PULMONARY LESIONS IN RABBITS WITH EXPERIMENTAL SCHISTOSOMIASIS JAPONICA

DERIVATION OF SCHISTOSOME EGGS

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In human cases and experimental animals of schistosomiasis japonica, schistosomal eggs are often detected in the lungs. On a derivation of the intrapulmonary eggs many reviews are reported. Though the major opinions are that they flow into the lungs from the portal vein and the hepatic vessels in which the flukes mainly inhabit, the route by which they reach the lungs is not known with certainty.

In order to study the problem, rabbits were infected with cercariae of Schistosoma japonicum, and observed for 2 or 32 weeks thereafter, and histological specimens were cut into serious sections and stained, and then stereographical scrutiny was carried out by the sketching reconstruction method.

Some worms lying within the pulmonary artery occasionally had mature eggs in their uterus, moreover, there were thrombi with eggs or egg nodules in its peripheral branch. These findings suggest with positive fact that the eggs in the lung are produced not only owing to an inflow from the portal vein, but also owing to a direct egg-laying in the lungs.

INTRODUCTION

It is generally recognized that pulmonary schistosomiasis occurs in the early stage of schistosomal infection during the passage of larvae through the lungs, and in the late stage during the deposition of ova and worms. But, schistosomal cor pulmonale is rare in Schistosoma haematobium or mansoni, and it is fewer in Schistosoma japonicum than in two former species.

The authors were interested in the pulmonary lesions of schistosomiasis japonica, and especially investigated the derivation of the intrapulmonary eggs in the experimental animals.

MATERIALS AND METHODS

Thirty nine male rabbits were used as experimental animals. Each rabbit received about 300 to 500 cercariae of Schistosoma japonicum through cutaneous infection. Observations were carried out for 2 to 32 weeks thereafter. Macroscopic examinations were made at autopsy. Histological specimens were
cut into serial sections, and stained by H & E and Azan-Mallory staining for stereographical scrutiny by the sketching reconstruction method.

RESULTS

The adult worms first appeared within the branches of the pulmonary vessel 21 days after infection (Fig. 1). The eggs began to be found in the lungs 35 days after infection, showing as egg embolus in a capillary of the alveolar septa and a small branch of the pulmonary artery. Next, an egg nodule was formed there according to the maturation of egg contents (Fig. 2). From sketch drawn by the reconstruction method of the lung sections containing that egg-nodule, it is revealed that the egg nodules of the last Fig. 2 were situated at the peripheral branches of the pulmonary artery (Fig. 3). The nodules increased in number, enlarged in size after that, and partially coalesced with one another (Fig. 4). These coalescent nodules were connected with the central side of the pulmonary artery in the sketch drawn by the reconstruction method of that part (Fig. 5). From the gross appearance of the lungs in this period, we could recognize only miliary white spots on the lung surface (Fig. 6).

Some worms recognized within the artery occasionally had a large number of mature eggs in their uterus, moreover, in its peripheral branch there were thrombi with eggs or egg nodules. The Fig. 7 showed the worm having the mature eggs and thrombus around itself. In other specimens, the thrombus with eggs was also formed in a peripheral branch bifurcated from that artery. The sketch of that part was given in Fig. 8 (38 days after infection). The Fig. 9 showed the worm having mature eggs, and the Fig. 10 was the picture drawn by the reconstruction method in the case of 40 days after infection, showing the same findings as the former.

DISCUSSION

Pathologically, Belleli (1885) was the first to record the presence of schistosome ova in the lungs, Symmers (1905) first reported the presence of schistosome worms in the blood vessels of the lungs, and Miller (1914) presented numerous schistosomal granulomata or pseudotubercles and fibrous thickening of the larger and smaller branches in the lungs.

In regard to the immigration of eggs and worms to the lungs, many views failed to reach an agreement. Fujinami (1916) considered that the eggs reached the lung from the hepatic portal vein by means of the hepatic portal branches or anastomosis. Koppisch (1937) seemed that the adult worms found within branches of the pulmonary arteries reached that by direct passage through the dilated sinusoids and efferent veins of the liver, rather than through pelvic anastomoses between the inferior hemorrhoidal plexus and the inferior vena cava. Erfan (1948), Meleney et al. (1953) said that this was probably the result mainly of migration of worms from the portal-mesenteric veins through anastomoses into the pelvic systemic veins or into the vena cava. Farid (1959) also reported collateral portal systemic veins facilitate the passage of adult schistosomes and their eggs from the portal into the pulmonary circulation. Fairley (1919) said that in B. haematobium the pelvic plexuses of veins were those mainly inhabited, and as these plexuses drained into the inferior vena cava, it was not surprising that B. haematobium worms were found in the pulmonary arterioles.
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According to Fujinami (1916), because the worms were occasionally found in the aorta and the pulmonary arteries, there is no denying a direct egg-laying in the lungs as well as migration of egg-emboli from the liver. Kenawy (1950) reported that coupled worms might also reach the lungs as emboli but they did not take any part in producing the vascular changes. Spencer (1969) said that both male and female worms were found in the pulmonary arteries and it was probable that fertilization occurred within these vessels, and he described the presence of living, fertile, female flukes in the pulmonary arteries added considerably to the number of eggs which were found in the lungs and increased the likelihood of cor pulmonale developing.

Our findings on the sketches which showed the adult worms with mature eggs and egg emboli within the same pulmonary artery as described above suggest with positive fact that the eggs in the lung are produced not only owing to an inflow from the liver, but also owing to a direct egg-laying in the lungs.

The pathological histology of the egg nodules was first exudative lesions, and thereafter changed to productive ones as they grew old. In addition, a dead worm surrounded by fibrous granulation tissues able to be found in the pulmonary vessels as seen in other literature. In the present experimental schistosomiasis japonica, although the formation of thrombi with eggs, egg emboli, egg nodules, and granulation tissues around the dead worm occurred, the typical pulmonary fibrosis due to schistosomiasis were scarcely recognized in a practical manner. Shaw and Ghareef (1938) stated that the severity of pulmonary disease was largely due to repeated reinfection of healing or healed lesions. From this point of view, it was a matter for deep reflection that our materials was of single infection.

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REFERENCES


EXPLANATION OF COLORS IN FIGURES

red—pulmonary artery
blue—pulmonary vein
black—bronchus
yellow—granulation tissues
brown—necrotic tissues
dark brown—worm
white dot—egg
Fig. 1 Adult worms of *Schistosoma japonicum* lying within the branches of the pulmonary vessel 21 days after infection.

Fig. 2 Egg nodule (EN) formed in the egg embolus according to the maturation of egg contents.
Fig. 3 Stereographical schema of the part around Fig. 2. The nodule situated at the peripheral branches of the pulmonary artery.

Fig. 4 Egg nodules increase in number, enlarge in size after that, and partially coalesce with one another.
Fig. 5 Stereographical schema of the part around Fig. 4. The coalescent nodules are connected with the central side of the pulmonary artery.

Fig. 6 Gross appearance of the lungs. Miliary white spots are just recognized on the lung surface.
Fig. 7 Worms within the pulmonary artery. The female has mature eggs.

Fig. 8 Stereographical shema of the part around Fig. 7 (38 days after infection). The thrombus with eggs is also formed in a peripheral branch bifurcated from the artery.
Fig. 9 The worms having mature eggs in other rabbit (40 days after infection).

Fig. 10 Stereographical schema of the part around Fig. 2. The same findings as the Fig. 8 are recognized.