ORIGINAL ARTICLE

Gut and Liver, Vol. 6, No. 1, January 2012, pp. 78-85

The Clinical Factors for Predicting Severe Diverticulitis in Korea: A Comparison with Western Countries

Sun Young Kim*, Tae Hoon Oh*, Ji Young Seo*, Tae Joo Jeon*, Dong Dae Seo*, Won Chang Shin*, Won Choong Choi*, and Myeong Ja Jeong†

*Departments of *Internal Medicine and †Radiology, Inje University Sanggye Paik Hospital, Inje University College of Medicine, Seoul, Korea*

Background/Aims: It is unclear whether the risk factors associated with complicated diverticulitis in Asian and Western countries are the same. We evaluated the risk factors associated with severe diverticulitis (SD) in Korea and compared the clinical characteristics of diverticulitis according to location. **Methods:** A retrospective review of 190 patients hospitalized with acute diverticulitis from January 2005 to June 2010 was conducted. SD was defined as one of the following: perforation, abscess, obstruction, sepsis, or peritonitis that required an urgent operation. **Results:** Twenty-four patients (12.6%) were diagnosed with SD. SD was significantly associated with older age, a fever over 38°C, changes in bowel habits and a high visceral adipose tissue (VAT)/total adipose tissue (TAT) ratio. Multivariate analysis showed that the risk factors for developing SD were an age of 40 years or more (odds ratio [OR], 3.2; p=0.032), male gender (OR, 4.0; p=0.021) and left-sided diverticulitis (OR, 6.2; p=0.017). Right-sided diverticulitis (n=175, 92.1%) was significantly associated with younger ages, fewer changes in bowel habits, fewer comorbidities and non-SD. **Conclusions:** This study suggests that the risk factors for developing SD in Korea, where right-sided diverticulitis is predominant, are the male gender, an age of more than 40 years old, and left-sided diverticulitis. Given that there are different risk factors for developing SD in Western countries, different strategies for the treatment of diverticulitis in the Korean population seem to be needed. **(Gut Liver 2012;6:78-85)**

Key Words: Diverticulitis; Diverticulosis; Location; Obesity

INTRODUCTION

Diverticula can occur at any sites in the colon. However, there are great variations in the incidence and distribution of diverticula in different geographic areas. In the Western population, in approximately 95% of cases, diverticula involve the sigmoid and left colon. With increasing age, they occur progressively more proximally. Consequently, right-sided diverticular disease is observed in older patients with pan-diverticulosis.[1] The incidence of left-sided diverticulitis is estimated above 96%.[2] In contrast, diverticular disease in Asian societies occurs primarily on the right side of the colon, with as many as 70% of the diverticula isolated to the right side. Right-sided diverticula occur at a younger age, with left-sided diverticula occurring later. The incidence of right-sided diverticulitis is estimated 75%.[3] This discrepancy in the pattern of disease according to geographic variation may help us clarify its etiology. In that point, location of diverticula is of particular interest.

Diverticulitis is a disease with wide spectrum of severity that runs from isolated, mild, acute attacks to severe, recurrent disease. Of those patients with diverticulitis, 15% to 20% will develop significant complications, such as abscess, fistula, obstruction, phlegmon, bleeding or perforation, and the overall mortality of those requiring surgery for perforated diverticular disease was reported between 12% and 36%.[4] Therefore, identification of predicting factors for complicated diverticulitis has received wide attention. In Western populations, younger age, female, obesity, smoking, recurrence, and comorbidity have been reported as risk factors of severe diverticulitis (SD), despite controversies. Historically, the treatment guideline has been based on some of these risk factors.[5,6] While there has been extensive study of the risk factors of SD in Western popula-

Correspondence to: Tae Hoon Oh
Division of Gastroenterology, Department of Internal Medicine, Inje University Sanggye Paik Hospital, Inje University College of Medicine, 761-1 Sanggye 7-dong, Nowon-gu, Seoul 139-707, Korea
Tel: +82-2-950-8867, Fax: +82-2-950-1955, E-mail: osbbang@paik.ac.kr
Received on April 21, 2011. Revised on June 20, 2011. Accepted on July 31, 2011.
pISSN 1976-2283 eISSN 2005-1212 http://dx.doi.org/10.5009/gnl.2012.6.1.78

tion, relatively limited investigation of those in Asian populations (who have different characteristics of diverticulosis) has been reported. Although left-sided location of diverticulitis has been consistently reported as a significant risk factor of SD in Asia,[7-12] there was few study performing extensive investigation handling variable risk factors of SD. Furthermore, risk factors predicting the complication of diverticulitis in Far East Asian countries differ from those in Western countries, with regard to age and recurrence.[9,13] Therefore, it seems inappropriate to follow the Western treatment guideline when treating the Asian population. This study was designed to evaluate the risk factors of SD in Korea, and additionally to compare the clinical characteristics of diverticulitis according to the location, which seemed to be the main difference between Western and Asian populations.

MATERIALS AND METHODS

1. Patients

A retrospective review of 190 patients hospitalized with acute diverticulitis from January 2005 to June 2010 was conducted. All data, such as patient's demographics, obesity parameters including body mass index (BMI), and waist circumference (WC), comorbid disease, symptoms, physical examination findings, white blood cell counts, investigations performed and pathologic reports, type of treatment, complications, duration of admission, and recurrence were collected through the computer review of medical records of the patients. Patients characteristics are defined as follows: For smoking, only current smoker were included. Comorbidity was defined as cardiopulmonary, endocrinologic, neurologic, malignant, and connective tissue diseases that were accompanied with known diverticulitis. Chronic constipation was defined as bowel movement with strain occurring less than 3 times a week. Bowel habit change was defined as new onset diarrhea or constipation. Recurrent diverticulitis was defined as acute diverticulitis occurred more than once. All patients underwent either the computed tomography (n=187) or the abdominal sonography (n=3) under the clinical suspicion of colonic diverticulitis. This study protocol was approved by the local ethics committee in our institute.

2. Definition of acute severe diverticulitis

The diagnosis of acute diverticulitis was defined as clinically suspected diverticulitis at presentation, in which 1) diverticulitis was definitely shown on the computed tomography (n=48), or 2) diverticulum was observed in the barium enema (n=118) or colonoscopy (n=17) after the treatment of suspected diverticulitis, or 3) diverticulitis was pathologically confirmed after the operation (n=11). Patients with appendicitis after the pathologic confirmation were excluded, even though they fell under the 1) or 2). SD was defined as at least one of the followings: perforation (either localized or free perforation), abscess, fistula, obstruction, sepsis, and peritonitis requiring urgent operation.

3. Measurement of obesity by computed tomography (CT) scan

The patients were scanned with either 4-detector CT scanner (Somatom Volume Zoom; Siemens Medical Solutions, Forchheim, Germany) or 64-detector CT scanner (Aquilion; Toshiba, Tochigi, Japan). A single 5 mm thick slice through the umbilicus level was obtained by 120 kVp and automatic tube current dose modulation system during 0.5 seconds scan time. Abdominal

Table 1. Patient Characteristics

Characteristic	No. of patients (n=190)
Age, yr	39.9±13.4
Male	101 (53.2)
Obesity	
BMI, kg/m^2	23.2±3.4
CT measurement, cm^2*	
VAT	108.7±55.9
SAT	151.7±63.2
TAT	260.4±97.0
Waist circumference, cm*	81.5±8.8
Smoking	78 (41.4)
Location	
Right-sided diverticulitis	175 (92.1)
Left-sided diverticulitis	15 (7.9)
Range of diverticula	
Right	146 (76.9)
Left	9 (4.7)
Both (right and left)	35 (18.4)
No. of diverticula	
Single	64 (33.7)
Multiple	126 (66.3)
Comorbidity	32 (16.8)
Recurrence	9 (4.7)
Complication	24 (12.6)
Perforation	16 (66.7)†
Abscess	10 (41.7)†
Fistula	2 (8.3)†
Obstruction	0 (0.0)†
Sepsis	1 (4.2)†
Peritonitis requiring emergent operation	1 (4.2)†
Operation	11 (5.8)†

Data are presented as mean±SD or number (%).
BMI, body mass index; CT, computed tomography; VAT, visceral adipose tissue; SAT, subcutaneous adipose tissue; TAT, total abdominal adipose tissue.
*Available number of patients, 172; †Number of cases with complications [(number of cases/number of patients with complications) ×100], overlapping cases were available.

adipose tissue was calculated at this slice using the off-line workstation (Aquarius software, version 3.6.3.0; TeraRecon Inc., Foster City, CA, USA). It determined the adipose tissue area electronically by setting the attenuation values for the region of interest within a range of -190 and -30 Hounsfield units. Visceral adipose tissue (VAT), subcutaneous adipose tissue (SAT), and total abdominal adipose tissue (TAT) were determined separately with the use of a trace function, which manually defined the boundary between the visceral and subcutaneous fat with a cursor.

4. Statistical analysis

Analysis was performed using the SAS for Windows software version 9.1 (SAS Institute Inc., Cary, NC, USA). For univariate analysis for identification of patients characteristics according to the severity, statistical significance was taken as p-values <0.05 by chi-square for the categorical variables and a t-test for the continuous ones. In addition, patients characteristics which were previously investigated as potential risk factors of SD in the literature were selected from the variables belonged to univariate analysis to identify risk factors of SD by multivariate analysis. Some variables considered as signs of SD, rather than risk factors, such as fever and bowel habit change were excluded for the multivariate analysis, even though they were significant factors in the univariate analysis. For multivariate analysis, binary logistic regression method was used.

RESULTS

1. Characteristics of study population

There were a total of 190 patients (101 males, 89 females). The mean±standard deviation age of population was 39.9±13.4 years. The parameters related to obesity were within normal range, as follows: mean BMI (23.2±3.4 kg/m^2), mean VAT (108.7±55.9 cm^2), mean TAT (260.4±97.0 cm^2) and mean WC (81.5±8.8 cm). Isolated right-sided diverticula (76.9%) were observed most frequently, and subsequently right-sided diverticulitis (92.1%) occurred most frequently. However, even in patients with diverticula on both sides of the colon (n=35, 18.4%), right-sided diverticulitis (n=29, 82.9%) was more common. Nine

Table 2. Patients Characteristics according to the Severity

Characteristic	No. of patients with SD (n=24, 12.6%)	No. of patients with NSD (n=166, 87.4%)	p-value
Age, yr	49.1±14.9	38.5±12.7	<0.001
Male	17 (70.8)	84 (50.6)	NS
Obesity			
BMI, kg/m^2	23.3±3.5	23.1±3.4	NS
Waist circumference, cm*	82.8±9.9	81.3±8.6	NS
CT measurement*			
VAT, cm^2	138.0±76.7	104.5±51.1	NS
SAT, cm^2	130.1±45.2	154.8±65.0	NS
TAT, cm^2	268.1±112.5	259.3±94.8	NS
VAT/TAT, %	48.8±12.6	40.0±12.6	0.002
Smoking	9 (37.5)	69 (41.6)	NS
Fever (>38.3°C)	7 (29.2)	17 (10.2)	0.017
Leukocytosis (WBC >10,000/mm^3)	21 (87.5)	121 (72.9)	NS
Location of diverticulitis (Rt./Lt.)	18/6 (75.0/25.0)	157/9 (94.6/5.4)	0.005
Range of diverticula (pan-colon)	2 (8.3)	33 (19.9)	NS
No. of diverticula (single/multiple)	8/16 (33.3/66.7)	56/110 (33.7/66.3)	NS
Comorbidity	7 (29.2)	25 (15.1)	NS
Chronic constipation	1 (4.2)	6 (3.6)	NS
Bowel habit change	7 (29.2)	19 (11.4)	0.027
Nausea/Vomiting	4 (16.7)	18 (10.8)	NS
Tenderness/Rebound tenderness	23/15 (95.8/62.5)	166/104 (100.0/62.7)	NS/NS
Recurrence	2 (8.3)	7 (4.2)	NS

Data are presented as mean±SD or number (%).
SD, severe diverticulitis; NSD, non-severe diverticulitis; NS, not significant; BMI, body mass index; CT, computed tomography; VAT, visceral adipose tissue; SAT, subcutaneous adipose tissue; TAT, total abdominal adipose tissue, WBC, white blood cell.
*Available number of patients, 172 (severe, 22; non-severe, 150).

patients (4.7%) suffered from recurrent diverticulitis. Twenty-four patients (12.6%) were diagnosed as SD, and perforation (n=16, 66.7%) was the most common complication. Eleven patients (5.8%) underwent surgery because of complications. The baseline characteristics of the study population are summarized in Table 1.

2. Patients' characteristics according to the severity of diverticulitis

The characteristics of subjects between SD and non-severe diverticulitis (NSD) are compared in Table 2. Of 190 subjects, there were 24 (12.6%) patients with SD and 166 (87.4%) patients with NSD. Compared to those with NSD, patients with SD had significant relationships with older age (49.1±14.9 vs 38.5±12.7, p<0.005), fever over 38.3°C (n=7 [29.2%] vs n=17 [10.2%], p=0.017) and bowel habit change (n=7 [29.2%] vs n=19 [11.4%], p=0.027). Of anthropometric measurements of obesity, we found that only VAT/TAT was significantly higher in the SD group (48.8±12.6 vs 40.0±12.6, p=0.002), whereas BMI and WC did not significantly differ between the two investigated groups. Moreover, there was no significant difference in other factors, such as sex, smoking, leukocytosis, range and number of diverticula, comorbidity, chronic constipation, nausea, vomiting, tenderness, rebound tenderness, and recurrence between SD and NSD groups.

3. The risk factors for severe diverticulitis

The results of multivariate analysis are presented in Table 3. The statistical significance was shown in age over 40 years (odds ratio [OR], 3.2; 95% confidence interval [CI], 1.104 to 9.237; p=0.032), male (OR, 4.0; 95% CI, 1.237 to 13.183; p=0.021), and left-sided diverticulitis (OR, 6.2; 95% CI, 1.382 to 28.086; p=0.017). However, obesity-associated factors like BMI, WC, and fat measurements by CT scan were not significantly related to the severity. Moreover, despite the significant relationship with the location of diverticulitis and severity, the range and number of diverticula were not associated with the severity of acute diverticulitis.

4. Patients' characteristics according to the location of diverticulitis

Table 4 shows patients' characteristics according to the location of diverticulitis, comparing right and left-sided diverticulitis. There were 175 (92.1%) patients with right-sided diverticulitis and 15 (7.9%) patients with left-sided diverticulitis. Right-sided diverticulitis had significant relationships with younger age (38.2±11.8 vs 59.0±16.9), lower VAT/TAT (40.3±12.8 vs 50.8±9.0), shorter WC (81.0±8.6 vs 88.6±8.4), lesser comorbidity, lesser bowel habit change and NSD. However, obesity parameters were not statistically significant when adjusted by age. Eventually, surgical interventions were required less frequently in the right-sided diverticulitis and the patients stayed shorter in the hospital.

DISCUSSION

The purpose of this study was to investigate the prognostic factors of acute diverticulitis in Korea and to identify difference

Table 3. The Risk Factors for Severe Diverticulitis

Characteristic	Frequency of patients with SD within each subgroup	Adjusted analysis		
		OR	95% CI	p-value
Age >40, yr	18/85 (21.2)	3.194	1.104-9.237	0.032
Male	17/101 (16.8)	4.039	1.237-13.183	0.021
Obesity				
BMI >30, kg/m^2	2/8 (25.0)	1.850	0.223-14.703	NS
Waist circumference, cm*	82.8±9.9	0.964	0.897-1.306	NS
VAT/TAT, %*	48.8±12.6	1.040	0.978-1.106	NS
Smoking	9/78 (11.5)	0.603	0.204-1.783	NS
Left-sided diverticulitis	6/15 (40.0)	6.230	1.382-28.086	0.017
Range of diverticula (pan-colon)	2/35 (5.7)	0.227	0.040-1.282	NS
No. of diverticula (multiple)	16/126 (12.7)	0.805	0.283-2.286	NS
Comorbidity	7/32 (21.9)	1.521	0.447-5.179	NS
Chronic constipation	1/7 (14.3)	0.677	0.068-6.747	NS
Recurrence	2/9 (22.2)	2.340	0.395-13.848	NS

Data are presented as mean±SD or number (%).
SD, severe diverticulitis; OR, odds ratio; CI, confidence interval; BMI, body mass index; NS, not significant; VAT, visceral adipose tissue; TAT, total abdominal adipose tissue.
*Available number of patients, 172 (severe, 22; non-severe, 150).

Table 4. Patients Characteristics according to the Location of Diverticulitis

Characteristic	Right-sided diverticulitis (n=175, 92.1%)	Left-sided diverticulitis (n=15, 7.9%)	p-value
Age, yr	38.2±11.8	59.0±16.9	<0.001
Male	93 (53.1)	8 (53.3)	NS
Obesity			
BMI, kg/m^2	23.0±3.4	24.7±3.2	NS
Waist circumference, cm*	81.0±8.6	88.6±8.4	0.002†
CT measurement*			
VAT, cm^2	103.1±50.7	177.8±71.3	<0.001†
SAT, cm^2	150.7±64.7	163.2±41.2	NS
TAT, cm^2	253.8±94.1	341.1±99.2	0.002†
VAT/TAT, %	40.3±12.8	50.8±9.0	0.004†
Smoking	73 (41.7)	5 (33.3)	NS
Fever (>38.3°C)	21 (12.0)	3 (20.0)	NS
Leukocytosis (WBC >10,000/mm^3)	132 (75.4)	10 (66.7)	NS
No. of diverticula (single/multiple)	59 (33.7)	5 (33.3)	NS
Comorbidity	25 (14.3)	7 (46.7)	0.005
Chronic constipation	6 (3.4)	1 (6.7)	NS
Bowel habit change	21 (12.0)	5 (33.3)	0.037
Nausea/Vomiting	20 (11.4)	2 (13.3)	NS
Tenderness/Rebound tenderness	175/110 (100.0/62.9)	14/9 (93.3/60.0)	NS/NS
Recurrence	9 (5.1)	0 (0.0)	NS
Severe diverticulitis	18 (10.3)	6 (40.0)	0.005
Requiring operation	6 (3.4)	5 (33.3)	0.001
Hospital days	7.5±4.1	16.2±22.8	0.044

Data are presented as mean±SD or number (%).
NS, not significant; BMI, body mass index; CT, computed tomography; VAT, visceral adipose tissue; SAT, subcutaneous adipose tissue; TAT, total abdominal adipose tissue; WBC, white blood cell.
*Available number of patients, 172 (right-sided diverticulitis, 159; left-sided diverticulitis, 13); †Variables were not statistically significant when adjusted by age.

from those of acute diverticulitis in Western countries. In addition, we also tried to suggest the possible reasons by the comparison of clinical characteristics according to the predominant location of diverticulitis between the two ethnic groups. The result of our study demonstrated that the risk factors of SD in Korea, which are older age, male and left-sided location, are different to those of Western diverticulitis.

Complicated diverticulitis generally refers to diverticulitis associated with perforation, abscess, stricture, or obstruction. In this study, SD was defined as not only complicated diverticulitis on CT or pathologic report, but also clinical manifestation, such as sepsis or peritonitis requiring emergency operation. Although there have been controversies, the reported risk factors of SD are different between Western and Asian societies. In Western countries, younger age, gender, obesity, smoking, recurrence, and comorbidity have been reported as risk factors of SD. However, it is not clear whether the relationship of these factors to the complicated diverticulitis in Asian countries is equal when compared to that of Western countries. From this point, this study provides informative clue about this question despite relatively small number of patients. Although, in the many studies from Korea, age, sex, and location of diverticulitis have been evaluated,[7-10,12,14,15] there is few study performing extensive investigation of variable risk factor of SD. We directly compared the clinical factors between non-SD and SD handling risk factors not only that are already suggested in Korea but also that are unknown or potential including obesity, smoking, range and number of diverticula, comorbidity, bowel habit change, and recurrence.

It was suggested that, in Western countries, most diverticula are located in the sigmoid colon. The lack of dietary fiber and consequent increase in intraluminal pressure of the colon are believed to be important etiological factors, which seem to be determined by mixed factors, such as lifestyle, constipation and irritable bowel syndrome.[16] They are acquired over time with increasing age and multiple and false diverticula in which herniation involve only the mucosal and submucosal layer. On the contrary, in Asian countries, most diverticula are located on the right colon around the cecum, and they seem to be congenital, isolated and true diverticula.[17] In agreement with this study, left-sided location of diverticulitis has been consistently reported as a significant risk factor of SD,[7-10] and poor outcome even in patients who underwent surgery in Asia.[11,12,18] In addition to the prognostic aspect, different characteristics with respect to age, premorbid condition, rate of perforation and obesity were reported according to the location of diverticulitis in Asia.[7-11,15,18] Although the reason why left-sided location is virulent factor is not clear, it could be plausible that advanced age, concomittent medical conditions and higher rate of perforation leading to generalized peritonitis, which may be due to false diverticula without any muscle layer might adversely affect the clinical course of left-sided diverticulitis.[11] In this study, right-sided diverticulitis was predominant (92.1% of total patients), similar to results from other Asian studies, even in patients with both-sided diverticula. This finding suggests that the development of right or left-sided diverticulitis might mainly result from the genetic difference. On the other hand, in Western country where left-sided diverticulitis is predominant, there are some reports that right-sided diverticulitis is associated with higher rate of complication.[19,20] Moreover, in contrast to recommendations for left-sided diverticulitis with respect to age and frequency of attack, conservative medical therapy of uncomplicated diverticulitis is effective due to the benign and self-limited natural

history of right-sided diverticulitis.[13,14,21] The difference in the predominant location of diverticulitis (with its accompanying characteristics and natural course) between the Asian and Western countries supports the hypothesis that a unique spectrum of disease, with its own pathogenesis, may be present within specific ethnic groups. Therefore, a different treatment guideline for Asian diverticulitis, where the right-sided location is predominant, seems to be required. Considering the less aggressive course of the right-sided diverticulitis, following the treatment guideline of Western studies might lead to the overtreatment of acute diverticulitis in Asia. Medical treatment seems enough to manage the acute diverticulitis in Asia, but special consideration may be required for patients with older age and left-sided diverticulitis.

Although this view is still under considerable debate in Western countries,[22] historically, younger patients were supposed to show a more aggressive and fulminant course of the disease[23] and the treatment guideline reflected this idea by recommending more aggressive treatment in those cases.[6] Meanwhile, in Korea, although several studies showed that age factor is not a significant risk factor of SD requiring surgical therapy,[7,8,14] some studies including this study suggested older age is an independent risk factor of complicated diverticulitis regardless of location of diverticulitis and comorbidity.[9] Further large scaled studies would be needed to confirm this finding.

Although, historically, younger patients with complicated diverticulitis tend to be male, gender as a predictive factor is controversial. Most studies presented no preponderance of certain gender, but some Western studies reported females were significantly associated with complicated diverticular disease and poor prognosis.[24] Meanwhile, in Asian population, the multivariate analysis of our study showed that males were likely to have SD. Although no case control study in Asian population reported male as a statistically significant risk factor of SD, male predominance was reported in several studies of patients who underwent surgery.[11,12,15,25] These findings suggest that relatively small number of patients who are included in SD group might lead to be a statistical insignificance of sex distribution as a virulent factor in Asia where right-sided diverticulitis is predominant. Further large scaled study including large number of patients who have left-sided diverticulitis would be needed for the clarification of this question.

Obesity is a growing health concern worldwide. Although the mechanism by which obesity contributes to the development of acute diverticulitis is not completely understood, several studies from Western society using anthropometric measurements of obesity, such as BMI and WC, have suggested that obesity may have a relationship not only with the development of acute diverticulitis, but also with the higher rate of complications and recurrence.[26-28] However, it is still controversial whether obesity increases severity.[29] To the best of our knowledge, just one report which include relatively small number of patients using only single obesity parameter, BMI, has been published regarding the relationship between obesity and the severity of the diverticular disease in Asians.[7] In addition, direct measurement of abdominal adipose tissue using CT scan has never been used to evaluate the relationship between obesity and SD in the literature until now. In this study, not only BMI and WC, but also fat measurement by CT scan (which is the gold standard for the measurement of visceral obesity) was used to evaluate the degree and subtype of obesity. Although, as a result, the proportion of visceral adipose tissue was significantly associated with SD in the univariate analysis, various measurements of obesity including BMI, WC, VAT, and VAT/TAT were not significantly associated with SD in the adjusted analysis in accordance with previous Korean study.[7] This finding might suggest the possibility of difference in the pathogenesis of diverticulitis between two ethnic groups and additional studies focusing on the significance of obesity as a virulent factor of diverticulitis in Korea where obesity prevalence is relatively low compared to Western population would be needed.

In the literature, the reported recurrence rate of right-sided diverticulitis was 12.6% to 60% after medical treatment,[13,21,30-32] and that of left-sided diverticulitis was 7% to 45%.[6] However, because of the small number of patients with recurrent diverticulitis in this study (n=9, 4.7%), it might not be reasonable to evaluate the relationship between recurrence and SD here. There also have been reports about smoking as a risk factor of complicated diverticulitis of the sigmoid colon.[33] However, we could not find any statistically significant difference between complicated and uncomplicated groups in this study. Although there is strong evidence that a reduced intake of insoluble dietary fiber is associated with an increased risk of diverticulitis,[34] chronic constipation resulting from reduced dietary fiber was not associated with complicated diverticulitis in this study. Comorbidity, measured by the Charlson score, was suggested as a major determinant of severity in acute diverticulitis.[35] Some also reported certain comorbid conditions, such as hypoalbuminemia, chronic obstructive pulmonary disease and glucocorticoid use, might predispose patients to recurrent or complicated attacks of diverticulitis requiring colectomy.[36] However, we could not find the significance of comorbidity as a determinant of severity, but it is possibly because most patients in this study had less severe comorbid conditions, like uncomplicated diabetes and/or hypertension, according to the Charlson scores.

The weakness of the present study was that patients included were only inpatients, and outpatients with mild diverticulitis were not included, so it was limited in representing the clinical characteristics of the whole cohort of patients diagnosed with diverticulitis. Moreover, there is a possibility that some patients might have not been followed up, and therefore some cases of recurrent diverticulitis might have been missed. In addition, because this study was a single center study, it might be also limited to evaluate and represent the clinical characteristics and

risk factors of SD in Korea as a whole, even taking into account the comparable incidence of SD published in the other report.

In conclusion, the risk factors of SD in Korea are different from those of Western countries. Our study suggests that the risk factors of SD in Korea are age over 40 years, male and left-sided diverticulitis. We can assume that it resulted from the different etiology and clinical spectrum according to the predominant location of diverticulitis. Therefore, different strategy for the treatment of diverticulitis seems to be needed in Korea.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

ACKNOWLEDGEMENTS

This work was supported by Grant from Inje University, 2006.

REFERENCES

1. Hughes LE. Postmortem survey of diverticular disease of the colon. I. Diverticulosis and diverticulitis. Gut 1969;10:336-344.
2. Hildebrand P, Kropp M, Stellmacher F, Roblick UJ, Bruch HP, Schwandner O. Surgery for right-sided colonic diverticulitis: results of a 10-year-observation period. Langenbecks Arch Surg 2007;392:143-147.
3. Sugihara K, Muto T, Morioka Y, Asano A, Yamamoto T. Diverticular disease of the colon in Japan: a review of 615 cases. Dis Colon Rectum 1984;27:531-537.
4. Morris CR, Harvey IM, Stebbings WS, Speakman CT, Kennedy HJ, Hart AR. Epidemiology of perforated colonic diverticular disease. Postgrad Med J 2002;78:654-658.
5. Stollman NH, Raskin JB. Diagnosis and management of diverticular disease of the colon in adults: Ad Hoc Practice Parameters Committee of the American College of Gastroenterology. Am J Gastroenterol 1999;94:3110-3121.
6. Wong WD, Wexner SD, Lowry A, et al. Practice parameters for the treatment of sigmoid diverticulitis: supporting documentation. The Standards Task Force. The American Society of Colon and Rectal Surgeons. Dis Colon Rectum 2000;43:290-297.
7. Kim JH, Cheon JH, Park S, et al. Relationship between disease location and age, obesity, and complications in Korean patients with acute diverticulitis: a comparison of clinical patterns with those of Western populations. Hepatogastroenterology 2008;55:983-986.
8. Kim SH, Byun CG, Cha JW, Choi SH, Kho YT, Seo DY. Comparative study of the clinical features and treatment for right and left colonic diverticulitis. J Korean Soc Coloproctol 2010;26:407-412.
9. Choi KS, Byeon JS, Yoon SM, et al. Diverticulitis: focused on clinical course and relapse. Intest Res 2008;6:37-44.
10. Lee HC, Jeon SW, Kim SY, et al. Clinical characteristics of right versus left colonic diverticulitis. Korean J Med 2008;75:533-538.
11. Law WL, Lo CY, Chu KW. Emergency surgery for colonic diverticulitis: differences between right-sided and left-sided lesions. Int J Colorectal Dis 2001;16:280-284.
12. Kim KY, Kim IK, Jung SW, Park KH, Park YJ. Analysis on the surgical treatment of colonic diverticulitis. J Korean Surg Soc 2007;73:36-41.
13. Komuta K, Yamanaka S, Okada K, et al. Toward therapeutic guidelines for patients with acute right colonic diverticulitis. Am J Surg 2004;187:233-237.
14. Kim MR, Kye BH, Kim HJ, Cho HM, Oh ST, Kim JG. Treatment of right colonic diverticulitis: the role of nonoperative treatment. J Korean Soc Coloproctol 2010;26:402-406.
15. Kim HU, Kim YH, Choe WH, et al. Clinical characteristics of colonic diverticulitis in Koreans. Korean J Gastroenterol 2003;42:363-368.
16. Commane DM, Arasaradnam RP, Mills S, Mathers JC, Bradburn M. Diet, ageing and genetic factors in the pathogenesis of diverticular disease. World J Gastroenterol 2009;15:2479-2488.
17. Wagner DE, Zollinger RW. Diverticulitis of the cecum and ascending colon. Arch Surg 1961;83:436-443.
18. Chung HD, Park KJ, Heo SC, Kang SB. Surgical treatment for diverticular disease of the colon. J Korean Soc Coloproctol 2001;17:243-250.
19. Anderson L. Acute diverticulitis of the cecum: study of 99 surgical cases. Surgery 1947;22:479-488.
20. Reisman Y, Ziv Y, Kravrovitc D, Negri M, Wolloch Y, Halevy A. Diverticulitis: the effect of age and location on the course of disease. Int J Colorectal Dis 1999;14:250-254.
21. Yang HR, Huang HH, Wang YC, et al. Management of right colon diverticulitis: a 10-year experience. World J Surg 2006;30:1929-1934.
22. Hall J, Hammerich K, Roberts P. New paradigms in the management of diverticular disease. Curr Probl Surg 2010;47:680-735.
23. Pautrat K, Bretagnol F, Huten N, de Calan L. Acute diverticulitis in very young patients: a frequent surgical management. Dis Colon Rectum 2007;50:472-477.
24. McConnell EJ, Tessier DJ, Wolff BG. Population-based incidence of complicated diverticular disease of the sigmoid colon based on gender and age. Dis Colon Rectum 2003;46:1110-1114.
25. Lo CY, Chu KW. Acute diverticulitis of the right colon. Am J Surg 1996;171:244-246.
26. Strate LL, Liu YL, Aldoori WH, Syngal S, Giovannucci EL. Obesity increases the risks of diverticulitis and diverticular bleeding. Gastroenterology 2009;136:115-122.
27. Dobbins C, Defontgalland D, Duthie G, Wattchow DA. The relationship of obesity to the complications of diverticular disease. Colorectal Dis 2006;8:37-40.
28. Zaidi E, Daly B. CT and clinical features of acute diverticulitis in an urban U.S. population: rising frequency in young, obese adults. AJR Am J Roentgenol 2006;187:689-694.
29. Sorser SA, Hazan TB, Piper M, Maas LC. Obesity and complicated diverticular disease: is there an association? South Med J

2009;102:350-353.
30. Fang JF, Chen RJ, Lin BC, Hsu YB, Kao JL, Chen MF. Aggressive resection is indicated for cecal diverticulitis. Am J Surg 2003;185:135-140.
31. Oudenhoven LF, Koumans RK, Puylaert JB. Right colonic diverticulitis: US and CT findings--new insights about frequency and natural history. Radiology 1998;208:611-618.
32. Harada RN, Whelan TJ Jr. Surgical management of cecal diverticulitis. Am J Surg 1993;166:666-669.
33. Turunen P, Wikstrom H, Carpelan-Holmstrom M, Kairaluoma P, Kruuna O, Scheinin T. Smoking increases the incidence of complicated diverticular disease of the sigmoid colon. Scand J Surg 2010;99:14-17.
34. Korzenik JR; NDSG. Diverticulitis: new frontiers for an old country: risk factors and pathogenesis. J Clin Gastroenterol 2008;42:1128-1129.
35. Lorimer JW, Doumit G. Comorbidity is a major determinant of severity in acute diverticulitis. Am J Surg 2007;193:681-685.
36. Yoo PS, Garg R, Salamone LF, Floch MH, Rosenthal R, Longo WE. Medical comorbidities predict the need for colectomy for complicated and recurrent diverticulitis. Am J Surg 2008;196:710-714.