Assessment of Voiding Function in Inhabitants Infected with
Schistosoma haematobium

by Kanji Watanabe,1 Ngethe D. Muhoho,2 Wilfred R. Mutua,2,* Francis M. Kiliku,2 Toshiki Awazawa,1,3 Kazuhiko Moji,4 and Yoshiki Aoki1

1Department of Parasitology, Institute of Tropical Medicine, Nagasaki University (NEKKEN), Sakamoto 1-12-4, 852-8523 Nagasaki, Japan
2Centre for Microbiology Research, Kenya Medical Research Institute (KEMRI), PO Box 54840, Nairobi, Kenya
3Eastern and Southern Africa Centre of International Parasite Control (ESACIPAC), Kenya Medical Research Institute (KEMRI), PO Box 54840, Nairobi, Kenya
4Research Center for Tropical Diseases, Institute of Tropical Medicine, Nagasaki University (NEKKEN), Sakamoto 1-12-4, 852-8523 Nagasaki, Japan

Correspondence: Yoshiki Aoki, Department of Parasitology, Institute of Tropical Medicine, Nagasaki University, 1-12-4 Sakamoto, Nagasaki 852-8523, Japan. E-mail: <aoki@nagasaki-u.ac.jp>

Present address: Toshiki Awazawa, JICA Niger Office 523 Rue des Lacs, PL523, Quartier Plateau, Commune 1, B.P. 10036, Niamey, Niger.
Present address: Kazuhiko Moji, Research Institute for Humanity and Nature, Kyoto 603-8047, Japan.
*Deceased.

Summary
Voiding function of Schistosoma haematobium infected students was evaluated in 45 schoolboys in Kwale district, Coast province, Kenya, using a questionnaire and uroflowmetry. Sixty-eight schoolboys who were S. haematobium negative were also examined. Symptoms related to the lower urinary tract were qualitatively assessed using the International Prostate Symptoms Score (I-PSS) questionnaire. The I-PSS showed that S. haematobium infected boys felt the need to strain to urinate and post voiding some urine still remained. To examine the disturbances revealed by I-PSS quantitatively, voiding was assessed by a portable uroflowmeter and a bladder scanner. Unexpectedly, no significant residual urine post voiding and no decline in urine flow rates were found in S. haematobium infected boys. However, volume-corrected maximum and average flow rates in S. haematobium infected boys were higher than in those not infected. These results suggest that cystitis associated with S. haematobium infection causes irritation and hypercontraction of the bladder.

Introduction
Schistosomiasis is classified as a neglected tropical disease that still affects as many as 200 million people. Reducing morbidity is the current aim of most schistosomiasis-control projects [1], and various measurements have been used to assess morbidity in schistosomiasis-control programs [2–6].

In the case of Schistosoma haematobium infection, hematuria and terminal dysuria have been well recognized as symptoms related to infection, and macro- or micro-hematuria detected by dipstick have been shown to be valuable indicators for detecting cases and assessing the prevalence of S. haematobium in an area [7, 8].

Pathologic lesions observed in urinary schistosomiasis by ultrasonography have been shown to resolve after treatment [9–12]. These lesions include thickening of the bladder wall, polypoid patches, ulceration, hydroureter and hydronephrosis. The latter two conditions have received particular attention because of their serious nature and long-term consequences in...
causing schistosomal obstructive uropathy, but are reversible if they are treated in the early stages of the disease [13].

Previous studies by our group, and others, have revealed that inhabitants of schistosomiasis-endemic areas frequently complain of lower urinary tract symptoms, i.e. frequency and burning, painful micturition with terminal hematuria and suprapubic pain, which are present in active schistosomiasis [14–16]. Although symptoms of *S. haematobium* are associated with the bladder, and pathologic lesions in the bladder have been observed, very little attention has been paid to disturbances in voiding in this disease and there are few reports that describe voiding function of infected people [17, 18]. In this study, we evaluated the nature of disturbances in voiding, among *S. haematobium* infected boys in a schistosomiasis-endemic area.

**Materials and Methods**

*Study area and population*

This study was carried out in Mtsanguatum, Mwachinga and Mlafyeni villages in the Kwale district of Coast Province, Kenya, between January 2001 and 2002. The details of Mtsanguatum and Mwachinga have been described elsewhere [19–21]. In these two villages, selective drug treatment against *S. haematobium* infection was carried out in 1999 and 2001. Since parasitologic and other urologic conditions were similar between the villagers the data were combined. Mlafyeni village is located 10 km from the Mtsanguatum river. The boys in this area had never been treated for schistosomiasis. Boys were chosen for the study because the machine we used was designed for only men. Sexually active adult men were excluded because they might suffer from sexually transmitted diseases, which could affect voiding. The characteristics of the boys enrolled in this study are detailed in Table 1. All students who agreed to be enrolled were registered and allocated to two groups, boys whose urine was positive for *S. haematobium* eggs (egg-positive boys; case), and boys whose urine was negative for the eggs (egg-negative boys; control). Growth retardation was observed in egg-positive boys who were on average 4 cm shorter in height and 6 kg lighter in weight than egg-negative boys. After the study, all students in the villages were treated with Praziquantel at 40 mg kg⁻¹ for *S. haematobium* infection regardless of the infection status.

This study was performed under a protocol approved by the Ethical Committee of Institute of Tropical Medicine, Nagasaki University, and by the Scientific Steering Committee and the Ethical Committee at the Kenya Medical Research Institute. Informed consent was obtained after explanation of the procedures planned.

**Questionnaire to evaluate the bladder symptoms**

To evaluate the voiding symptoms semi-quantitatively, International Prostate Symptoms Score (I-PSS) was used (Table 2). This system was first reported as American Urological Association Symptom Index (AUA symptoms index) for benign prostate hypertrophy (BPH) [22]. Currently it has been widely used as I-PSS.

This scoring system was developed to assess the symptoms of patients who had bladder outlet obstruction or irritability found in BPH [22, 23]. The assessment comprises seven questions regarding frequency, nocturia, weak urinary stream, hesitancy, incomplete emptying and urgency. Patients are asked to answer the questions by rating symptom burden as: 0 for ‘not at all’ 1 for ‘less than one in five times’, 2 for ‘less than half the time’, 3 for ‘about half the time’, 4 for ‘more than half the time’ and 5 for ‘almost always’. It is recommended that patients with mild symptoms (total score 0–7) be kept under observation, while those with moderate (8–19) or severe (20–35) symptoms should undergo further testing and/or treatment. The subject was questioned by the examiner and the scores for each question were recorded [23].

**Uroflowmeter and urinary flow investigations**

Urinary flow was examined using the portable uroflowmeter RMS1000 (Choryo Control Systems Co., LTD., Nagasaki, Japan), which is powered by a portable battery.

To perform the test, the subject was first asked to drink 500 ml of juice. When he felt ready to void, he informed the staff and stood in front of the uroflowmeter. The staff behind the wall activated the uroflowmeter and allowed the student to urinate. The parameters studied were essentially the same as

---

**Table 1**

<table>
<thead>
<tr>
<th>Egg</th>
<th>Egg</th>
</tr>
</thead>
<tbody>
<tr>
<td>positives</td>
<td>negatives</td>
</tr>
<tr>
<td>No. of subjects</td>
<td>45</td>
</tr>
<tr>
<td>Mean age, years (SD)</td>
<td>13 (1.5)</td>
</tr>
<tr>
<td>Height (SD) (cm)</td>
<td>143.8 (12.6)*</td>
</tr>
<tr>
<td>Weight (SD) (kg)</td>
<td>35.8 (12.0)*</td>
</tr>
<tr>
<td>No. of subjects</td>
<td></td>
</tr>
<tr>
<td>1–49 eggs 10 ml⁻¹</td>
<td>25</td>
</tr>
<tr>
<td>&gt;50 eggs 10 ml⁻¹</td>
<td>20</td>
</tr>
<tr>
<td>Geometric mean</td>
<td>39.1 (1–826)</td>
</tr>
</tbody>
</table>

*Note: Values are shown as mean (SD).
*p* < 0.05 compared with egg-negative boys by Mann–Whitney U test.*
those of Abrams et al. [24] (Table 3). After urination, the subject was examined for residual urine volume using a Bladder scan BVI 3000 (Diagnostic Ultrasound Co. USA).

Urine examination
Urine specimens of the boys were examined for eggs using the filtration method of Peters and others [25].

Statistical analysis
To compare the differences between groups, the Mann–Whiney U-test or the chi square test was used ($p < 0.05$), as appropriate.

Results

The prevalence of bladder associated symptoms
To determine the prevalence of lower urinary tract symptoms, possibly caused by *S. haematobium* infection, in a semi-quantitative manner, the students were assessed by means of the I-PSS. A total of 45 schoolboys who were *S. haematobium* egg positive in the urine and 68 schoolboys who were egg negative in the urine were enrolled (Table 1). Percentages of the boys who gave a score of $\geq 1$ to each question are shown in Fig. 1. Egg-positive boys showed higher scores in the questions relating to ‘incomplete emptying’ and ‘hesitancy’ compared with egg-negative boys. However, there was no difference between egg-positive and egg-negative boys among those who had a score $> 7$, which is the score considered to show moderate symptomatic impairment in the evaluation of prostate hypertrophy. The mean of

Table 2
I-PSS questionnaire

<table>
<thead>
<tr>
<th>Question</th>
<th>Not at all</th>
<th>Less than 1 times in 5</th>
<th>Less than half the time</th>
<th>About half the time</th>
<th>More than half the time</th>
<th>Almost always</th>
</tr>
</thead>
<tbody>
<tr>
<td>During the last month or so, how often have you had a sensation of not emptying your bladder completely after you finished urinating? (Incomplete emptying)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>During the last month or so, how often have you had to urinate again less than 2 hours after you finished urinating? (Frequency)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>During the last months or so, how often have you found you stopped and started again several times when you urinated? (Intermittency)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>During the last month or so, how often have you found it difficult to postpone urination? (Urgency)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>During the last month or so, how often have you had a weak urinary streams? (Weak stream)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>During the last month or so, how often have you had to push or strain to begin urination? (Hesitancy)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>During the last month, how many times did you most typically get up to urinate from the time you went to bed at night until the time you got up in the morning? (Nocturia)</td>
<td>None</td>
<td>1 time</td>
<td>2 times</td>
<td>3 times</td>
<td>4 times</td>
<td>5 or more times</td>
</tr>
</tbody>
</table>

Source: This scoring system was first reported as American Urological Association Symptom Index [22]. Currently this has been widely used as I-PSS. Therefore this scoring system is cited as I-PSS here. This table has been adopted from the original manuscript by Barry et al. [22] with the permission of Elsevier.

Fig. 1. Lower urinary symptoms measured by the I-PSS in *S. haematobium* infected boys. The rates of boys who gave a score $>1$ to each question are shown. Rate in egg-positive boys is shown in shaded columns; rate in egg-negative boys is shown in open columns. *$p < 0.05$* compared with egg-negative boys by chi-square test.
total scores of I-PSS in students was similar for egg-positive boys (mean ± SD, 6.73 ± 3.41), and egg-negative boys (6.76 ± 4.75). The total score of I-PSS was not statistically correlated with the egg count in the urine (data not shown); neither did egg count in urine correlate directly with scores for each symptom. However, the results showed that students who had urinary schistosomiasis recorded more distress in the lower urinary tract when voiding.

The assessment of urinary flow and residual urine volume
In order to examine whether the distress in the lower urinary tract revealed by I-PSS was indicative of voiding impairment, the urinary flow rates of students infected with *S. haematobium* were evaluated using a portable uroflowmeter. As shown in Fig. 1, students reported that they suffered from hesitancy and incomplete emptying, which are urinary flow related disturbances. It was therefore expected that slower flow rate (maximum and average) and more residual urine volume after urination would be found among those with *S. haematobium* infection. Results of the uroflowmeter measurements are shown in Table 3. Unexpectedly, there was no significant difference in urinary flow between egg-positive and egg-negative students, although values of voided urine and flow time were lower in the boys passing eggs in their urine. Considering the fact that flow rate tended to increase in accordance with urine volume and egg-positive boys voided less urine volume, the

<table>
<thead>
<tr>
<th></th>
<th>Egg positive</th>
<th>Egg negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum flow rate (ml s⁻¹)</td>
<td>22.3 (10.1)</td>
<td>20.3 (8.4)</td>
</tr>
<tr>
<td>Average flow rate (ml s⁻¹)</td>
<td>12.1 (4.9)</td>
<td>11.3 (5.0)</td>
</tr>
<tr>
<td>Time to maximum flow rate (s)</td>
<td>6.3 (5.6)</td>
<td>7.7 (6.4)</td>
</tr>
<tr>
<td>Flow time (s)</td>
<td>16.7 (8.2)*</td>
<td>24.2 (12.2)</td>
</tr>
<tr>
<td>Voided volume (ml)</td>
<td>191 (100)*</td>
<td>263 (165)</td>
</tr>
<tr>
<td>Residual urine volume (ml)</td>
<td>28.5 (31.1)</td>
<td>40.3 (63.9)</td>
</tr>
<tr>
<td>Volume corrected maximum flow rate</td>
<td>5.0 (2.5)*</td>
<td>4.2 (1.6)</td>
</tr>
<tr>
<td>Volume corrected average flow rate</td>
<td>1.4 (0.6)*</td>
<td>1.1 (0.4)</td>
</tr>
</tbody>
</table>

Notes: Values are shown as mean (SD). Maximum flow rate: the maximum measured value of flow rate; Average flow rate: voided volume divided by time; Time to maximum flow rate: the elapsed time from onset of flow to maximum flow; Flow time: the time over which measurable flow actually occurs; Residual urine: the volume of fluid remaining in the bladder immediately following the completion of micturition. *p < 0.05 compared with egg negative boys group by Mann–Whitney U test.

Discussion
In this study, the voiding function of schoolboys in a *S. haematobium* endemic area was evaluated using I-PSS and uroflowmetry. The subjects were allocated to two groups according to their infection status.

The I-PSS revealed that the schoolboys were experiencing certain problems related to urination. Boys whose urine was positive for *S. haematobium* eggs felt a sensation of incomplete emptying after urination and complained of hesitancy (Fig. 1). These symptoms were thought to arise partly as a result of residual urine associated with infection, but the results did not support this. It was suggested that these symptoms might arise from irritation caused by the schistosome infection.

It had been reported previously that the severity of bladder lesions was correlated with intensity of infection [27], but the I-PSS showed no such association. There are several reasons why the I-PSS in this study may not correlate with the egg count in the urine. First, the I-PSS was developed for the evaluation of severity of BPH and its disturbances in voiding [22, 23]. Even when intensity of infection is low, the disturbances caused by schistosome infection might be troublesome especially in children, while not showing any correlation with I-PSS scores developed for adult BPH. It seems that the score can show the existence of the lower urinary tract symptoms in certain diseases, but cannot easily be used to compare between individuals. Second, students might not have understood the questions adequately. Almost all of the students were <14 years of age. The I-PSS was developed for adults and the issues addressed may be difficult for boys, especially schoolboys, to understand. Some students recorded a score >7, but did not exhibit any positive results in the uroflow findings or even in the dipstick test for leukocyturia, hematuria and proteinuria. So results of this test should be interpreted cautiously in children.

To assess the voiding function quantitatively, we used uroflowmetry. The uroflowmetry results showed that the urine volume and flow times found in egg-positive students tended to be lower than those in egg-negative students (Table 3). It is possible that
an infected bladder caused irritation leading to earlier contraction when the bladder became full of urine. The I-PSS showed that egg-positive boys felt that they needed to strain to urinate. A report which investigated schistosomal lesions at autopsy showed that the polypoid patches were mainly in the trigone and there were few lesions around the orifice of the bladder [28]. Therefore it was expected that urinary flow might be slower in egg-positive boys. Unexpectedly, there were no differences in the flow rate (maximum, average) and time to maximum flow between the groups. Since the uroflow rate was affected by the voided volume, volume-corrected flow rates were calculated and compared. The corrected measurements in egg-positive boys were higher than those in egg-negative boys. Given that time to maximum flow rate tended to be shorter in egg-positive boys, using the volume-corrected flow rate, showed that the effectiveness of bladder contraction in infected students remained the same or was slightly higher than that of the non-infected students.

Irritation and hypercontraction in the bladder may have an influence on the cognitive abilities of schoolboys. It has previously been reported that the ability to concentrate is impaired by schistosome infection [29]. Treatment is expected not only to resolve pathologic lesions but also improve cognitive capabilities.

From this study, we conclude that active urinary schistosomiasis in childhood does not significantly impair the voiding function in boys positive for S. haematobium infection. Von Lichtenberg et al. (1971) reported that acute urinary schistosomiasis lesions of the bladder, such as polypoid patches, were mainly observed in teenagers [30]. These lesions are considered to be reversible, so that uroflowmetry findings of schistosome-infected students may improve after treatment. Our results clearly support treatment for schistosomiasis in the early stage of infection.

References
