THE EFFECT OF REPEATED FOUR MONTHLY TREATMENTS ON THE PREVALENCE AND WORM BURDEN OF *ASCARIS*, *TRICHURIS* AND HOOKWORM INFECTIONS IN AN ENDEMIC AREA

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Received February 14, 2000/Accepted July 27, 2000

Abstract: The effect of repeated 4 monthly treatment of single dose of 400 mg albendazole on the prevalence and worm burden of *Ascaris*, *Trichuris* and hookworm was studied in an endemic area. Repeated 4 monthly treatment, had significant effect in reducing the worm burden of *Ascaris* and not the prevalence. As for hookworm infection repeated 4 monthly treatment had significant impact in reducing both prevalence and worm burden in the community. However, repeated 4 monthly treatments had no significant impact in reducing the prevalence and worm burden of *Trichuris* infection in the community. *Trichuris* infection should be considered as a continuing infection rather than reinfection because of poor cure rate of albendazole at the onset of the study. Significant and strong predisposition ($p < 0.0001$) were detected after single and repeated 4 monthly treatment in *Ascaris* and *Trichuris* infection but not in hookworm infection. Stratification of data indicated that significant and strong predisposition was also seen in gender. This study concludes that changes in mean egg count per gram (mean EPG) is a sensitive indicator in measuring effect of treatment in an endemic area, and repeated 4 monthly treatments has successfully reduced the worm burden of *Ascaris* and hookworm infection. Subjects remained predisposed to *Ascaris* infection over 2 reinfection periods, and for hookworm infection evidence of predisposition was seen only over 1 reinfection period.

Key words: Predisposition, *Ascaris*, *Trichuris*, hookworm, reinfection

INTRODUCTION

In highly endemic areas of *Ascaris*, *Trichuris* and hookworm infections, reinfection can occur as early as 2 months after treatment (Norhayati *et al.*, 1995). By 4 months almost half and one-tenth of the population treated become reinfected with *Ascaris* and hookworm respectively (Norhayati *et al.*, 1997), and by 6 months the intensity of infection of *Ascaris* and *Trichuris* were similar to pre-treatment levels (Elkins *et al.*, 1988; Albinco *et al.*, 1995). Thus a 4 monthly targeted chemotherapy in highly endemic areas may be necessary in order to have an impact on the prevalence and intensity of infection of *Ascaris* and hookworm infections (Bundy *et al.*, 1990; Albinco *et al.*, 1995; Norhayati *et al.*, 1997).

Predisposition to reinfection following single-treatment has been reported in hookworm infection (Schad and Anderson, 1985), *Ascaris* infection (Elkins *et al.*, 1986; Thein-Hlaing *et al.*, 1987; Haswell-Elkins *et al.*, 1987; Forrester *et al.*, 1990) and *Trichuris* infection (Haswell-Elkins *et al.*, 1987; Bundy *et al.*, 1987; Bundy and Cooper, 1988; Forrester *et al.*, 1990). Predisposition has also been reported following repeated treatments (2 reinfection period) in *Ascaris* infection (Holland *et al.*, 1989; Hall *et al.*, 1992; Chan *et al.*, 1992) and in *Trichuris* infection (Chan *et al.*, 1992).

This intervention study was conducted in a highly endemic area of *Ascaris*, *Trichuris* and hookworm infections. The objectives of this study were to evaluate the impact of 4 monthly 400 mg albendazole treatment for

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12 months on the prevalence and intensity of infection/worm burden (mean eggs per gram-EPG) of *Ascaris*, *Trichuris* and hookworm infections and to examine the evidence of predisposition over 2 reinfection periods.

MATERIALS AND METHODS

Study Area

This study was part of a bigger study conducted among residents of 6 Orang Asli (Aborigine) villages in the sub-district of Dengkil, Selangor, Malaysia. It was situated about 50 km from Kuala Lumpur, the capital of Malaysia. Each village comprised a very small population and most of the residents worked as palm oil estate labourers, rubber tappers, farmers or were engaged doing odd jobs such as fishing and selling forest products. Most of them lived in single-roomed houses made of bamboo and wood. Almost all the houses in the villages had no electricity, no pipe water nor toilet facilities. The residents used well or river water for daily use and defaecated in the open among the bushes.

Subjects and Parasitologic Surveys

In all 205 children (95 males and 110 females) aged 1-13 years old were included in this study. Stool samples were collected and those found infected were treated with 400 mg of albendazole periodically at 4 months interval for 1 year. The prevalence and worm burden of *Ascaris*, *Trichuris* and hookworm infection at pre-treatment (phase I), at 4 months after single treatment (phase II) and at 12 months after repeated treatments (four monthly intervals-phase III) were determined before each intervention and compared. To measure the efficacy of albendazole, stool samples were collected and examined at 1 month after single treatment. All samples were examined by the Kato-Katz technique and worm burden was measured indirectly as EPG (WHO, 1987). For *Ascaris*, EPG of 1-9,999, 10,000-49,999 and 50,000 and above is defined as mild, moderate or severe infection respectively. For *Trichuris* and hookworm EPG of 1-1,999, 2,000-9,999 and 10,000 and above is defined as mild, moderate or severe infection respectively (WHO, 1987).

The efficacy of albendazole in reducing the prevalence and worm burden was measured by cure rate and mean egg count reduction rate respectively. Cure rate is the percentage of cured cases at 1 month after the single treatment. The mean egg count reduction rate is the reduction between the mean EPG at 1 month after treatment and the mean EPG at pre-treatment, expressed as a percentage of the mean EPG at pre-treatment.

Statistical Analysis

Changes in the prevalence and worm burden was compared by 2 proportional test and by paired t-test after logarithmic transformation of data respectively. Correlation of egg counts were analysed using Kendall's Rank Correlation Test. Data were analysed using EpiInfo (EpiInfo version 6.02, 1994) and SPSS for Windows (SPSS, 1993).

RESULTS

The overall pre-treatment prevalence of *Trichuris*, *Ascaris*, and hookworm infections in 205 children (95 boys and 110 girls) was 91.7%, 62.5% and 28.8% respectively. Almost two-third were infected with moderate and severe infections of *Trichuris*, 46.3% had moderate and severe infections of *Ascaris* and only 1.5% had moderate infection of hookworm. The cure rate of *Ascaris* infection was 97.4% and the mean egg count reduction rate was 99.9%; the cure rate of hookworm infection was 93.1% and the mean egg count reduction rate was 96.6%. The cure rate of *Trichuris* infection was low (5.5%), however the mean egg count reduction rate was more evident (49.1%).

Prevalence of *Ascaris*, *Trichuris* and hookworm infections

Table 1 shows the prevalence of *Ascaris*, *Trichuris* and hookworm infections at phase I, phase II and phase III. The overall prevalence of *Ascaris* infection at phase II and III decreased by 31.8% and 7.2% respectively, compared with phase I. However the difference was not statistically significant. The increase in the prevalence of *Trichuris* infection at phase II and III compared with phase I by 2.3% and 5.0% respectively was not statistically significant. For hookworm infection, the overall prevalence at phase II and III compared to phase I decreased by 63.9% and 69.8% respectively and the difference was statistically significant. Although the prevalence of *Ascaris* and *Trichuris* infections increased in phase III compared to phase II, the difference was not statistically significant. The decrease in the prevalence of hookworm infection between phase II and III was also not significant.

Intensity of *Ascaris*, *Trichuris* and hookworm infections

Table 2 shows the mean geometric EPG of *Ascaris*, *Trichuris* and hookworm infections at phase I, phase II and phase III. The mean EPG of *Ascaris* at phase II and III decreased by 53.3% and 75.0% respectively compared with phase I and the difference was statisti-

Table 1 Prevalence of *Ascaris*, *Trichuris* and hookworm infection at phase I, II and III

Infections	Prevalence (%)			Percent reduction	
	I	II	III	I-II/ I	I-III/ I
<i>Ascaris</i>	62.5	42.6	58.0	-31.8 (P > 0.05)	-7.2 (P > 0.05)
<i>Trichuris</i>	91.7	93.8	96.3	+2.3 (P > 0.05)	+5.0 (P > 0.05)
Hookworm	28.8	10.4	8.7	-63.9 (P < 0.05)	-69.8 (P < 0.05)

Table 2 Mean intensity of *Ascaris*, *Trichuris* and hookworm infection at phase I, II and III

Infections	Mean EPG (Geometric)			Percent reduction	
	I	II	III	I-II/ I	I-III/ I
<i>Ascaris</i>	24,071	11,251	6,008	-53.3 (P < 0.05)	-75.0 (P < 0.05)
<i>Trichuris</i>	5,516	5,604	5,822	+1.6 (P > 0.05)	+5.5 (P > 0.05)
Hookworm	131	59	10	-55.0 (P < 0.05)	-92.4 (P < 0.05)

cally significant. For *Trichuris*, the increase in the mean EPG at phase II and III compared with phase I by 1.6% and 5.5% respectively was not statistically significant. For hookworm infection, there was a significant decrease of mean EPG at phase II and III compared to phase I. Although the mean EPG of *Trichuris* infection increased in phase III compared to phase II, the difference was not statistically significant. The decrease in the mean EPG of *Ascaris* and hookworm infections between phase II and III was statistically significant.

Correlation of egg counts

The correlation for overall and stratified EPG of *Ascaris*, *Trichuris* and hookworm infections according to gender at phase I, II and III are shown in Table 3. Analysis shows that in *Ascaris* infection, there is a strong and significant positive correlation of mean EPG between phase I and II and phase I and III. When the data was stratified according to gender, the level of significance remained strong and significant except in males between phase I and III.

In *Trichuris* infection, strong and significant overall correlation was detected in all phases and when the data was stratified according to gender. In hookworm infection significant correlation was detected between phase I and II and between phase II and III but with lower significant level. When the data was stratified according to gender, significant correlation was detected in males (phase I & II and phase I & III) and in females (phase I & II), although the level was lower.

DISCUSSION

In endemic areas of *Ascaris*, *Trichuris* and hookworm infections, where reinfections occur continuously,

repeated treatments with effective antihelminthic were required to reduce worm burden (measured by mean EPG) in the community. The interval required varied. A study done in Burma suggests that 3 monthly repeated treatments give significant impact on the prevalence and worm burden of *Ascaris* (Thein-Hlaing *et al.*, 1987). In contrast, a study in Malaysia reports that 6 monthly repeated treatment has significant effect in reducing both prevalence and worm burden of *Ascaris* and *Trichuris* (Chan *et al.*, 1992). On the other hand, other studies show that by 6 months to 1 year, the prevalence and worm burden of *Ascaris* and *Trichuris* have reached

Table 3 Correlation of *Ascaris*, *Trichuris* and hookworm mean EPG between phase I and II and phase I and III

Group	Phase I and II	Phase I and III
<i>Ascaris</i>		
Overall	0.3517 ‡	0.2902 ‡
Gender		
Male	0.3531 ‡	0.2457 †
Female	0.3522 ‡	0.3480 ‡
<i>Trichuris</i>		
Overall	0.5388 ‡	0.4474 ‡
Gender		
Male	0.5533 ‡	0.4198 ‡
Female	0.5327 ‡	0.4758 ‡
Hookworm		
Overall	0.3304 †	0.1377
Gender		
Male	0.2730 *	0.1173
Female	0.4007 ‡	-0.0564

* Significant correlation at $p < 0.05$

† Significant correlation at $p < 0.01$

‡ Significant correlation at $p < 0.0001$

the pre-treatment level (Holland *et al.*, 1989; Elkins *et al.*, 1988; Albonico *et al.*, 1995).

We studied the impact of 4 monthly treatment (for 12 months) on the prevalence and worm burden of *Ascaris*, *Trichuris* and hookworm infections in an endemic area. The results of our study showed that repeated 4 monthly treatments had no significant impact in reducing prevalence and worm burden of *Trichuris* infection in the community and this was different from an earlier study done in Malaysia (Chan *et al.*, 1992). Poor cure rate of single dose of 400 mg albendazole against *Trichuris* infection and high prevalence of moderate and severe infections of the worm in this community compared to the study done by Chan *et al.* (1992) were the main reasons for the failure of repeated 4 monthly treatments in reducing prevalence and worm burden of *Trichuris* infection. In the present study, *Trichuris* infection should be considered as a continuing infection rather than reinfection because of poor cure rate at the onset. This factor explains the increases in prevalence and worm burden of *Trichuris* infection in this study.

Repeated 4 monthly treatments had significant effect in reducing worm burden of *Ascaris* but not the prevalence. The increase in *Ascaris* prevalence after repeated 4 monthly treatments can be explained by the continuing infection in the community. This factor suggests that the use of antihelminth can only control this infection by significantly reducing the worm burden in the community and not prevent people from becoming infected. As for hookworm infection, repeated 4 monthly treatments had significant impact in reducing both prevalence and worm burden in the community. Low prevalence, low worm burden and a drastic reduction in worm burden in the community following treatment may explain these findings. Besides that, the speed with which the worm burden bounces back to its pre-treatment level differs between species for example it is slower in hookworm and faster in *Trichuris* and *Ascaris* (Anderson, 1986). This finding also indicates that the mean egg count is a sensitive indicator in evaluating the progress of periodic chemotherapy in the control of *Ascaris* and hookworm infections. A similar finding was reported by Anderson and May (1985).

Based on this study, it is more relevant to suggest implementation of repeated 4 monthly treatments in the planning of periodic chemotherapy schedule in an endemic area. Such a suggestion is also supported by our earlier study in the same community, where after 4 months of treatment, the reinfection rate of *Ascaris* and

hookworm was seen in 50.0% and 10.0% of the subjects respectively (Norhayati *et al.*, 1997). Only one-fifth of the subjects infected with *Ascaris* reached their pre-treatment intensity (Norhayati *et al.*, 1997). Our pretest study also suggests that the mean EPG should be used as an indicator to monitor the progress of periodic chemotherapy in the community.

This study examines the evidence of predisposition over one and two reinfection periods of *Ascaris*, *Trichuris* and hookworm infections. For *Trichuris* infection evidence of predisposition was seen over one and two reinfections. This evidence was seen as a result of poor cure rate at the start.

As for *Ascaris* infection, evidence of predisposition was seen after one and two reinfection periods. This finding generally agreed with most of the studies done before (Holland *et al.*, 1989; Hall *et al.*, 1992; Chan *et al.*, 1992). For hookworm infection evidence of predisposition after one reinfection period was weak and after two reinfection periods, the evidence was negative. Predisposition following one reinfection period has been reported in hookworm infection by Schad and Anderson (1985). These findings indicate that subjects remained predisposed to *Ascaris* infection over 2 reinfection periods and for hookworm infection evidence of predisposition was only seen over 1 reinfection period.

It can be concluded that repeated 4 monthly treatments have successfully reduced the worm burden of *Ascaris* and hookworm infection in the Orang Asli community. The risk of acquiring similar worm burden as before treatment was only evident in *Ascaris* and not in hookworm infection.

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