal E.S.R. of less than 10 mm. in one hour; 193 (64.5 per cent.) had an increased E.S.R. of more than 10 mm. in one hour. The average E.S.R. for the 193 cases with an abnormal E.S.R. was 27 mm. in one hour and the average of the 300 cases was 21 mm. in one hour. This confirms a previous investigation in which the E.S.R. of 500 unselected African recruits had an average E.S.R. of 15.4 mm. in one hour, and it is presumed the high E.S.R. reading in apparently healthy Africans is due to subclinical infections.

II. Post Mortem Material

Histological preparations are made on the lungs of all deceased miners in the pathological department of the Bureau. At least five blocks are prepared routinely from each case, and in 200 unselected cases evidence of schistosomial infection was found in 25 (8.3 per cent.). It is appreciated that if preparations had been made for the specific purpose of demonstrating schistosomiasis infection such as was employed by Gelfand, the incidence rate would probably be very much higher. Infection in many cases was heavy. Others showed only an occasional focus with giant cell reaction or small isolated calcified areas.

Figure 1 demonstrates a small focus of fibrogenic and cellular reaction with associated eosinophilic reaction around a schistosoma ovum which is undergoing calcification.

Figure 2 shows minimal cellular reaction around a cluster of schistosoma ova which are calcified. These illustrate the typical foci of schistosomiasis infection of the lung that we see at routine examination. They are so small that it would be impossible to visualise them radiologically.

III. Sputum

As it has been considered by some investigators that ova may reach the air spaces in the lungs, a wet specimen of sputum from all 300 cases was examined microscopically, but in no case was the ova of *S. haematobium* isolated.

IV. Radiology

The work of Lodge (1946) gives an excellent description of the pulmonary vascular markings, and it is generally accepted that the normal pulmonary pattern is produced by the pulmonary vessels. In assessing and interpreting variations in the extent and density of the linear striations, many factors must be considered. Striations vary greatly with the radiographic technique employed, for even in the same individual slight alterations in penetrations will alter the appearance of the linear striations, soft films producing an apparent increase of the pulmonary markings generally, heavily penetrated films tending to obliterate them.

The processing technique too can alter considerably the appearance of the linear striations. It is, therefore, essential before drawing any conclusions as to the presence or absence of increased striations that the films must be of a standard technique and be comparable. X-ray films at the Bureau are produced by two identical X-ray units each four valve of 90 K.V.P. x 500 m.a. fitted with C.R.T. 1-2 rotating annode tubes of focal spot 1 mm. or 2 mm. The technique employed is:—

Projection: Postero-anterior at full inspiration with the tube centred on the fourth or fifth dorsal vertebra.

Distance: 60 in. (152 cm.).

Focal spot: 2 mm.

Screens: Kodak ultra speed.

Milliamperes: 300.

Time: Iontomat controlled exposure by built-in iontomats.

K.V.P.: 50/65 according to the thickness of the chest wall.

No filters are used apart from those incorporated in the tube. Standard films are used exclusively and developing is invariable at 5 min. at a temperature of 68° F. With this technique it is possible to obtain comparable films, and nothing short of such a technique will do so.

Fletcher (1949) points out the serious disagreement among doctors experienced in reading pneumoconiosis films. Concerning limits within which a film may be regarded as normal, most experienced observers have a mental standard of comparison, but as this may be variable it is essential to have an accepted standard, especially in the reading of linear densities. Figures A to D illustrate the standards adopted here. Figure A (Category 0) is that of a normal thorax in which the normal linear or dendritic striations radiate from both hilar regions and taper off towards the middle of the lung fields, the remainder of the lung fields being clear. The hilar prominences are normal in size and outline.

Figure B (Category 1) illustrates the first stage in an abnormal increase in linear striation. In these films it will be seen that the hilar prominences are still normal in size and outline,

but the linear or dendritic striations radiate beyond the middle of the lung fields and extend out towards the periphery.

Figure C demonstrates a Category 2 increase in linear striation. Here the hilar prominences are larger and the linear and dendritic striations radiating from the hilar areas are more pronounced in numbers and density and they extend to the periphery of the lung fields.

Figure D illustrates a Category 3 increase in linear striation. Here there is a well marked increase in the number and extent of the linear and dendritic striations, and both lung fields are occupied by a generalised arborisation and the smallest branches of the bronchial segments including the bronchioles are involved. The hilar prominences are enlarged.

These categories are the appearances normally seen in the chest skiagram of a miner in the course of his working life before the development of overt silicosis. Categories 1 and 2 are not necessarily specific of dust fibrosis, but where they develop in a miner who at initial examination had a Category 0 film, and where such appearances have developed in a relatively short time, it can be accepted that these changes are due to peri-vascular and peri-bronchial fibrosis resulting from the inhalation of silica dust. However, other conditions such as chronic bronchitis and even advancing age can produce such variations in linear densities resulting in a marked increase in the linear striations.

In this series of cases, therefore, no case of chronic bronchitis was included and all the recruits examined were under 30 years of age.

Of the 300 cases originally included in the investigation, 45 had to be eliminated, as they had previous exposure to mineral dust. The films of the remaining 255 cases were read by three groups each consisting of two observers. The films were read and the presence of any of the following abnormalities noted:—

(a) Increase in striation and its category.
(b) Nodulation.
(c) Enlargement of the hilar prominences.
(d) Diffuse pulmonary fibrosis.
(e) Calcified foci.
(f) Emphysema.

The films were read independently by each of the three groups A, B and C and finally by Groups A, B and C together. The results are shown in Table II.

It will be seen that there was close correlation in the readings of the three groups, and the overall reading of the combined groups was accepted in each series.

In the 255 cases infected with *S. haematobium*, 234 (91.8 per cent.) had a Category 0 film or normal thorax; 21 (8.2 per cent.) had a Category 1 increase in linear striation. This is the lowest category increase in linear striation which we recognise. There were no cases in Categories 2 or 3 and no group recorded the presence of calcified foci, nodulation, diffuse fibrosis, enlargement of the hilar prominences or generalised fibrosis with emphysema.

Table II.—Radiological Classification of 255 Cases of Schistosomiasis

X-ray Category	0		1		2	3	Other Abnormalities
Group A	233	91.4%	22	8.6%	0	0	0
Group B	247	93%	18	7%	0	0	0
Group C	229	89.8%	26	10.2%	0	0	0
Groups A, B and C	234	91.8%	21	8.2%	0	0	0

Table III.—Radiological Classification of 300 Control Cases

X-ray Category	0		1		2	3	Other Abnormalities
Group A	284	94.7%	16	5.3%	0	0	0
Group B	271	90.4%	29	9.6%	0	0	0
Group C	286	95.4%	14	4.6%	0	0	0
Groups A, B and C	275	91.7%	25	8.3%	0	0	0

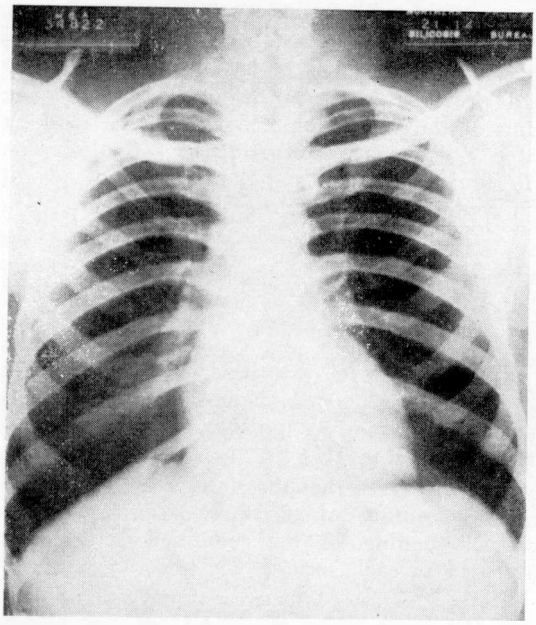

Fig. A (Category O).

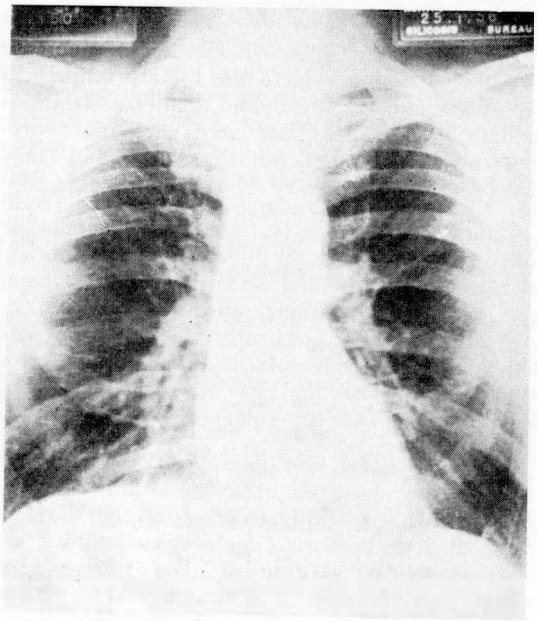

Fig. C (Category II).

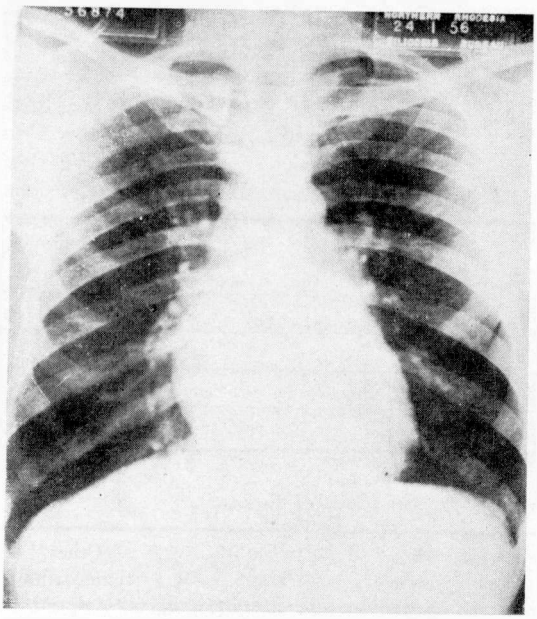

Fig. B (Category I).

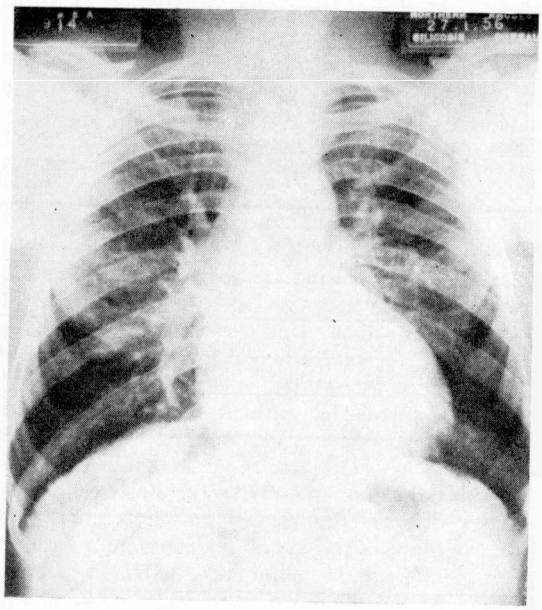

Fig. D (Category III).

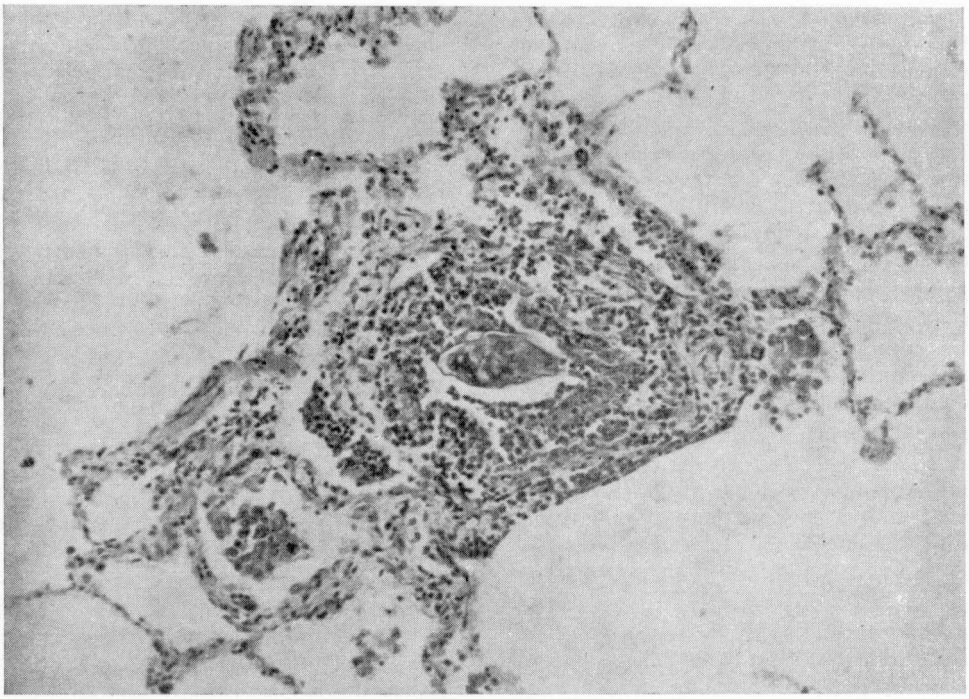

Fig. 1—Showing a typical inflammatory reaction around an ovum.

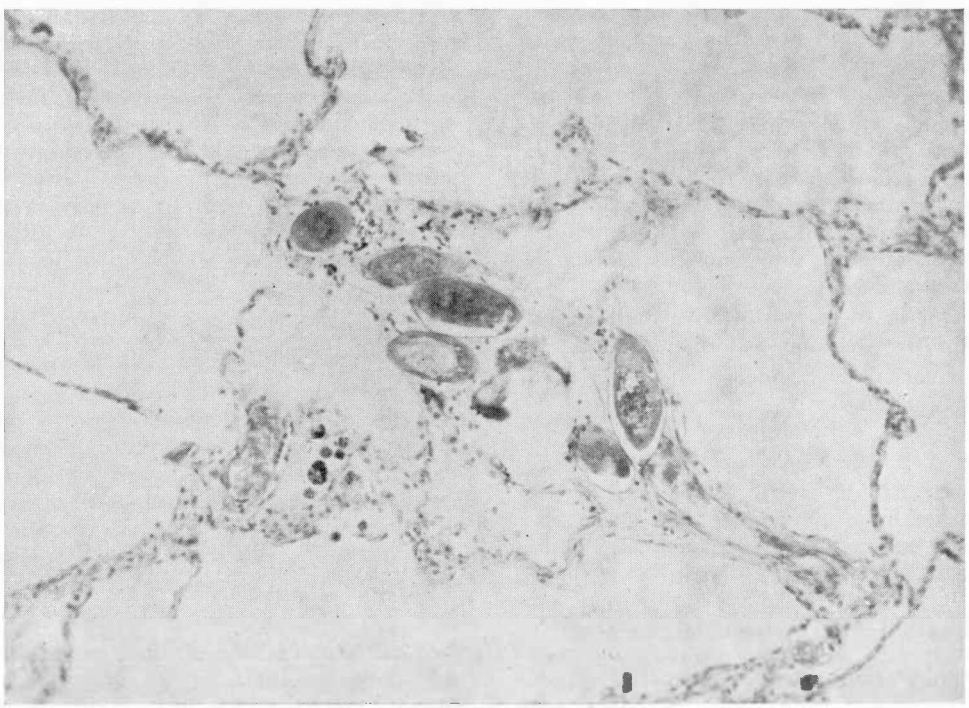

Fig. 2—Slight cellular reaction around a number of bilharzial ova.

The same procedure was adopted in the 300 control cases. Again there was close correlation between the three groups, and overall readings of Groups A, B and C placed 275 (91.7 per cent.) of the control cases in Category 0; 25 cases (8.3 per cent.) were placed in Category 1. Again no cases were placed in Categories 2 or 3 and again no observer recorded the presence of any of the abnormalities mentioned above.

The numbers placed in Category 1 in both series of *S. haematobium* infection and control cases are strikingly similar—21 (8.2 per cent.) in the 250 cases of *S. haematobium* infection and 25 (8.3 per cent.) in the control series.

From this it would appear that infection with *S. haematobium* does not give rise to an increase in the pulmonary linear striations and we could find no evidence of any of the other abnormalities described by previous workers.

Cardio-vascular System

The cardiac outline of both series was also studied by Groups A, B and C. There was no diversity of opinion, for in the 300 cases of schistosomiasis all three groups recorded two cases of enlarged pulmonary conus.

In the series of 300 control cases, two cases of enlarged pulmonary conus were also recorded. No other abnormalities of the cardiac outline were noted in either group.

At the beginning of the investigation, electrocardiographic studies were carried out on selected cases, but in no instance were the changes typical of chronic cor pulmonale observed, such as high-peaked P waves in leads II, III and A.V.F. or small R waves in the right pre-cordial leads and deep S waves in the left pre-cordial leads.

In view of the repeated negative findings, this part of the investigation was discontinued.

To summarise, no evidence of chronic cor pulmonale was found.

V. Respiratory System

Each case had a careful clinical history recorded through an interpreter and in no case did any patient complain of symptoms relating to his chest, such as cough, pain or dyspnoea on exertion. Similarly, no symptoms were complained of relating to the urinary system. This particular finding is limited in its value, however, in that no specific questions relating to the urinary system were asked, but none were volunteered.

No clinical abnormality of the lung fields was observed in any of the 300 cases.

Conclusions

Infection with *S. haematobium* was always accompanied by an albuminuria.

Haematological investigation of the 300 cases investigated showed evidence of associated anaemia in only three. The majority had a demonstrable eosinophilia. Leucocytosis was found in only a relatively small number and no case had a leucopenia. The E.S.R. was found to be raised in almost two-thirds of the series investigated.

Clinical and electrocardiographic studies revealed no cases of cor pulmonale. Symptomless enlargement of the pulmonary conus was found in two cases and also in two of the control series.

In the 300 cases investigated, no abnormal physical signs were recorded and no symptoms were elicited.

Radiological investigations showed that the incidence of increased striation was practically the same in the group infected with schistosomiasis as the control series and the increase in striation was confined to the earliest category. This suggests that infection with *S. haematobium* does not give rise to an abnormal increase in the pulmonary linear striations. No evidence of any pulmonary abnormalities such as nodulation, calcification, emphysema or enlarged hilar prominences were observed.

It would appear, therefore, that on the whole there is no reason why recruits infected with schistosomiasis should not be admitted to the mining industry.

Summary

The haematological, radiological and other findings in 300 African recruits infected with *S. haematobium* are recorded. No specific radiological changes were found in the chest skiagrams of the patients so infected.

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Acknowledgments

I am grateful to my colleagues at the Bureau for their assistance in the preparation of this paper and particularly to Mr. S. C. Eve, Laboratory Technician.