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Activity of Brush Border Membrane Bound Enzymes in the Small Intestine of Mice Infected with *Fibricola seoulensis*

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=Abstract=***Fibricola seoulensis* is a trematode of the human intestine inducing severe atrophy of the villi. Human cases suffer from severe diarrhea, abdominal discomfort and fever. The heavily infected mice died mainly because of dehydration and luminal bleeding. The atrophic change of the intestinal mucosa is suspected to be related to functional derangements. The present study intended to observe the changing activity of the brush border membrane bound enzymes in the intestines of infected mice. Each mouse was infected with 100 or 1000 metacercariae collected from snakes. The mice were sacrificed chronologically after infection, and after praziquantel treatment. The mucosa of their intestines (duodenum, proximal jejunum and distal jejunum) was collected and homogenized. The protein content and enzymatic activity of the homogenates were measured. The activity of sucrase, lactase, trehalase, alkaline phosphatase and leucine aminopeptidase in the intestinal mucosa increased just after infection and began to decrease after 1 week to 32 days. Decreased activity recovered distinctively 20 days after treatment. The activity of all the enzymes increased in the distal jejunum. In mice infected with 1000 metacercariae, the activity changed in a similar pattern to those with 100 metacercariae. The findings suggest that the infection of *F. seoulensis* disturbs final digestion and absorption on the brush border membrane eventually causing osmotic diarrhea. Such effects were recovered after treatment with praziquantel.**

Key Words: Fibricola seoulensis, *Mouse, Sucrase, Lactase, Trehalase, Leucine aminopeptidase, Alkaline phosphatase, Treatment*

INTRODUCTION

Diplostomid flukes live in the intestines of carnivorous mammals or rodents (Shoop 1989a). Human infection with these flukes in the adult stage is known only by *Fibricola seoulensis* (Seo *et al.* 1982; Hong *et al.* 1984 & 1985) and *F. cratera* (Shoop 1989b). A major source of human infection of *Fibricola* is from eating raw snakes. The metacercariae locate mainly in the mesentery and perigastric soft tissue of snakes (Hong *et al.* 1982).

Through animal experiments, it has been proved to cause severe mucosal atrophy such as shortening, widening and fusion of the villi, edema and

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inflammation in the villous stroma of rats or mice (Lee *et al.* 1985). Such changes began to appear after 3 days and became obvious 1 week after infection. Most of the heavily infected mice died 7 to 12 days after infection (Huh *et al.* 1988). The main cause of death might be severe dehydration and intestinal bleeding. These findings suggested malabsorption in the infected hosts.

The brush border membrane of the small intestine contains various enzymes for digestion and absorption on the membrane (Song *et al.* 1986). In rats infected with *Giardia lamblia*, estimated activity of the secreted pancreatic and intestinal brush border enzymes decreased (Sood *et al.* 1987). The decreased activity of those enzymes was interpreted as the mechanism of steatorrhea.

The degenerative histopathological changes caused by *F. seoulensis* must influence the activity of the brush border membrane bound enzymes in the small intestine. The present study was carried out to observe the activity of some brush border membrane-bound enzymes which hydrolyze disaccharides, peptides and phosphate to reveal any functional derangement in fibricoliasis. Also changes during recovery after elimination of the worms were observed.

MATERIALS AND METHODS

1. Chemicals used

Folin-ciocalteus phenol reagent and 4-nitrophenylphosphate were purchased from Merck. Deoxycholic acid, sodium salt, trichloroacetic acid, p-nitrophenol standard solution, ammonium sulfamate, N-1-naphtyl ethylene diamine, sucrose, lactose, D (+)-trehalose, glucose oxidase, peroxidase, o-dianisidine and L-leucine β-naphthylamide HCl were purchased from Sigma Chemical Co., U.S.A.

2. Infection of the mice with *F. seoulensis*

The metacercariae of *F. seoulensis* were collected from the peptic digested debris of snakes, *Rabdophis tigrina tigrina*. Each mouse of ICR strain was orally introduced with 100 or 1000 metacercariae. The mice were bred in an animal room with tap water and commercial animal diet *ad libitum*. They were sacrificed according to the group after infection, and after treatment with praziquantel suspension 10 mg/kg. Each treated group was accompanied with non-infected control and infected mice (Tables 1 & 2).

3. Tissue collection and pretreatment

The intestines of the experimental animals were resected, and the segments of 5 cm length were selected at the location of 1 cm (duodenum), 20 cm (proximal jejunum) and 70 cm (distal jejunum) from the pylorus. The mucosa was scraped with a slide glass on ice into 0.05 M mannitol 2 mM Tris HCl buffer (pH 7.0). The scraped mucosa was frozen at −70℃ until the biochemical analysis. The mucosal samples were thawed in ice water and homogenized with a Potter-Elvjem type homogenizer (Stir-R Model S63C Tri-R Instrument Inc., U.S.A.) in ice. $CaCl_2$ (0.4 M) was added into the homogenates to be diluted to 10 mM concentration, and sonicated for 15 seconds twice in ice using an ultrasonic sonicator (Sonicator W-385, Heat Systems-Ultrasonics Inc., U.S.A.).

4. Assay of protein content and activities of enzymes

The protein content was measured by spectrophotometry (UV/VIS Spectrophotometer, Hewlett-Packard Co.) following the modified method of Lowry *et al.* (1951). Each sample was duplicately prepared for the activities of 5 enzymes; sucrase, lactase, trehalase, aminopeptidase and alkaline phosphatase. The mean activities of the two reactions were used.

1) Disaccharidases (sucrase, lactase, trehalase) activities

Three 0.056 M substrates of sucrose, lactose, or trehalose in 0.1 M sodium maleate buffer (pH 6.0) were used for these enzymes. TGO solution was prepared with 0.5 M TrisHCl (pH 7.0) 100 ml, glucose oxidase 4 mg, peroxidase 0.5 mg and o-dianisidine 10 mg. The mucosal homogenates of 50 μl each were mixed with an equal volume of the substrate buffer, and incubated for 30 minutes in a 37℃ water bath. After this 1.5 ml of ice cold TGO solution was added, and incubated again at 37℃. The reaction was stopped by mixing the solution with 0.75 ml of 50% H_2SO_4 in an ice bath.

The absorbances were measured at 530 nm.

2) Aminopeptidase activities

1.3 mM leucine-β-naphthylamide HCl in 0.1 M phosphate buffered saline was the substrate. Samples of 10 μl were mixed with the substrate solution 100 μl and incubated for 15 minutes at 37℃. The reaction was terminated by adding 32% trichloroacetic acid, 0.3% $NaNO_2$, 1.5% ammonium sulfamate, N-1-naphthyl ethylene diamine, and stabilized for 30 minutes at room temperature. Absorbances were measured at 560 nm.

3) Alkaline phosphatase activities

10 mM p-nitrophenyl phosphate dissolved in 200 μl, 0.5 M $NaHCO_3$ (pH 10.0) 190 μl, 50 mM $MgCl_2$ and 10 mM $ZnSO_4$ 50 μl was mixed with 10 μl of the tissue homogenate, and incubated for 30 minutes at 37℃. The reaction was terminated by adding ice cold 0.02 N NaOH 2.5 ml and stabilized for 30 minutes at room temperature. The absorbance was checked at 400 nm.

RESULTS

The enzyme activity was widely fluctuating according to the batch of mice or to individual mouse within a group.

1. Sucrase activity

The activities of sucrase in the 100 metacercaria group were found as shown in Table 1. It decreased to 14.4 mu/mg protein nearly half that of the control in the duodenum. Contrary to this, the activities increased just after infection for a week and decreased 12 days after infection in the proximal and distal jejunum. The activity in the jejunum recovered after 20 days from treatment, but not in the duodenum. In the mice infected with 1000 metacercariae, the activity was lowered to almost one third of the control all over the small intestine. However, the increase at the initial stage of infection was not found in the proximal and distal jejunum. The changing patterns are summarized in Fig. 1.

2. Trehalase activity

The trehalase activity in the duodenum of the 100 metacercariae group was much lessened after infection compared to the control, 169.3 mu/mg

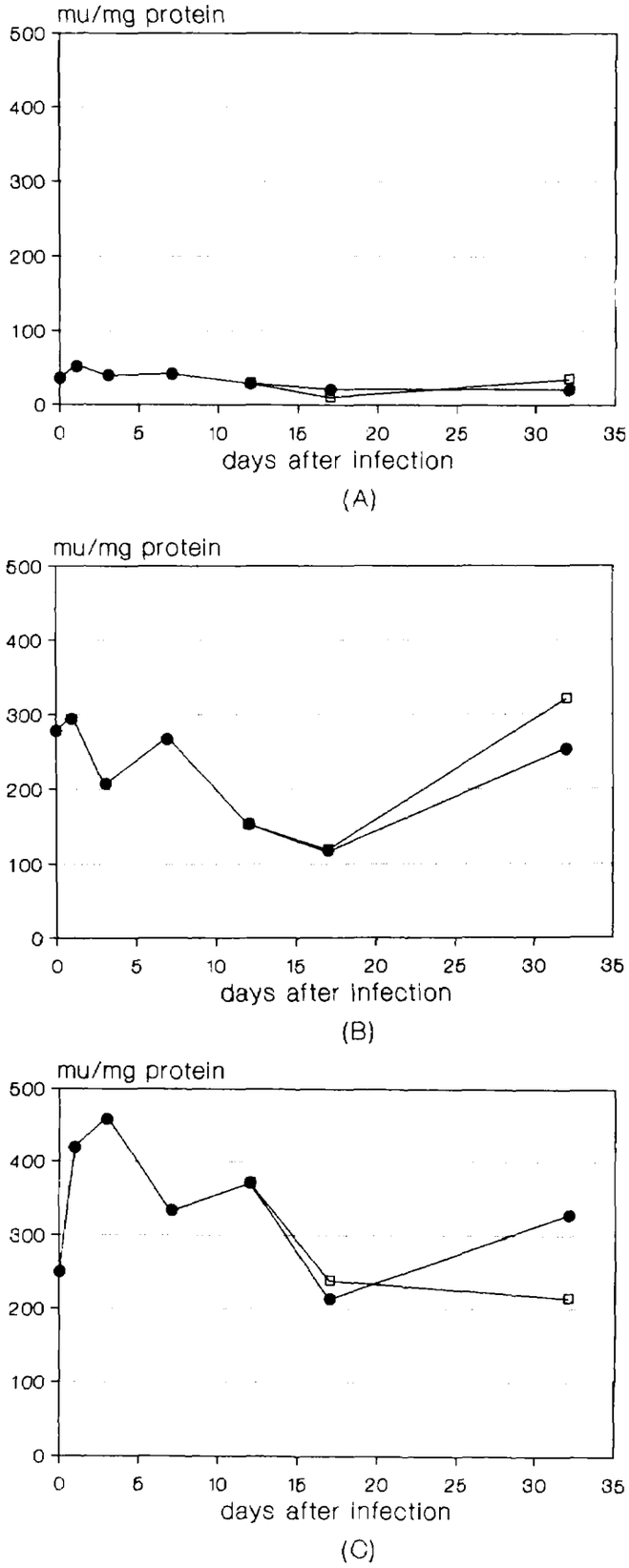


Fig. 1. Changing pattern of sucrase activity in the small intestine of mice infected with *F seoulensis* by duration of infection.
A: duodenum, B: proximal jejunum, C: distal jejunum
(●: Infected Group, □: Treated Group).

Table 1. Mean activity of disaccharidases in the brush border membrane of the small intestine of mice infected with 100 metacercariae of *F. seoulensis* (unit: mu/mg protein)

Study group	Number mice	Duodenum		Prox. jejunum		Dist. jejunum	
		Activity	% change	Activity	% change	Activity	% change
control	10	35.4	100.0	278.6	100.0	252.0	100.0
PI 1	10	53.2	150.3	297.2	106.7	421.4	167.2
PI 3	10	39.3	111.0	206.3	74.0	461.8*	183.3
PI 7	10	41.6	117.5	269.1	96.6	332.8*	132.1
PI 12	10	28.7	81.1	153.0	54.9	371.5*	147.4
PI 17	10	21.4*	60.5	116.6*	41.9	213.7	84.8
PT 5	10	10.5*	29.7	119.1*	42.7	238.0	94.4
PI 32	10	21.1*	59.6	254.8	91.5	328.7*	130.4
PT 20	10	35.1	99.2	320.0	114.9	214.9	85.3
control	10	177.7	100.0	887.1	100.0	672.3	100.0
PI 1	10	312.1	175.6	1424.7*	160.6	914.7*	136.1
PI 3	10	250.6	141.0	1001.7	112.9	866.2*	128.8
PI 7	10	224.4	126.3	978.2	110.3	696.9	103.7
PI 12	10	136.2	76.6	698.6	78.8	716.7	106.6
PI 17	10	94.3*	53.1	466.0	52.5	447.3	66.5
PT 5	10	65.3*	36.7	346.3	39.0	640.7	95.3
PT 32	10	109.7	61.7	820.3	92.5	893.7*	132.9
PT 20	10	176.6	99.4	774.7	87.3	519.7	77.3
control	10	11.8	100.0	67.6	100.0	118.9	100.0
PI 1	10	11.7	99.2	96.4	142.6	249.0	209.4
PI 3	10	11.8	100.0	58.3	86.2	235.5*	198.1
PI 7	10	13.6	115.3	62.5	92.5	146.5	123.2
PI 12	10	8.8	74.6	37.0	54.7	63.8	53.7
PI 17	10	12.7	107.6	16.0*	23.7	63.1	53.1
PT 5	10	8.9	75.4	19.7*	29.1	28.8*	24.2
PT 32	10	7.3	61.9	32.5	48.1	15.3*	12.9
PT 20	10	13.9	117.8	50.5	74.7	40.8*	34.3

* Statistically significant as $P < 0.05$ by Wilcoxon rank sum analysis.

Table 2. Mean activity of leucine aminopeptidase in the brush border membrane of the small intestine of mice infected with 100 metacercariae of *F. seoulensis* (unit: mu/mg protein)

Study group	Number mice	Duodenum		Prox. jejunum		Dist. jejunum	
		Activity	% change	Activity	% change	Activity	% change
control	10	7.0	100.0	8.8	100.0	22.8	100.0
PI 1	10	6.5	92.9	11.4	129.5	52.1*	228.5
PI 3	10	5.6	80.0	7.4	84.1	36.0*	157.9
PI 7	10	6.5	92.9	12.0	136.4	28.7	125.9
PI 12	10	6.2	88.6	11.9	135.2	37.8*	165.8
PI 17	10	5.0*	71.4	6.9	78.4	18.0	78.9
PT 5	10	3.3	47.1	5.7	64.8	19.1	83.8
PI 32	10	4.3	61.4	9.2	104.5	25.8	113.2
PT 20	10	7.0	100.0	14.7	167.0	15.2	66.7

* Statistically significant as $P < 0.05$ by Wilcoxon rank sum analysis.

protein to 31 mu/mg protein, after 12 days. In the jejunum, it was significantly elevated at the first day after infection, but began to decrease after one week (Table 1). The activity after infection in the 1000 metacercariae group was increased at the third day and decreased definitely 12 days after infection. After treatment, the activity in the proximal and distal jejunum of treated mice started to increase and became more than that of the infected control at 20 days after treatment (Fig. 2).

3. Lactase activity

Lactase activity was low in the mouse intestines. However, it decreased nearly one third after infection in the whole small intestine (Table 1). The activity recovered in the jejunum but not in the duodenum 20 days after treatment (Fig. 3).

4. Leucine aminopeptidase activity

Leucine aminopeptidase activity which hydrolyzes oligopeptides on the mucosal surface decreased significantly after infection in the duodenum, but its activity was higher than that of the control in the jejunum on the first day after infection and was similar to that of the control after then up to 12 days. However, activity in infected mice was much lower than that of the non-infected control. It was almost normalized by treatment in the duodenum, proximal and distal jejunum after 20 days (Table 2 & Fig. 4).

5. Alkaline phosphatase activity

The activity of alkaline phosphatase decreased markedly in the duodenum after infection, but in-

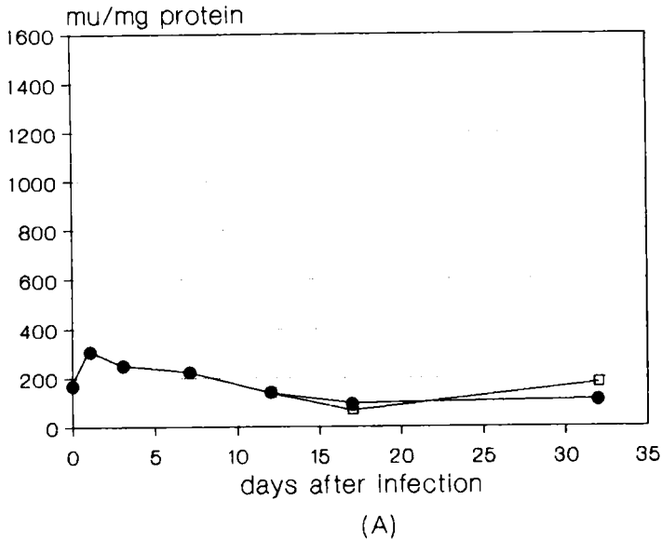
Table 3. Mean activity of alkaline phosphatase in the brush border membrane of the small intestine of mice infected with 100 metacercariae of *F. seoulensis* (unit: mu/mg protein)

Study group	Number mice	Duodenum		Prox. jejunum		Dist. jejunum	
		Activity	% change	Activity	% change	Activity	% change
control	10	1038.5	100.0	262.5	100.0	428.9	100.0
PI 1	10	1475.2	142.1	394.9	150.4	740.8*	172.7
PI 3	10	757.6	73.0	323.0	123.0	1057.8*	246.6
PI 7	10	1191.8	114.8	372.5	141.9	580.5*	135.3
PI 12	10	630.4	60.7	291.2	110.9	518.1*	120.8
PI 17	10	297.6*	28.7	275.2	104.8	338.3	78.9
PT 5	10	279.4*	26.9	165.9	63.2	349.6	81.5
PI 32	10	484.9*	46.7	263.8	100.5	445.1	103.8
PT 20	10	737.4*	71.0	257.4	98.1	291.5	68.0

* Statistically significant as $P < 0.05$ by Wilcoxon rank sum analysis.

Table 4. Changes of small intestinal brush border enzyme activity of mouse infected with 1000 metacercariae of *F. seoulensis*, D: duodenum, PJ: proximal jejunum, DJ: distal jejunum, *: $P < 0.05$, [ ]: number of mice, Unit: mu/mg protein

	Sucrase			Trehalase			Lactase		
	D	PJ	DJ	D	PJ	DJ	D	PJ	DJ
Control	31.3 [5]	132.2 [5]	125.4 [5]	169.3 [5]	382.7 [5]	299.1 [5]	4.6 [5]	11.9 [5]	12.6 [5]
PI 1	28.0 [5]	122.0 [5]	132.1 [5]	167.6 [5]	497.6 [5]	301.5 [5]	4.4 [5]	14.3 [5]	16.0 [5]
PI 3	23.5 [5]	126.1 [5]	111.6 [5]	96.2 [5]	394.8 [5]	263.5 [5]	2.6 [5]	12.3 [5]	9.2 [5]
PI 7	12.2 [5]	135.3 [5]	97.0* [5]	48.0 [5]	297.8 [5]	219.9 [5]	2.7 [5]	6.4* [5]	5.8 [5]
PI 12	10.4 [5]	59.1* [5]	49.5* [5]	24.8 [5]	69.9* [5]	34.4* [5]	2.9 [5]	4.0* [5]	2.5 [5]



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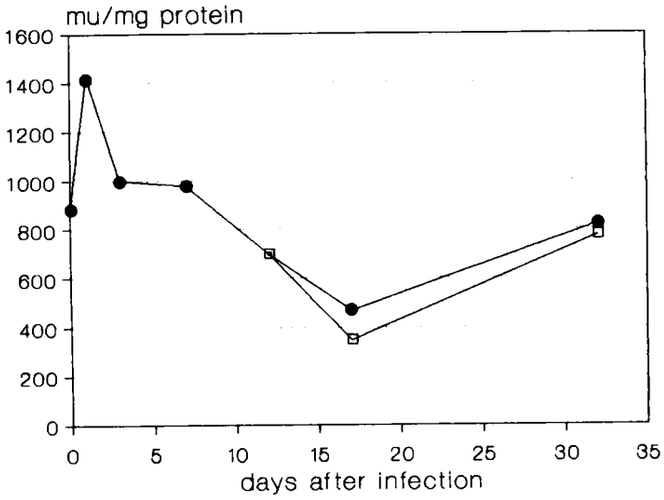

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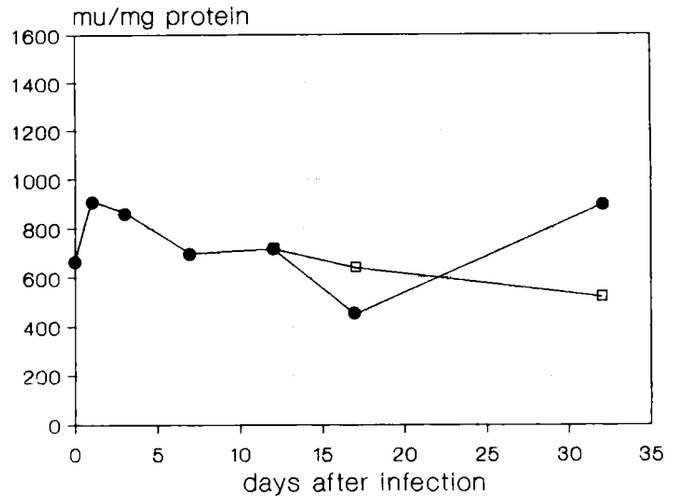
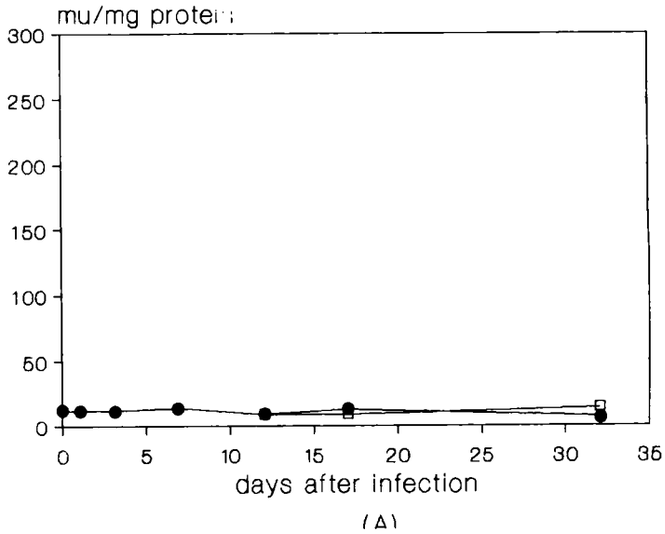


(C)

Fig. 2. Changing pattern of trehalase activity in the small intestine of mice infected with *F. seoulensis* by duration of infection.
A: duodenum, B: proximal jejunum, C: distal jejunum
(●: Infected Group, □: Treated Group).



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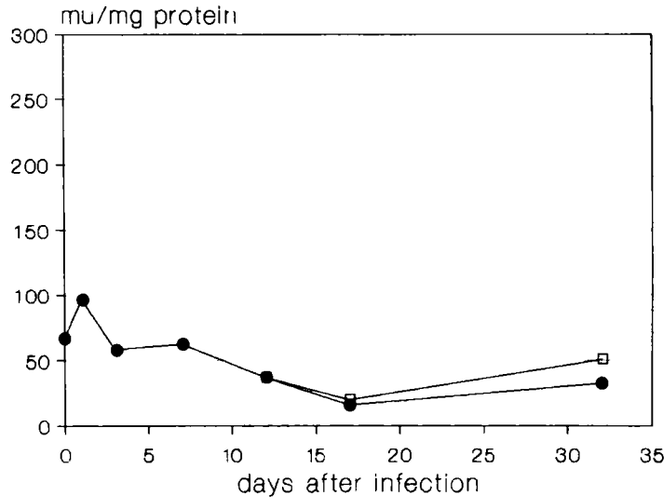

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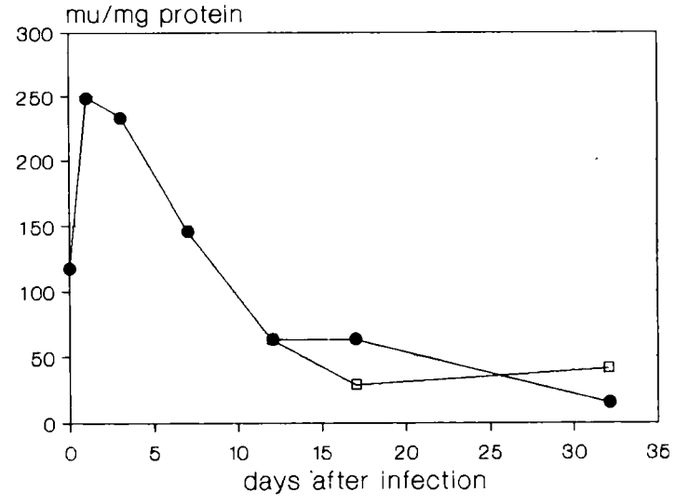

(C)

Fig. 3. Changing pattern of lactase activity in the small intestine of mice infected with *F. seoulensis* by duration of infection.
A: duodenum, B: proximal jejunum, C: distal jejunum
(●: Infected Group, □: Treated Group).

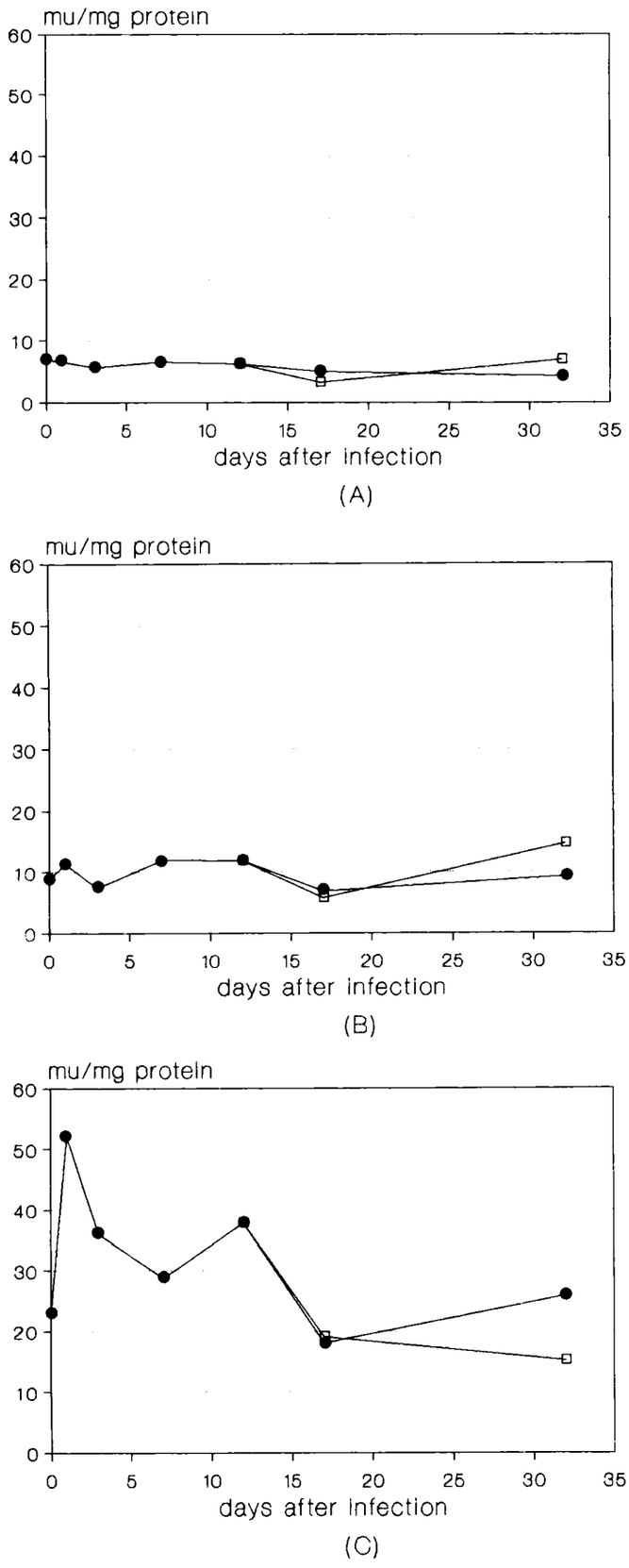

Fig. 4. Changing pattern of leucine aminopeptidase activity in the small intestine of mice infected with *F. seoulensis* by duration of infection. A: duodenum, B: proximal jejunum, C: distal jejunum
(●: Infected Group, □: Treated Group).

creased in the jejunum for the first week after infection. Activity decreased 20 days after infection in the ileum (Table 3). In mice infected with 1000 metacercariae, it was significantly decreased in the duodenum and distal jejunum after 12 days, but not in the proximal jejunum (Table 4). It had not recovered 5 days after treatment but was almost same as that of the control after 20 days (Fig. 5).

DISCUSSION

Brush border membrane bound enzymes in the small intestine are important for final digestion of nutrients before absorption. Disaccharidases, aminopeptidases, and phosphatases are the major enzymes of this type (Newcomer and McGill 1966; Nordstrom *et al.* 1967; Dahlqvist 1968; Bella *et al.* 1982). The activity of these enzymes is known to be altered, especially diminished in some diseased conditions (Andersen *et al.* 1983; Kim *et al.* 1986; Sood *et al.* 1987).

The present results reveal that superficially locating enzymes, *i.e.* disaccharidases and aminopeptidases significantly lessen their activity in the duodenum after infection with *F. seoulensis*. The duodenum just distal to the pyloric ring is the major parasitic location of the fluke (Hong 1982). Therefore, the duodenum should be the mainly affected focus of any functional derangements made by this fluke. Although the enzymes showed the least activity in the duodenum among the sites of the small intestine, the enzyme activity in the infected duodenum was one half to one third that of the control 12 days after infection. The same decreasing pattern was observed in 1000 metacercarial infection.

In the proximal or distal jejunum, however, the activity of disaccharidases and aminopeptidase seems to increase on the first infection day and to return to the control level after one week. Is there any positive stimulation to enzyme activity during initial settlement of the worms? Such a surge in enzyme activity was not found in metagonimiasis (Hong *et al.* 1991). The difference may originate from different niches between the two flukes. The initially elevated activity of the enzymes was also noticed after gamma-irradiation in the small intes-

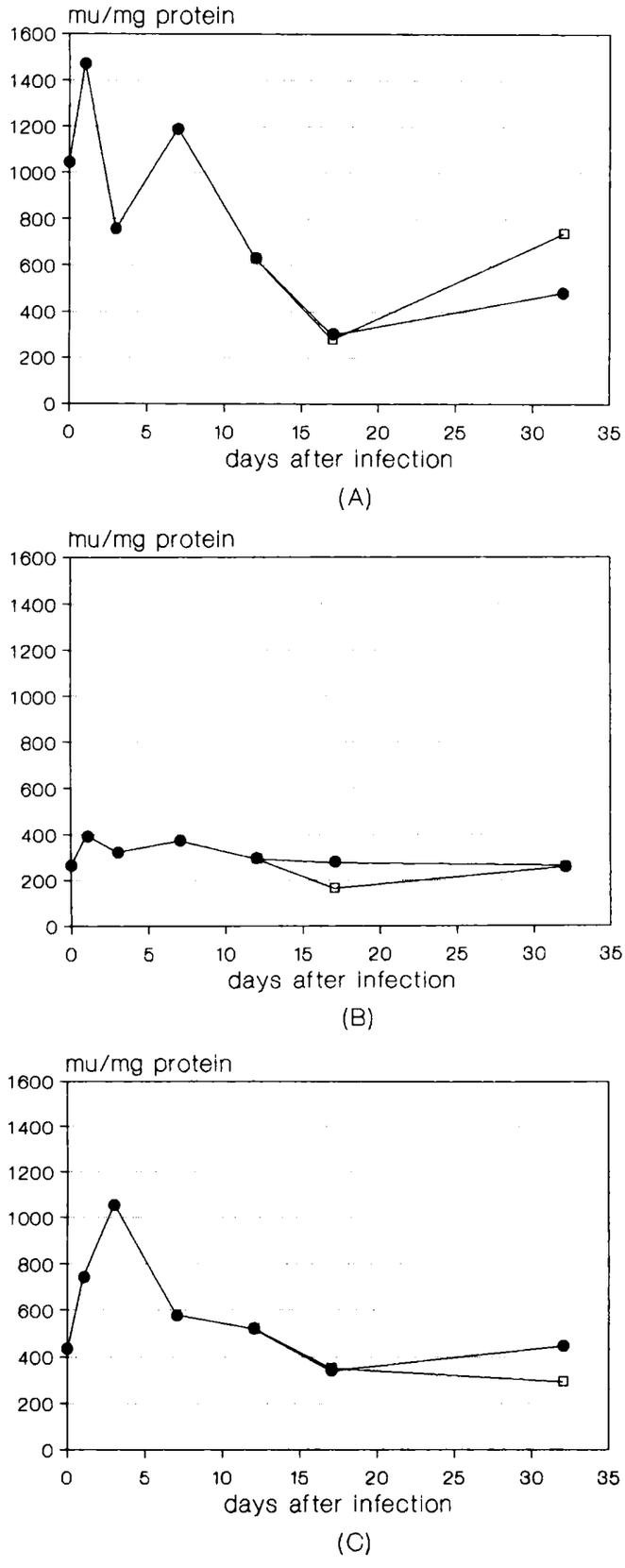

Fig. 5. Changing pattern of alkaline phosphatase activity in the small intestine of mice infected with *F. seoulensis* by duration of infection.
A: duodenum, B: proximal jejunum, C: distal jejunum
(●: Infected Group, □: Treated Group).

tine of rats (Becciolini *et al.* 1982). However, most of the enzymes were significantly less active than those of the control 12 days or later after infection as expected. The degree of diminished enzyme activity was the same in both the 100 and 1000 metacercaria groups. Hong *et al.* (1982) found that the worms were located mainly in the duodenum and the jejunum showed an almost normal configuration when infected with a 100 metacercarial burden. Therefore, any functional disorder in the duodenum can be compensated in the jejunum or ileum in the lightly infected host. The unexpected decrease of activity in the lightly infected jejunum may be an extending effect of atrophic changes on the duodenal mucosa. But they also showed almost the same changing pattern in the mice infected with 1000 metacercariae which was a great enough burden to spread into the jejunum.

The decrease in enzyme activity can suggest two explanations. One is an outcome made by immature enterocytes on atrophied villi and a diminished mucosal surface area. The other plausibility is that any material from the worms may play a role in inhibiting enzyme activity in the jejunum as well as in the duodenum. The second view needs further evaluation.

The mucosal epithelial cells in the small intestine are normally rapidly regenerating (Eastwood 1977). The atrophic change of the mucosa in metagonimiasis, which is the most widely prevalent trematodiasis in Korea, was interpreted as a result of more destruction of the cells by penetration of the crypt layer than the regenerating capability (Kang *et al.* 1983). Decreasing activity of the brush border enzymes in fibricoliasis looks related to the histopathological changes of the mucosa. The changes were first noted minimally 3 days after infection (Lee *et al.* 1985). The changes became obviously atrophic at the first week, and progressed further up to one month. The increased enzyme activity on the first and third day after infection was lowered to that of the control group one week after infection. Thereafter, activity began to diminish significantly, and was lowest 12 days after infection. As a whole, enzyme activity followed atrophic change of the villi. The time lag between the 2 changes may be influenced by the initial increase in activity.

When the enzyme activity of the control mice was compared according to the location, it was highest in the proximal jejunum. Therefore, the proximal jejunum may be the most active site of the enzymes and must harbour enough buffer reserve against any inhibitory stimulus. However, *F. seoulensis* infection suppressed the activity of the enzymes in the whole small intestine for one month after infection. Also alkaline phosphatase which locates deeply on the brush border membrane lost up to half its activity. This fluke may have powerful inhibitory effects on all kinds of brush border enzymes. By sectional morphologies, the tribocytic organ of the fluke is a glandular one secreting some kinds of enzymes (Seo 1989). The organ can invade the villous stroma beneath the epithelial layer (Lee *et al.* 1985). The invasion must be boosted by any secretion from the organ. The relation between the secretion of the worm and the activity of brush border membrane enzymes of the host should be evaluated.

The enzyme activity was not recovered to the control level on the fifth day after treatment. It was almost normalized 20 days from treatment regardless of the site in the intestine or the kind of enzymes. This decreased activity of brush border enzymes must be a reversible change in fibricoliasis as is the histopathological change (Lee *et al.* 1989). The recovery of the two changes takes about 20 days after elimination of worms.

The present findings reveal that *F. seoulensis* causes not only villous atrophy but also degenerative change of the brush border membrane in the intestine of hosts. Ultrastructural change of the membrane is also expected. In fibricoliasis, digestion of disaccharides or peptides may be affected, and eventually absorption must be hindered to make osmotic diarrhea.

REFERENCES

Andersen KJ, Schjoensby H, Skagen DW. Jejunal mucosal enzymes in untreated and treated coeliac disease. Scand. J. Gastroenterol. 1983, 18: 251-256

Becciolini A, Lanini A, Giache V, Balzi M, Bini R. Modifications in the brush border enzymes of the small intestine after irradiation at different times of the day. Acta Radiol. Oncol. 1982, 21: 273-279

Bella AM Jr, Erickson RH, Kim YS. Rat intestinal brush border membrane dipeptidyl aminopeptidase IV: Kinetic properties and substrate specificities of the purified enzyme. Arch. Biochem. Biophys. 1982, 218: 156-162

Dahlqvist A. Assay of intestinal disaccharidase. Anal. Biochem. 1968, 27: 99-107

Eastwood GL. Gastrointestinal epithelial renewal. Progress in Gastroenterology 1977, 72: 962-975

Hong ST, Chai JY, Lee SH. Ten human cases of *Fibricola seoulensis* infection and mixed one with *Stellantchasmus* and *Metagonimus*. Korean J. Parasit. 1986, 24: 94-96

Hong ST, Cho TK, Hong SJ, Chai JY, Lee SH, Seo BS. Fifteen human cases of *Fibricola seoulensis* infection in Korea. Korean J. Parasit. 1984, 22: 61-65

Hong ST, Hong SJ, Lee SH, Seo BS, Chi JG. Studies on intestinal trematodes in Korea VI. On the metacercaria and the second intermediate host of *Fibricola seoulensis*. Korean J. Parasit. 1982, 20: 101-111

Huh S, Chai JY, Hong ST, Lee SH. Clinical and histopathological findings in mice heavily infected with *Fibricola seoulensis*. Korean J. Parasit. 1988, 26: 45-53

Kang SY, Cho SY, Chai JY, Lee JB, Jang DH. A study on intestinal lesions of experimentally reinfected dogs with *Metagonimus yokogawai*. Korean J. Parasit. 1983, 21: 58-73

Kim HR, Lee KH, Chung HB, Yoon YB, Song IS, Kim CY. The change of brush border membrane-bound enzyme activities in patients with active and healed duodenal ulcer. Korean J. Gastroenterol. 1986, 18: 131-135

Lee SH, Kim BI, Hong ST, Sohn WM, Chai JY. Observation of mucosal pathology after praziquantel treatment in experimental *Fibricola seoulensis* infection in rats. Korean J. Parasit. 1989, 27: 35-40

Lee SH, Yoo BH, Hong ST, Chai JY, Seo BS, Chi JG. A histopathological study on the intestine of mice and rats experimentally infected by *Fibricola seoulensis*. Korean J. Parasit. 1985, 23: 58-72

Newcomer AD, McGill DB. Distribution of disaccharidase activity in the small bowel of normal and lactase deficient subject. Gastroenterology 1966, 51: 481

Nordstrom C, Dahlqvist A, Josefsseu L. Quantitative

determination of enzyme in different parts of villi and crypts of rat small intestine. J. Histochem. Cytochem. 1967, 15: 713-721

Seo BS. Comparative growth and development of the metacercariae of *Fibricola seoulensis* (Treamtoda: Diplostomidae) *in vitro, in vivo* and on the chick chorioallantois. Korean J. Parasit. 1989, 27: 231-248

Seo BS, Lee SH, Hong ST, Hong SJ, Kim CY, Lee HY. Studies on intestinal trematodes in Korea V. A human case infected by *Fibricola seoulensis* (Trematoda: Diplostomatidae). Korean J. Parasit. 1982, 20: 93-99

Shoop WL. Systematic analysis of the Diplostomidae and Strigeidae (Trematoda). J. Parasitol. 1989a, 75: 21-32

Shoop WL. Experimental human infection with *Fibricola cratera* (Trematoda: Neodiplostomidae). Korean J. Parasit. 1989b, 27: 249-252

Song IS, Yoshioka M, Erickson RH, Miura S, Guan D, Kim YS. Identification and characterization of brush-border membrane-bound neutral metalloendopeptidases from rat small intestine. Gastroenterology 1986, 91: 1234-1242

Sood R, Singh S, Ahuja SP, Gupta PP, Chawla LS. Effects of experimental infection of rats with *Giardia lamblia* on the activities of pancreatic and brush border enzymes and on *in vitro* absorption from the intestines. Jpn. J. Parasitol. 1987, 36: 1-8

=국 문 초 록=

*Fibricola seoulensis*에 감염된 마우스 소장의 미소융모막 효소활성도의 변화

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국내에서 신종으로 기술하고 새로운 종류의 인체감염 흡충으로 기록한 장흡충인 *Fibricola seoulensis*의 소장점막 미소융모막 효소활성에 관한 영향을 관찰하고자 이 연구를 수행하였다. 이 흡충을 감염시킨 동물의 소장 점막은 심한 퇴행성 변화와 점막 상피층의 손상을 받고 있어 소화와 흡수 등의 기능에 영향을 줄 것으로 기대되었다. 자연감염된 뱀에서 얻은 피낭유충을 마우스에 100개 및 1000개씩 경구감염시키고 감염 후에 경시적으로 관찰하고, 감염 12일에 프라지콴텔로 치료한 후 5일 및 20일에 관찰한 결과 다음의 결과를 얻었다.

이당류 분해효소(sucrase, trehalase, lactase), 펩타이드 효소(leucine aminopeptidase) 및 alkaline phosphatase의 활성도가 모두 감염 12일 후에 소장 전 부위에서 유의하게 감소하였다. 공장에서는 감염 후 1일 및 3일에 전 효소의 활성이 증가하였고 7일에 대조군과 비슷한 수준이었다. 감염 후 감소된 효소활성도는 치료 후 20일에 대조군의 수준으로 회복되었다. 이러한 효소활성도의 감소유형은 100개 및 1000개 감염량에 따라서 차이가 없이 십이지장과 공장에서 비슷하게 관찰되었다. 즉 충체가 기생하여 직접 접촉하지 않는 부위에서도 융모막 효소의 활성이 감소하는 것으로 확인되었다. 이 효소활성의 감소는 이 흡충의 감염으로 인하여 소장점막에 퇴행성 변화가 초래되고, 이때 나타나는 융모상피세포가 완전하게 성숙되지 않는 것이 주요 원인으로 생각된다. 그러나 충체가 분비하는 어떤 물질이 이러한 효소의 활성을 억제하는 역할을 할 가능성도 고려해야 할 것이다.