

ORIGINAL ARTICLE

EVALUATION OF CLINICAL FEATURES OF ISCHEMIC COLITIS: COMPARISON BETWEEN YOUNG AND ELDERLY

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Background: It has been thought that ischemic colitis is caused by vascular and intestinal factors. Although elderly patients with arteriosclerosis are more susceptible to ischemic colitis, many young patients suffering ischemic colitis are also reported. The present study aimed to clarify the relationship between arteriosclerosis and ischemic colitis, and to evaluate various risk factors for ischemic colitis.

Methods: We compared the clinical features of patients with ischemic colitis (54 cases) and control patients without ischemic colitis (86 cases), all diagnosed by colonoscopy. Subjects were classified into a young group (60 cases) under 60 years of age, and an elderly group (80 cases) of over 60 years. The degree of arteriosclerosis was measured by pulse wave velocity (PWV) level, and the effects of vascular and intestinal factors in the development of ischemic colitis were evaluated using multivariate analytical models.

Results: In the elderly group, the PWV level was significantly higher in ischemic colitis patients than in the controls. By analyzing with multivariate analytical models, a high level of PWV and underlying diseases related to arteriosclerosis were thought to be risk factors for ischemic colitis in the elderly group. In the young group, intestinal factors such as irregular bowel movement, which is often seen in irritable bowel syndrome, habitual constipation, and prior history of an abdominal operation, were thought to be contributors to ischemic colitis.

Conclusion: These findings suggest that intestinal factors in younger patients and vascular factors in more elderly patients are the primary contributors in the development of ischemic colitis.

Key words: arteriosclerosis, ischemic colitis, pulse wave velocity.

INTRODUCTION

Ischemic colitis was first described by Boley *et al.*¹ in the 1960s, as a 'reversible' vascular occlusion of the colon; and Marston and associates² classified this disease into transient, stricture, and gangrenous forms. The majority of patients reveal transient form, which responds well to conservative therapy. Since the publication of these reports, much information about ischemic colitis has been reported, and the clinical features of this disease have now been established. The etiological basis of ischemic colitis is thought to be inadequate tissue perfusion. The gut mucosa is particularly sensitive to ischemic injury because of its high rate of growth and replacement, so, at first, ischemic changes appear in the colonic mucosa as the result of inadequate tissue blood flow.

Vascular disorders such as thrombus, embolism, vasospasm and arteriosclerosis occur frequently in elderly people. As the prevalence of vascular and cardiac diseases increases with age, ischemic colitis has been thought to occur frequently in the elderly. Ischemic colitis in younger age groups has been reported as a relatively rare phenomenon,³ or even as a new clinical entity.⁴ However, we have experienced many cases in which younger people without arteriosclerosis have suffered

from ischemic colitis. According to previous reports, vascular factors such as embolism⁵ and vasospasm,⁶ intestinal factors such as constipation,^{7,8} some underlying systemic diseases^{5,6,9} and some medications^{10–13} have been thought to be predisposing factors to the development of ischemic colitis. Although it has been assumed that arteriosclerosis contributes to the development of ischemic colitis in the elderly, other factors may play the main roles in the development of this disease in younger patients.

There have been few reports evaluating the various factors related to the development of ischemic colitis in both younger sufferers and the elderly.^{7,8} Additionally, previous studies seemed to have difficulties in non-invasively evaluating the degree of arteriosclerosis. In the present study, we evaluate the degree of arteriosclerosis using pulse wave velocity (PWV), which is a superior measuring index for the determination of arteriosclerosis,¹⁴ and we analyze the relationship between arteriosclerosis and ischemic colitis. Further, to clarify the etiology of ischemic colitis, we investigate the clinical features of ischemic colitis patients, and compare these between young and elderly groups.

SUBJECTS AND METHODS

Subjects

The study group consisted of 54 patients admitted to our hospital with abdominal symptoms, and diagnosed with

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ischemic colitis between January 2002 and June 2004. The diagnosis of ischemic colitis was made on the basis of the following criteria: (i) acute onset of symptoms such as abdominal pain, diarrhea and bloody stool; (ii) no medical history of inflammatory bowel disease such as ulcerative colitis or Crohn's disease; (iii) no antibiotic use just prior to the onset of symptoms; (iv) negative pathological bacterial cultures in stools; (v) endoscopic findings consistent with the characteristics of ischemic colitis;¹⁵⁻¹⁷ and (vi) histological findings in biopsy specimens obtained from colonic mucosa consistent with characteristics of ischemic colitis.^{16,17} The ages of the patients ranged from 24 to 90 years old (average 63.7), and the ratio of men versus women was 2:3. We divided subjects into a young group (< 60 years old; 22 cases) and an elderly group (\geq 60 years old; 32 cases). The mean (SD) ages of ischemic colitis patients in the young group and the elderly group were 38.9 years (5.8) and 74.2 years (8.4), respectively. We also reviewed 86 patients who were admitted to our hospital for colonoscopy and were diagnosed as being without ischemic colitis, as control subjects. The ages of the control subjects ranged from 22 to 87 years old (average 61.1), and the ratio of men versus women was 2:3. The control subjects were also divided into a young group (< 60 years old; 38 cases) and an elderly group (\geq 60 years old; 48 cases). The mean (SD) ages of control subjects in the young group and the elderly group were 38.2 (5.1) years and 73.0 (7.7) years, respectively.

Measurements of variants

We thoroughly reviewed the clinical features of all patients concerning their arteriosclerosis, laboratory data, obesity, chronic constipation, habitual use of laxatives, recent use of an enema, smoking history, medical background of abdominal surgery, and underlying diseases. For evaluation of arteriosclerosis, we measured the pulse wave velocity (PWV) between the brachium and ankle, which is thought to accurately reflect systemic arteriosclerosis,¹⁴ by using a blood pressure plethysmography device (Form PWV/ABI; Japan Korin Co., Komaki-city, Japan). Ankle-brachial index (ABI), an index of lower extremities artery obstruction by atherosclerosis,¹⁸ was also measured using this device. For biochemical measurements, blood samples were obtained after a 12-h fasting period, and total cholesterol, HDL cholesterol, triglyceride (TG), and fasting plasma glucose (FPG) were assayed by enzymatic procedures. We also calculated body mass index (BMI) of all patients, for the purpose of evaluating the degree of obesity. Chronic constipation was defined as usual bowel movements less than once every 3 days. Altered bowel function (repeating constipation and diarrhea) and intermittent abdominal pain in the left lower quadrant with a stressful situation were defined as irritable bowel syndrome, after excluding other diseases such as inflammatory bowel disease.

Statistical analysis

All statistical analyses were performed using STATVIEW 5.0 software (Abacus Concepts, Berkeley, CA, USA). When comparing the two groups, Student *t*- or Chi-squared tests were used, as appropriate, for statistical analyses. When necessary, log transformation was used for skewed variables, and

data were presented as geometric means. Unless otherwise indicated, values were expressed as mean \pm SD or percentages. Correlation of age associated with PWV score was evaluated by simple regression. All variables, such as clinical characteristics, PWV/ABI and laboratory data, were included in a stepwise regression analysis, using the development of ischemic colitis as the dependable variable. Two-sided *P*-values < 0.05 were considered statistically significant.

RESULTS

First, we reviewed the clinical features of the ischemic colitis patients, and compared these between the young and the elderly groups. Clinical characteristics and biochemistry data of the two groups are summarized in Table 1. The smoking rate, frequency of chronic constipation and medical history of abdominal operation were almost the same between the two groups. BMI and FPG level were not statistically different between the two groups. Frequency of habitual use of laxatives, incidence of arteriosclerosis-related underlying diseases, and averages of total cholesterol and TG were higher in the elderly group compared with the younger group. In contrast, the frequency of irritable bowel syndrome and an average of HDL cholesterol were higher in the younger group compared with the elderly group.

Next, we compared the characteristics of ischemic colitis patients and the controls in both the young and elderly groups, respectively. In the young groups, frequency of chronic constipation, irritable bowel syndrome and a medical history of an abdominal operation were significantly higher in the ischemic colitis patients (Table 2). In the case of elderly groups, averaged PWV score and frequency of arteriosclerosis-related underlying diseases were statistically higher, and an average of HDL cholesterol level was statistically lower, in the ischemic colitis patients (Table 3). Other factors were not significantly different between ischemic colitis and control patients.

The PWV score became higher with age; and an increasing rate of the PWV score was significantly higher in the ischemic colitis group compared to the controls (Fig. 1). There were no significant differences in the average PWV scores in the younger patients between the ischemic colitis and the control groups (Fig. 2a). In contrast, in the elderly groups, the average PWV score showed a statistically significant high level in the ischemic colitis group (Fig. 2b). No cases in this study revealed an abnormal ABI value (data not shown).

We also analyzed the relationship between the clinical features and the development of ischemic colitis with multivariate analytical models. By stepwise regression analysis (Table 4), using the development of ischemic colitis as the dependent variable, intestinal factors such as chronic constipation, irritable bowel syndrome and a history of abdominal surgery were independently associated with the development of ischemic colitis in the younger group. In contrast, in the case of the elderly group, vascular factors such as a high PWV score level and arteriosclerosis-related underlying diseases were thought to be predisposing factors for the development of ischemic colitis.

Next, we reviewed the clinical forms of ischemic colitis, and compared these characters in the young and in the elderly groups. We performed follow-up colonoscopy for all ischemic colitis patients, and divided them into transient and

Table 1. Clinical features of ischemic colitis patients: Comparison between young and elderly groups

	Young group (< 60 years old) (n = 22)	Elderly group (≥ 60 years old) (n = 32)	Statistical significance
Age (years)	38.9 ± 5.8	74.2 ± 8.4	<i>P</i> < 0.05
Ratio of males/females (%)	69.2 (9/13)	68.4 (13/19)	N.S.
Smoking rate (%)	22.7	21.9	N.S.
Chronic constipation (%)	22.7	25.0	N.S.
Habitual use of laxatives (%)	18.2	21.9	<i>P</i> < 0.05
Irritable bowel syndrome (%)	27.3	15.6	<i>P</i> < 0.05
History of abdominal operation (%)	18.2	21.9	N.S.
Underlying disease			
Diabetes mellitus (%)	13.6	25.0	<i>P</i> < 0.05
Hypertension (%)	18.2	28.1	<i>P</i> < 0.05
Hyperlipidemia (%)	13.6	21.9	<i>P</i> < 0.05
IHD (%)	9.1	21.9	<i>P</i> < 0.05
Body mass index (kg/m ²)	21.3 ± 2.2	22.5 ± 1.7	N.S.
Laboratory data			
FPG (mg/dL)	104.3 ± 9.3	119.2 ± 8.0	N.S.
Total cholesterol (mg/dL)	210.8 ± 10.1	230.1 ± 9.1	<i>P</i> < 0.05
HDL cholesterol (mg/dL)	50.4 ± 3.6	39.4 ± 2.5	<i>P</i> < 0.05
TG (mg/dL)	141.2 ± 8.0	162.7 ± 7.2	<i>P</i> < 0.05

Data are expressed as mean ± SD or percentage.

Percentages of males, smoking rate, chronic constipation, habitual use of laxatives, irritable bowel syndrome, history of abdominal operation, and underlying disease were evaluated with chi-squared test. Other data were evaluated with Student's *t*-test after skewing variables with log transformation.

FPG, fasting plasma glucose; IHD, ischemic heart diseases; N.S., not statistically significant; TG, triglyceride.

Table 2. Comparison of characteristics between ischemic colitis patients and control patients in the young group

	Ischemic colitis patients (n = 22)	Control patients (n = 38)	Statistical significance
Age (years)	38.9 ± 5.8	38.2 ± 5.1	N.S.
Ratio of males/females (%)	69.2 (9/13)	72.7 (16/22)	N.S.
Smoking rate (%)	22.7	21.1	N.S.
Chronic constipation (%)	22.7	15.8	<i>P</i> < 0.05
Habitual use of laxatives (%)	18.2	15.8	N.S.
Recent use of enema (%)	9.1	7.9	N.S.
Irritable bowel syndrome (%)	27.3	18.4	<i>P</i> < 0.05
History of abdominal operation (%)	18.2	10.5	<i>P</i> < 0.05
Underlying disease related to arteriosclerosis [†] (%)	18.2	15.8	N.S.
Pulse wave velocity (cm/s)	1465 ± 112	1459 ± 104	N.S.
Ankle brachial index	1.21 ± 0.20	1.19 ± 0.13	N.S.
Body mass index (kg/m ²)	21.3 ± 2.2	21.6 ± 1.8	N.S.
Laboratory data			
FPG (mg/dL)	104.3 ± 9.3	106.8 ± 5.3	N.S.
Total cholesterol (mg/dL)	210.8 ± 10.1	213.7 ± 8.8	N.S.
HDL cholesterol (mg/dL)	50.4 ± 3.6	52.9 ± 3.5	N.S.
TG (mg/dL)	141.2 ± 8.0	139.3 ± 7.1	N.S.

[†]Including diabetes mellitus, hypertension, hyperlipidemia and ischemic heart diseases.

Data are expressed as mean ± SD or percentage.

Percentages of males, smoking rate, chronic constipation, habitual use of laxatives, recent use of enema, irritable bowel syndrome, history of abdominal operation and underlying disease were evaluated with chi-squared test. Other data were evaluated with Student's *t*-test after skewing variables with log transformation.

FPG, fasting plasma glucose; IHD, ischemic heart diseases; N.S., not statistically significant; TG, triglyceride.

stricture forms, according to previously reported criteria.¹⁹ All patients in the young group displayed the transient form, whereas the elderly group included three cases of the stricture form, which required surgery to remove the colonic obstruction. No gangrenous form was found in our study

subjects. By evaluating the PWV score from the aspect of clinical forms, there was no significant difference in PWV score between transient and stricture forms (Fig. 3a). Although it has been reported that recurrence of ischemic colitis is rare, in the present study, three recurring cases

Table 3. Comparison of characteristics between ischemic colitis patients and control patients in the elderly group

	Ischemic colitis patients (<i>n</i> = 32)	Control patients (<i>n</i> = 48)	Statistical significance
Age (years)	74.2 ± 8.4	73.0 ± 7.7	N.S.
Ratio of males/females (%)	68.4 (13/19)	65.5 (19/29)	N.S.
Smoking rate (%)	21.9	20.8	N.S.
Chronic constipation (%)	25.0	22.9	N.S.
Habitual use of laxatives (%)	21.9	22.9	N.S.
Recent use of enema (%)	15.6	12.5	N.S.
Irritable bowel syndrome (%)	15.6	14.6	N.S.
History of abdominal operation (%)	21.9	20.8	N.S.
Underlying disease related to arteriosclerosis [†] (%)	34.4	29.2	<i>P</i> < 0.05
Pulse wave velocity (cm/s)	1942 ± 111	1715 ± 107	<i>P</i> < 0.05
Ankle brachial index	1.08 ± 0.20	1.07 ± 0.15	N.S.
Body mass index (kg/m ²)	22.5 ± 1.7	22.7 ± 1.4	N.S.
Laboratory data			
FPG (mg/dL)	119.2 ± 8.0	118.3 ± 6.1	N.S.
Total cholesterol (mg/dL)	230.1 ± 9.1	231.2 ± 8.3	N.S.
HDL cholesterol (mg/dL)	39.4 ± 2.5	43.1 ± 2.3	<i>P</i> < 0.05
TG (mg/dL)	162.7 ± 7.2	158.4 ± 7.7	N.S.

[†]Including diabetes mellitus, hypertension, hyperlipidemia and ischemic heart diseases.

Data are expressed as mean ± SD or percentage.

Percentages of males, smoking rate, chronic constipation, habitual use of laxatives, recent use of enema, irritable bowel syndrome, history of abdominal operation and underlying disease were evaluated with chi-squared test. Other data were evaluated with Student's *t*-test after skewing variables with log transformation.

FPG, fasting plasma glucose; IHD, ischemic heart diseases; N.S., not statistically significant; TG, triglyceride.

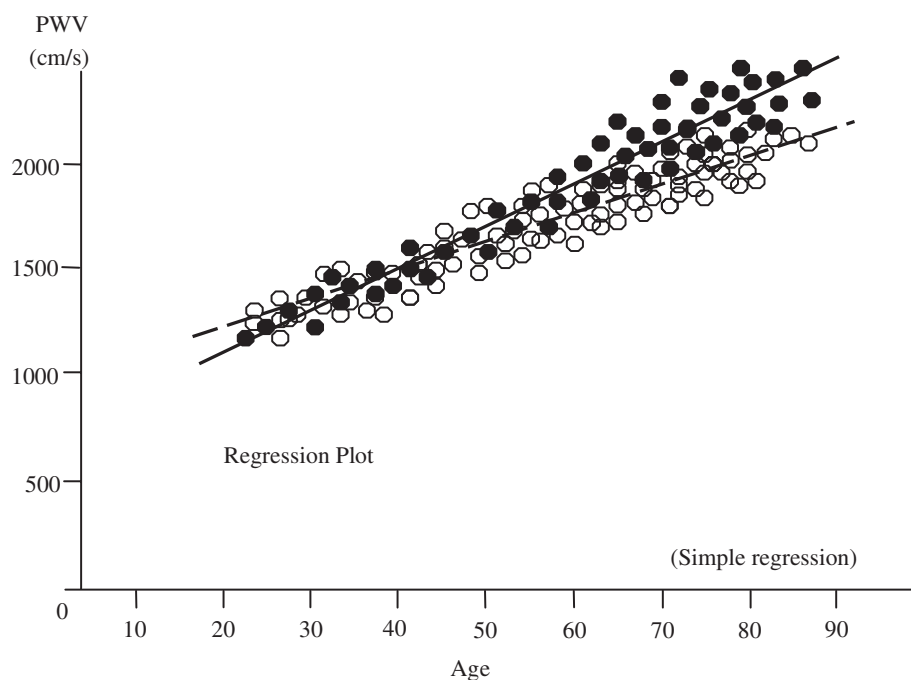


Fig. 1. Correlation of age associated with pulse wave velocity (PWV) analyzed by simple regression. PWV score becomes higher with age in both the ischemic colitis group (*n* = 54; ●—) and the control group (*n* = 86; ○-----). The rate of increase is higher in the ischemic colitis group compared to the control group.

(5.5%) were experienced in the elderly group. The clinical characteristics of recurring cases compared to non-recurring cases are described in Table 5. The average age, frequency of constipation and arteriosclerosis-related diseases were remarkably higher in the recurring cases. Recurring cases also revealed a high average PWV score in comparison with non-recurring cases (Fig. 3b). Thus, every recurring case revealed intestinal factors such as constipation, as well as arteriosclerotic conditions.

As for clinical symptoms, the frequency of abdominal pain prior to a bloody stool was lower in the elderly group (84%) compared to the younger group (100%). In endoscopic findings, obvious luminal narrowing by severe mucosal edema was highly observed in the elderly group (31%) compared with the younger group (18%). Other endoscopic findings, such as erosive, reddish and hemorrhagic changes in colonic mucosa, had almost the same frequency between the young and the elderly groups. As for the range of ischemic segment,

Fig. 2. Comparison of pulse wave velocity (PWV) scores between ischemic colitis and control patients. (a) In the young groups, there are no significant differences in average PWV scores between the ischemic colitis group (●) and the control group (○). (b) In the case of the elderly groups, the average PWV score shows statistically significant high levels in the ischemic colitis group (●). N.S., not statistically significant.

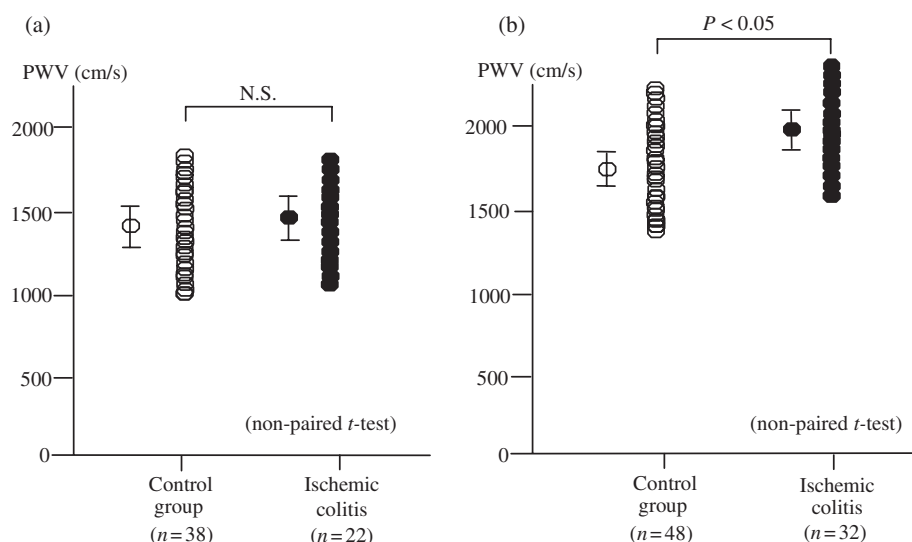


Table 4. Stepwise regression analysis associated with the development of ischemic colitis

	Young group (< 60 years old)		Elderly group (≥ 60 years old)	
	β	P	β	P
Smoking rate	0.291	0.141	0.217	0.193
Chronic constipation	0.147	0.049*	0.187	0.115
Habitual use of laxatives	0.230	0.158	0.165	0.158
Recent use of enema	0.318	0.202	0.237	0.218
Irritable bowel syndrome	0.081	0.034*	0.254	0.193
History of abdominal operation	0.118	0.042*	0.197	0.140
Arteriosclerosis-related underlying disease [†]	0.278	0.240	0.083	0.041*
Pulse wave velocity	0.199	0.221	0.104	0.037*
Ankle brachial index	0.275	0.207	0.224	0.285
Body mass index	0.186	0.293	0.216	0.186
Laboratory data				
Fasting plasma glucose	0.211	0.184	0.153	0.217
Total cholesterol	0.184	0.256	0.219	0.180
HDL cholesterol	0.241	0.175	0.128	0.092
Triglyceride	0.210	0.238	0.196	0.121
P		0.047*		0.041*
R		0.465		0.429

* $P < 0.05$.

[†] Including diabetes mellitus, hypertension, hyperlipidemia and ischemic heart diseases.

Regression analysis was performed using the development of ischemic colitis as the dependent variable.

there was no clear difference between the young and elderly groups. There was also no apparent relationship between the PWV score and the characteristics of the endoscopic findings (data not shown).

We also reviewed the correlation of ischemic colitis associated with the control of arteriosclerosis-related diseases. We measured the HbA1c score in all patients suffering from diabetes mellitus (DM); this is an accurate index of glucose control, and we divided diabetic patients into two groups; those that responded well to treatment ($\text{HbA1c} < 8\%$) and those that responded poorly to treatment ($\text{HbA1c} \geq 8\%$). The development of ischemic colitis had almost the same frequency between the two groups (data not shown). From this result, predicting the development of ischemic colitis

from the control of arteriosclerosis-related diseases was thought to be difficult.

DISCUSSION

Ischemic colitis is described as an ischemic alteration of colonic mucosa; among the tissue layers of the colonic wall, the mucosa is the most metabolically active region and so it is the first place to demonstrate ischemic changes. According to a previous report,²⁰ ischemic colitis is usually caused by disturbances of the blood flow in the colonic wall. The circulatory disturbance leads to a thrombus occurring in the arteries of the colonic wall, which causes vascular occlusion in the peripheral region. From these mechanisms, arteriosclerosis

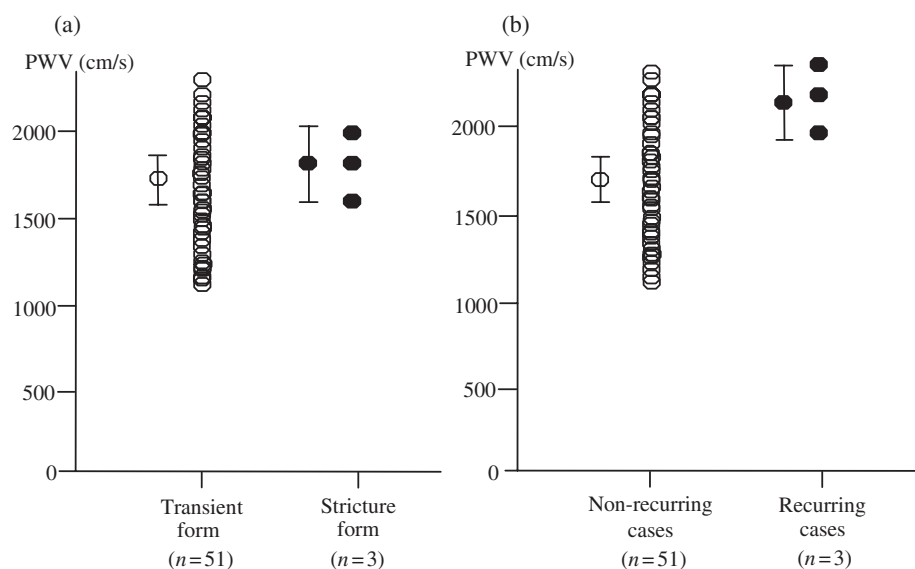


Fig. 3. Evaluation of pulse wave velocity (PWV) score based on clinical forms of ischemic colitis. (a) There is no significant difference in PWV score between the transient (○) and stricture (●) forms. (b) Recurring cases of ischemic colitis (●) revealed a high average PWV score in comparison with non-recurring cases (○).

Table 5. Comparison of characteristics between recurring and non-recurring cases of ischemic colitis patients

	Recurring cases (n = 3)	Non-recurring cases (n = 51)
Age (years)	82.3 ± 4.7	63.0 ± 3.2
Chronic constipation (%)	100.0	23.5
Habitual use of laxatives (%)	66.7	17.6
Irritable bowel syndrome (%)	0.0	21.6
History of abdominal operation (%)	33.3	19.6
Underlying disease related to arteriosclerosis [†] (%)	100.0	23.5
Pulse wave velocity (cm/s)	2028 ± 175	1712 ± 108
Ankle brachial index	1.06 ± 0.27	1.15 ± 0.18
Body mass index (kg/m ²)	21.7 ± 3.9	22.1 ± 1.8
Laboratory data		
FPG (mg/dL)	126.3 ± 11.2	116.3 ± 7.4
Total cholesterol (mg/dL)	231.7 ± 10.8	221.0 ± 8.4
HDL cholesterol (mg/dL)	35.4 ± 3.1	44.4 ± 2.8
TG (mg/dL)	181.6 ± 12.5	150.1 ± 8.7

[†]Including diabetes mellitus, hypertension, hyperlipidemia and ischemic heart diseases.

Data are expressed as mean ± SD or percentage.

FPG, fasting plasma glucose; TG, triglyceride.

has been thought to be one of the important risk factors for the development of ischemic colitis.

The typical ischemic colitis patient is elderly, so arteriosclerosis has been thought to be a predisposing factor. However, although the frequency of vascular disease increases with age, many cases of ischemic colitis in younger patients without arteriosclerosis have also been recently documented.^{3,4,21,22} Therefore, it is questioned whether arteriosclerosis is a major risk factor in the development of ischemic colitis in these cases. According to previous reports, interactions of vascular factors, such as arteriosclerosis, and intestinal factors, such as constipation, have been estimated to cause ischemic changes in colonic mucosa. Colonic distention and increased bowel pressure are supposed to increase intramural pressure, which results in venous stasis and eventually impairs the arterial supply, finally resulting in reduction of arteriovenous oxygen in the distended colonic wall.²³ However, there have been just a few published reports^{7,8} evaluating the effects of vascular and intestinal factors in the

development of ischemic colitis. In the present study, we investigated the correlation between vascular and intestinal factors associated with ischemic colitis.

We divided patients into young and elderly groups, and performed a prospective review of their clinical characteristics, including the analysis of arteriosclerosis. Thanks to recent technical progress, the degree of arteriosclerosis can easily be evaluated. In the present study, we measured the PWV score, which is one of the best physiological measuring indexes for the determination of arteriosclerosis.¹⁴ PWV mainly reflects arteriosclerosis with intimal hyperplasia and stable plaque caused by vascular endothelium damage, which is often seen in DM and hypertension. PWV shows high levels in cases in which arteriosclerosis progresses extensively, such as aging,²⁴ DM²⁵ and hypertension.²⁶ In the present study, the average PWV score in ischemic colitis patients showed a significantly higher level compared to the control patients in the elderly group. Therefore, we speculated that measuring PWV is also useful for estimating the

risk of ischemic colitis in the elderly, as well as in the prediction of cardiovascular disease.

ABI is an index for evaluating arterial stenosis of the lower extremities by atherosclerosis.¹⁸ ABI values below 0.9 mean doubtful cases of arterial stenosis of the lower extremities. It has been reported that patients with this type of arterial stenosis are more susceptible to coronary heart and cerebral artery diseases.²⁷ Therefore, ABI has been thought to be an independent index for estimating the death risk by coronary disease or stroke. In the present study, we found no cases with abnormal ABI values, and there was no apparent relationship between ABI and PWV score. From these results, it was thought that arteriosclerosis, mainly by vascular endothelium damage, contributed to the development of ischemic colitis in the elderly group.

There are many other measuring methods to evaluate the degree of arteriosclerosis. Among these, measuring the wall thickness of the carotid artery (intima-media complex: IMC) using a supersonic wave apparatus is a representative method, one which is often used in risk evaluation of coronary and cerebral vascular diseases.²⁸ In the present study, we also measured IMC in 30 patients who suffered from arteriosclerosis-related diseases, and analyzed the relationship between IMC and PWV score. However, no apparent relationship was found (data not shown). Although there are many indexes to evaluate arteriosclerosis, we speculated that the PWV score is a suitable index for evaluating arteriosclerosis as a risk factor of ischemic colitis.

By analyzing the clinical characteristics, intestinal factors such as chronic constipation, irritable bowel syndrome and a medical history of abdominal operations were thought to be contributing factors for ischemic colitis in the younger group. In addition to chronic constipation, younger patients tended to be bothered more by irregular bowel movements, which are often seen in irritable bowel syndrome. In contrast, there was no statistical relationship between intestinal factors and the development of ischemic colitis in the elderly group. Chronic constipation is classified as either flaccid type, which doesn't show any abdominal pain, or convulsive type, which manifests as abdominal pain related to spasm of colon. In the present study, elderly patients showed flaccid constipation, whereas young patients tended to suffer from convulsive constipation. From these results, bowel conditions influenced by convulsive constipation may be deeply associated with the development of ischemic colitis.

Because arterial sclerosis progresses with age, it is predicted that the influence of vascular factors in the development of ischemic colitis becomes dominant in the elderly patients. In contrast, in the case of younger patients without arteriosclerosis, it seems to be natural that the influence of intestinal factors becomes dominant as a result of the decreasing influence of vascular factors. However, elderly patients tend to experience more frequent constipation, because the regularity of bowel movements often deteriorates with age. If every type of constipation becomes a risk factor in the development of ischemic colitis, frequency of ischemic colitis should increase with age. However, this supposition contradicts the results we experienced in the present study. Although it is unclear how intestinal factors clinically affect the blood flow in the colonic wall, we speculate that convulsive constipation and abnormal bowel movements related to irritable bowel syndrome increase intraluminal

pressure, interfere with the colonic blood supply and, finally, cause ischemic changes of the colonic mucosa.

Ischemic colitis is the most prevalent form of gastrointestinal ischemic disease. However, in many cases, it is not accurately diagnosed because the symptoms are often non-specific and often overlap with those of infectious colitis and inflammatory bowel disease. In the present study, more than 95% of the young group patients reported abdominal pain, diarrhea and bloody stool; all typical symptoms for ischemic colitis. However, we experienced difficulty in correctly diagnosing ischemic colitis from just reported symptoms. Furthermore, 16% of the elderly patients did not report typical symptoms for ischemic colitis. Colonoscopy has been the principal method used to accurately diagnose ischemic colitis, because ischemic changes are often limited to the superficial mucosa. According to previous reports,¹⁵⁻¹⁷ diagnostic endoscopic findings of ischemic colitis are as follows: (i) bluish-black mucosa representing mucosal gangrene; (ii) edematous mucosa; (iii) erythema; (iv) submucosal hemorrhage; (v) ulcerated areas, which elongated, resulted in well-defined longitudinal ulcers; (vi) a sharp line of demarcation between the ischemic mucosa and normal mucosa; and (vii) rapid resolution of these findings. At the beginning of the present study, we performed colonoscopy for every patient who complained of abdominal symptoms. We diagnosed 54 ischemic colitis patients from characteristic endoscopic findings, and 86 control patients without these views. Histological findings of colonic mucosa from ischemic colitis patients were consistent with previously reported histopathological characteristics of ischemic colitis.¹⁷

A previous report has described that a pattern of colonic blood supply gradually changes with age, which may be associated with the development of ischemic colitis and the location of the ischemic segment.²⁹ It has been thought that ischemic change predominantly occurs in the left side of the colon, because of the pattern of blood flow of the inferior mesenteric artery. Reeders *et al.* reported that 75% of ischemic colitis was observed in the left side of the colon.³⁰ In the present study, we investigated the location of the ischemic segment of the colon, and ischemic changes were predominantly seen in the left side of the colon. There was no apparent difference in the range of ischemic segment between the young and the elderly groups, except for one case in which an anal side of ischemic change was observed at the rectum in an elderly patient. However, according to recent reports, the frequency of ischemic colitis in the right side of the colon has increased.³¹⁻³³ It is necessary to further evaluate the relationship between the age of the patient and the location of ischemic colitis through more clinical studies.

For analyses of clinical forms, all young patients displayed a transient form, in which prompt and complete healing of ischemic changes was obtained. In comparison with the young, three cases of the stricture form were seen in the elderly group; these required surgery to remove the narrow segment of colon. Previous reports have described that while ischemic colitis in elderly patients frequently developed into the stricture form, most of the young patients revealed the reversible transient form.^{22,34} Our results are completely compatible with previous reports. The differences in the severity of ischemic colitis between young and elderly patients may be explained by differences in the degree of the decrease in the blood supply to the colon.

Arteriosclerosis has been thought to be an irreversible and progressive disease. If the development of ischemic colitis in elderly patients is only affected by vascular factors, we would expect to encounter more cases of recurring ischemic colitis. However, there were few recurring cases revealed in the present study. By considering these results, it is estimated that the development of ischemic colitis in elderly patients is not only influenced by vascular factors such as arteriosclerosis, but is also affected by other conditions such as intestinal factors. In contrast, recurring cases in the present study revealed a high average PWV score. Comparison of PWV scores between recurring cases and non-recurring cases was clinically impossible, because the number of recurring cases is few. However, judging from the PWV scores in recurring cases, severe arteriosclerosis may be one of the candidates contributing the recurrence of ischemic colitis.

Finally, we reached the following conclusion; intestinal factors are mainly related to the development of ischemic colitis in younger patients, whereas arteriosclerosis is thought to be a major predisposing factor for ischemic colitis in the elderly. However, there were some cases in which previously reported etiological factors³⁻¹³ could not be obviously identified. Although the complete mechanism controlling the development of ischemic colitis remains unclear, it may be possible to elucidate etiology and prevent this disease in the future by accumulating many cases and analyzing the various estimated risk factors in greater detail.

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