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Infection of Schistosome in the Japanese Expatriate in Zambia: Man-made Lake May be Possible Source of Infection

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Abstract

Serological diagnosis of schistosomiasis using micro-ELISA was performed for 82 Japanese who were staying in Zambia for more than 6 months, and 12 cases were found positive of infection. For these 12 cases, further laboratory examinations and inquiries into the clinical course were conducted as well as investigation on possible source of infection.

Of the 12 cases, schistosome eggs were identified in two (one with *Schistosoma mansoni* and the other with *Schistosoma haematobium*). The results of the laboratory examinations revealed eosinophilia in all cases and an increase of serum total IgE in eight cases. Fever was recognized in nine cases. Lumbago and hematuria which were suspected to have appeared accompanied by infection with schistosome was found in one case. Lake Kariba, a man-made lake created by the construction of a dam, was suspected to be the source of infection because all 12 sero-positives had a history of swimming in the lake. Among sero-negatives, only two reported swimming in Lake Kariba.

Schistosomiasis is one of the important diseases for prophylaxis while staying in an endemic area. Extreme care must be taken on exposure to water of man-made lakes because they are often turned into new foci of infection within relatively a short period.

Key words: schistosomiasis; man-made lake; micro-ELISA; Zambia; fever of unknown origin.

Introduction

Schistosomiasis is widely distributed in tropical and subtropical areas of the world, causing the socioeconomic and public health problems in many countries (W.H.O., 1985; W.H.O., 1990). In the endemic areas of schistosomiasis, travellers and temporal residents are at high risk of infection as the indigenous people.

Recently many examples have been reported on the introduction or spread of schistosomiasis as a result of dam construction or irrigation facilities in or near the areas where schistosomiasis is endemic (Audibert, 1990; Babiker *et al.*, 1985; Betterton *et al.*, 1988; Bolton, 1988; Cline *et al.*, 1989; Hunter *et al.*, 1982). In such newly created foci of infection, especially besides the lake made by construction of a dam, resort areas often are formed (Cetron, *et al.*, 1993).

The authors recently examined Japanese residents in Zambia for schistosomiasis infection and found 12 people who were supposed to have been infected with schistosomes while swimming in a man-made lake. The present paper deals with the investigation of the cases and the possible source of infection.

Materials and Methods

Subjects of survey

The subjects of the present survey were 82 Japanese (67 males and 15 females) who were staying in

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Zambia for the purpose of technical cooperation. The length of their stay was between 6 months and 22 months (average 13 months) and their age was between 23 and 38 (average 29).

Methods of survey

The survey was conducted from July 1992 to October 1993. The sera of these 82 subjects collected in Zambia were sent to Japan, where serological test for schistosome was performed. In the serological investigation, the standard micro-ELISA was employed. The period between exposure to lake water (described below) and serum collection for schistosome serological test was 69–151 days (average 88 days). The method of micro-ELISA followed the description of Matsuda *et al.* (1984). The antigen used in this study was prepared by the extract of *Schistosoma mansoni* eggs. ABTS,2,2'-azido-bis (3-ethylbenzothlazoline-6-sulfonic acid), was used as substrate of peroxidase. When an absorbance (antibody titer) exceeded 0.2, the case was determined to be positive. In this method both IgM and IgG antibodies to *S. mansoni* were measured and cases infected with *Schistosoma haematobium* also found positive cross reaction.

For the positive serological cases, further investigation was conducted on their history, and various tests such as stool, urine, blood, liver function and renal function were carried out at local hospitals. In addition, serum total IgE (RIST method) was measured in the reference lab of Japan. To identify the source of infection, the positive cases were interviewed about contact with water and development of signs and symptoms. The items for serological and laboratory tests in this study are summarized in Table 1.

Treatment was undertaken with oral administration of praziquantel at doses of 60 mg/kg divided in 3 in 1 day. However subsequent changes in antibody titers were not followed up in this study while stool and urine tests for infected cases were conducted.

Table 1 Items of tests conducted on the subjects of present survey

1. Serological tests*
Serological test for schistosome with micro-ELISA
Measurements of total IgE level
2. Blood, liver and renal function tests†
Red blood cell count, White blood cell count, Hemoglobin, Hematocrit
GOT, GPT, ALP, ZTT, Total cholesterol
Total bilirubin, BUN, Creatinine
3. Urinalysis†
Sugar, Protein, Occult blood
4. Stool test†
Detection of parasite eggs

* Performed on 82 subjects; † Performed on 12 subjects who showed positive reaction with micro-ELISA.

Results

Serological tests and eosinophil count

Twelve subjects were proved to be positive to the serological test for schistosome. Table 2 summarizes the results of examinations for these 12 positive cases. Antibody titer of micro-ELISA was between 0.439 and 2.159. Increase of serum total IgE was noted in 8 cases. Eosinophilia was found in all 12 cases.

Detection of parasite eggs

Of the 12 serologically positive cases, eggs of schistosome were detected in two (one with *S. mansoni* in stool and one with *S. haematobium* in urine). Besides, eggs of *Trichuris trichiura* were detected in the stool of one case. Neither eggs nor parasites were detected in 10 cases (Table 2).

Source of infection

All of the positive cases for schistosome serological test had histories of swimming in Lake Kariba, whereas 68 out of 70 subjects who showed negative reaction with micro-ELISA had no history of swimming. Statistical significance was recognized in the infection rate between those who swam in Lake Kariba and those who did not ($P<0.01$) (Table 3).

Lake Kariba is a man-made lake created when the Zambezi River was dammed up by building Kariba Dam in 1959. This lake is located about 150 km to the south of Lusaka, the capital of Zambia. Half of this lake belongs to Zambia and the other half to Zimbabwe. Schistosomiasis is distributed in various parts of Zambia, while the region near Lake Kariba is not specifically designated as a schistosome endemic area (the boards warning of schisto-

Table 2 Results of serological examinations, parasite eggs detection and eosinophil count

Case	Sex	Antibody titer (micro-ELISA)*	Parasite eggs	Serum IgE titer†	Eosinophil count (%)
1	F	0.439	ND	659	12
2	M	1.771	ND	739	9
3	M	2.159	ND	421	23
4	M	2.072	*S. mansoni*	1033	22
5	M	0.457	*S. haematobium*	165	9
6	M	1.440	ND	117	13
7	M	1.055	*T. trichiura*	120	28
8	M	0.531	ND	1298	14
9	M	0.561	ND	138	15
10	M	1.288	ND	879	35
11	M	0.865	ND	2780	30
12	M	1.106	ND	1678	17

* ≤0.2 reciprocal titer (normal range); † ≤181.63 reciprocal titer (normal range); ND, not detected.

Table 3 History of swimming in Lake Kariba and results of schistosome serology

Schistosome serology	*Swimming in Lake Kariba*		Total
	(+)	(–)	
Positive	12	0	12
Negative	2	68	70
Total	14	68	82

($P<0.01$, χ^2 test)

some are installed on the Zimbabwe side).

Signs and symptoms of schistosomiasis cases

Signs and symptoms of the cases, and history of the exposure to lake water are summarized in Table 4. In 9 of 12 cases, fever was noted within 37–87 days (average 64.7 days) after exposure to the lake water. In these cases the fever spontaneously resolved within 4 days. There were recognized cases of diarrhea (case 4 and 7) and lumbago with associated hematuria (case 5). No other abnormal findings

Table 4 Signs and symptoms recognized after exposure to lake water

Case	Sex	Exposure to lake water (A)	Symptoms and signs (B)	Days between (A) and (B)*
1	F	+	fever	37
2	M	+	fever	68
3	M	+	fever	78
4	M	+	fever, diarrhea	70
5	M	+	lumbago, hematuria	60
6	M	+	fever	45
7	M	+	diarrhea	64
8	M	+	fever	42
9	M	+	fever	87
10	M	+	fever	83
11	M	+	–	–
12	M	+	fever	72

* Days between swimming in Lake Kariba and the appearance of signs and/or symptoms.

were observed in the laboratory examinations of the 12 sero-positive cases. An outline of case 4 and 5 in Tables 2 and 4 in which parasite eggs were recognized have been described below.

Case 4: 29 year old male who swam in Lake Kariba on December 2, 1992. On February 10, 1993, 70 days after swimming, he had a temperature (38.9°C), headache and systemic malaise associated with diarrhea. Similar symptoms were found on the next day. The fever resolved when antipyretic was given. However in the morning of February 12, fever was noted again (38.0°C) but no diarrhea. The subject underwent blood tests by a local physician. The results were: malaria (–), leukocyte count 8,100, and eosinophilia (22%). Urine and stool were normal. No drug was given.

The temperature of 37 to 38°C persisted until the evening of February 13 and then spontaneously resolved. There were no particular symptoms. On March 25, the subject underwent re-evaluation, and *S. mansoni* eggs were detected in his stool. He was diagnosed as having schistosomiasis mansoni. Praziquantel was given on March 30. Serum was collected on April 19 and serological examination for schistosomiasis was conducted in Japan. The antibody titer found 2.072, a strongly positive reaction. No parasite eggs were detected in stool test conducted on April 14.

Case 5: 30 year old male who swam in Lake Kariba on December 16, 1992. Lumbago occurred 60 days later. Then he was aware of hematuria. A local physician detected *S. haematobium* eggs and increase of erythrocyte count in urine (70–100 per field) was recognized on February 18, 1993. He was diagnosed as Schistosomiasis hematobia and praziquantel was given on February 24.

After one week of drug administration, both the lumbago and hematuria resolved. Serum was collected on March 16 and serological test for schistosomiasis was conducted. The antibody titer was 0.457, showing positive reaction. No parasite eggs were detected in either urine or stool on March 16.

Discussion

The high sensitivity and specificity of serological examination employing micro-ELISA have already been shown in the previous papers: 96.6% of egg positives showed positive reactions while none of the non-infected control group was positive (Tanaka *et al.*, 1983). In a study testing humans and rodents, the absorbance was less than 0.08 in 99% of the negative cases (Matsuda *et al.*, 1984). It is known that in this method cross reaction among other helminthes is rare (Ogumba *et al.*, 1982). In the present survey schistosome eggs were not detected in 10 out of 12 sero-positive cases, but they were considered as infected with schistosome from the results of serum reaction. The infection rate was significantly high among those who swam in Lake Kariba and no other definite source of infection was identified. From these results, it was considered that 12 subjects were infected with schistosome while swimming in Lake Kariba.

Schistosomiasis is the disease for which special hygienic care must be taken when the individuals from developed countries stay in or visit an endemic area (Ohara *et al.*, 1990; W.H.O., 1991). Recently, the Center for Disease Control and Prevention (CDC), U.S.A. investigated the infection rate of schistosome for Americans and Europeans staying near Lake Malawi in East Africa. The result of serological examinations done with micro-ELISA showed that 42% of the subjects under investigation were positive (Cetron *et al.*, 1993).

Lake Malawi has been announced as a "safe lake with no risk of infection with schistosome", and many people swim in the lake. However, the actual infection rate is high. As shown in the present study and in the results of the CDC investigation, even in the lakes which are publicly announced as "safe" without detection of schistosome, the infection rate sometimes is high.

At present dams and irrigation channels are built in tropical and subtropical countries as the means of social development. When lakes or rivers near endemic areas become suitable for the growth of intermediate host due to artificial reasons, dense infection source can occur within a relatively short period (Verhoef and Bos, 1992). In Zambia both schistosomiasis mansoni and haematobia are prevalent in many parts of the country (Ministry of Health, Zambia, 1990; T.D.R.C., Zambia; 1992), but there is no previous definite information that Lake Kariba is a source of infection. Lake Kariba, which was made by dam construction, is known as a resort where many foreigners visit and enjoy swimming.

When people stay in a schistosome endemic area, they must pay attention to contact with water, particularly in the area of man-made lakes or water channels for irrigation because they often become dense source of infection. In the present study, it is suspected that Lake Kariba is no longer free of schistosomiasis. Further investigation is needed to clarify the extent of endemicity, especially on cercariae and intermediate hosts in the lake in addition to the infection rate in people living near the lake.

In this survey, fever was recognized in 9 out of 12 Japanese cases and eosinophilia was present in all 12 cases. These signs are suspected to have appeared associated with the infection of schistosome because no other definite cause was recognized. Therefore, it should be noted that schistosome infection, as experienced in these cases, can be one of the causes of fever of unknown origin and eosinophilia which are sometimes experienced in the Japanese subjects staying in tropical or subtropical area.

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References

1) Audibert, M. (1990): Irrigation, schistosomiasis and malaria in the Logone Valley, Cameroon. Am. J. Trop. Med. Hyg., 42, 550–560.
2) Babiker, S. M., Blankespoor, H. D., Wassila, M., Fenwick, A. and Dafalla, A. A. (1985): Transmission of *Schistosoma haematobium* in North Gezira, Sudan. J. Trop. Med. Hyg., 88, 65–73.
3) Betterton, C., Ndifon, G. T., Bassey, S. E., Tan, R. M. and Oyeyi, T. (1988): Schistosomiasis in Kano State, Nigeria, I. Human infections near dam sites and the distribution and habitat preferences of potential snail intermediate hosts. Ann. Trop. Med. Parasitol., 82, 561–570.
4) Bolton, P. (1988): Schistosomiasis control in irrigation schemes in Zimbabwe. J. Trop. Med. Hyg., 91, 107–114.
5) Cetron, C., Chitsulo, L., Addiss, D., Sullivan, J., Tsang, V. and Pilchere, J. (1993): Schistosomiasis transmission potential along the southern shore of Lake Malawi, a preliminary report of an investigation of expatriates in Malawi. Report of Center for Disease Control, U.S.A.
6) Cline, B. L., Richards, F. O., El Alamy, M. A., El Hak, S., Ruiz-Tiem, E., Hughes, J. M. and McNeelsy, D. F. (1989): 1983 Nile delta schistosomiasis survey: 48 years after Scott. Am. J. Trop. Med. Hyg., 4, 56–62.
7) Hunter, M. J., Rey, L. and Scott, D. (1982): Man-made lakes and man-made diseases. Soc. Sci. Med., 16, 1127–1145.
8) Matsuda, H., Tanaka, H., Blas, B. L., Noseñas, J. S., Tokawa, T. and Ohsawa, S. (1984): Evaluation of ELISA with ABTS, 2-2'-azido-di-(3 ethylbenz-thiazoline sulfonic acid), as the substrate of peroxidase and its application to the diagnosis of schistosomiasis. Jpn. J. Exp. Med., 54, 131–138.
9) Ministry of Health, Zambia (1990): Bulletin of health statistics, major health trends 1978–1988.
10) Ogumba, E. O., Maddison, S. E., Tsang, V. C. W. and Slemenda, S. B. (1982): Reactivity of fractionated antigens of *Schistosoma mansoni* with sera of patients infected with *S. haematobium*. Afr. J. Med. Sci., 11, 67–73.
11) Ohara, H., Matsuda, H., Fujita, K., Naruto, H. and Tanaka, H. (1990): Schistosome infections among Japanese during long stays in endemic areas – evaluation of serological diagnosis, eosinophilia and treatment with praziquantel. Jpn. J. Parasitol., 18, 159–171.
12) Tanaka, H., Matsuda, H., Blas, B. L., Noseñas, J. S., Hayashi, M., Iuchi, M., Nakao, M. and Santos, A. T. Jr. (1983): Evaluation of micro-ELISA for schistosomiasis japonica using crude egg antigen. Jpn. J. Exp. Med., 53, 147–154.
13) Tropical Diseases Research Centre, Zambia (1992): Technical Report, Establishment and first stage of development.
14) Verhoef, H. and Bos, R. (1992): Development and vector-borne diseases, World Health, November–December, 15–17.
15) World Health Organization (1985): The control of schistosomiasis; report of a WHO expert committee, Geneva, World Health Organ., Tec. Rep. Ser. 16–22, UI, 8703452.
16) World Health Organization (1990): Schistosomiasis, acute schistosomiasis in travellers returning from Africa, Wkly Epidmiol. Rec., 65, 194–195.