

Clinical Characteristics of Colonic Diverticulosis in Korea: A Prospective Study

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Background/Aims: The prevalence of colonic diverticulosis has been reported to be lower in Korea than in Western countries. This disease also shows markedly different characteristics in the Korean population. We describe herein a prospective investigation, based on colonoscopic examination, of the prevalence, clinical characteristics, and factors associated with colonic diverticulosis in Korea.

Methods: We prospectively analyzed data from 848 patients who underwent colonoscopy between July and October 2008 in Seoul Paik hospital. Clinical features such as the presence of diverticula and their location and number were assessed. Information on the subjects' symptoms, body mass index, diet, underlying disease, and alcohol and smoking habits was obtained through completion of a questionnaire.

Results: The overall prevalence of colonic diverticulosis was 12.1% (103 / 848). The right side of the colon was involved in 84.5% of patients (87 / 103); patients with right side diverticula were, on average, younger than those with left side diverticulosis ($p = 0.014$). Multiple diverticula were observed in 60.2% (62 / 103) of patients. Age greater than 60 years, a high-fat diet, and alcohol consumption were significantly associated with the presence of colonic diverticulosis ($p < 0.05$).

Conclusions: The prevalence of colonic diverticulosis in Korea is increasing and is most commonly located in the right side of the colon. Further, old age and diet may affect the risk of development of this disease. (**Korean J Intern Med 2010;25:140-146**)

Keywords: Diverticulum, colon; Korea; Colonoscopy; Prospective studies

INTRODUCTION

A diverticulum is a herniation through a weak site of the bowel wall that produces a small outpouching [1]. The majority of patients with diverticula are asymptomatic, but circa 20% evidence of clinical manifestations, most commonly diverticulitis or diverticular bleeding [2]. Colonic diverticulosis shows both geographic and ethnic variability. It is rare in Africa and Asia, but common in the USA, Europe, and Australia [2-8]. In Western countries, colonic diverticula occur mainly in the sigmoid colon [2-6], whereas in Asian patients, the right side of the colon is more commonly involved [2,5]. These geographic and ethnic variabilities are generally attributed to dietary and

genetic factors. The prevalence of colonic diverticulosis in Korea was around 5% in the early 1980s [9, 10]. However, this is increasing and exceeded 10% in the 1990s (Table 1) [9-16]. The increasing reported prevalence of colonic diverticulosis in Korea may result from an increasingly Westernized diet, an aging society, development of improved diagnostic tools, and/or greater colon cancer screening. Although many reports relating to colonic diverticulosis in Korea have been published, all are retrospective investigations and have limitations in terms of their interpretation of clinical features. Therefore, we investigated the prevalence and clinical characteristics of and factors associated with colonic diverticulosis in Korea prospectively.

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Table 1. Clinical characteristics of colonic diverticulosis in Korea

Author	Period, yr	Gender ratio ^a of study population	Prevalence, %			Location, %			Method
			Total	Male	Female	Right	Left	Both	
Kim et al. [11]	1971 - 1986	-	0.59	-	-	81.0	15.0	4.0	BE
Kim et al. [9]	1982 - 1984	1.17	5.5	7.3	3.4	84.6	6.6	8.8	BE
Kim et al. [10]	1983 - 1984	0.76	4.8	5.1	4.7	84.0	6.8	9.2	BE
Kwoen et al. [12]	1983 - 1987	0.86	6.0	7.2	5.0	81.2	3.6	15.2	BE
Lee et al. [13]	1984 - 1989	0.93	6.8	8.3	5.3	88.7	4.7	6.6	BE
Son et al. [14]	1987 - 1989	0.98	8.5	11.1	5.9	79.0	2.6	18.4	BE
Ko et al. [15]	1993 - 1995	2.94	11.8	13.3	7.3	62.4	12.0	25.6	BE
Choi et al. [16]	2002 - 2005	-	10.1	-	-	79.0	14.0	7.0	CFS

BE, barium enema; CFS, colonoscopy.

^aMale / Female.

Table 2. Scores on diet questionnaire (mini dietary assessment index)

Questions	Frequently	Sometimes	Rarely
Fiber			
Eat vegetables and Kimchi every meal	5	3	1
Eat one serving size of fruit or fruit juice everyday	5	3	1
Fat			
Eat more than one serving size of fried or stir-fried food every two days	1	3	5
Eat more than one serving size of fatty meat every three days	1	3	5

METHODS

Study population

We prospectively collected and analyzed data from 848 individuals who underwent colonoscopy at Seoul Paik Hospital between July and October 2008. The institutional ethics committee approved the study protocol. If an individual underwent two or more colonoscopies during the study period, all examinations were considered together as one examination. We excluded those who were not Korean citizens or had poor bowel preparation, a previous colectomy, or failure of cecal intubation.

Colonoscopic examination

All endoscopic procedures were performed by a gastroenterologist working at Seoul Paik Hospital. The bowel was prepared using either polyethylene glycol or sodium phosphate solution. Conscious sedation was administered using intravenous midazolam and intramuscular pethidine. Standard colonoscopes (CF-Q240L or CF-Q260AL, Olympus Medical Systems, Tokyo, Japan) were used for the examinations. If diverticula were observed

within the colon of a patient, their location and number were recorded carefully. For the purposes of this study, we defined the right side of the colon as the cecum and the ascending and transverse colon, and the left side as the descending and sigmoid colon.

Collection of patient lifestyle data

We obtained information regarding the subjects' symptoms, body mass index (BMI), diet (fiber and fat intake), any underlying conditions (diabetes mellitus [DM] and hypertension), and alcohol and smoking habits by means of a questionnaire. In total, 762 subjects completed the questionnaire. The mini dietary assessment (MDA) index was used to assess diet (Table 2) [17]. Of the four questions in the MDA index, two related to fiber intake and two to fat intake. If the sum of the two scores regarding fiber was high, we considered the respondent's fiber intake to be high. If the sum of the two scores relating to fat intake was high, we considered the respondent's fat intake to be low.

Table 3. Comparison of characteristics in patients with or without colonic diverticulosis

Factors	Diverticulum		p value
	Absent	Present	
Age, yr			0.021
< 40	155 (93.4)	11 (6.6)	
40 - 49	211 (87.2)	31 (12.8)	
50 - 59	184 (87.6)	26 (12.4)	
≥ 60	195 (84.8)	35 (15.2)	
Sex			0.001
Female	306 (92.7)	24 (7.3)	
Male	439 (84.7)	79 (15.3)	
BMI, kg/m ²	23.4 ± 3.2	24.6 ± 2.8	0.002
Fiber, MDA score	7.1 ± 2.2	7.0 ± 2.0	0.803
Fat, MDA score	7.3 ± 2.2	6.5 ± 2.3	0.005
Hypertension			0.003
Absent	424 (88.7)	54 (11.3)	
Present	95 (78.5)	26 (21.5)	
Diabetes mellitus			0.246
Absent	474 (87.5)	68 (12.5)	
Present	40 (81.6)	9 (13.4)	
Alcohol			< 0.001
Nondrinker	212 (93.0)	16 (7.0)	
Drinker	313 (82.8)	65 (17.2)	
Smoking			0.024
Nonsmoker	384 (88.7)	49 (11.3)	
Smoker	139 (81.8)	31 (18.2)	

Values are presented as mean ± SD or number (%).

BMI, body mass index; MDA, mini dietary assessment.

Statistical analysis

Statistical analysis was performed using SPSS version 10.0 (SPSS Inc., Chicago, IL, USA). The chi-square test was used to assess any association of colonic diverticulosis with gender, alcohol, smoking, DM, and hypertension. The relationship between colonic diverticulosis and BMI or diet was assessed using the t test. Variables found to be associated with colonic diverticulosis in the univariate analysis were reassessed using logistic regression analysis. A *p* value of less than 0.05 was considered statistically significant.

RESULTS

Clinical characteristics and prevalence of colonic diverticulosis

The mean age of the 848 subjects (518 men and 330 women) was 50.9 ± 12.3 years. The prevalence of colonic

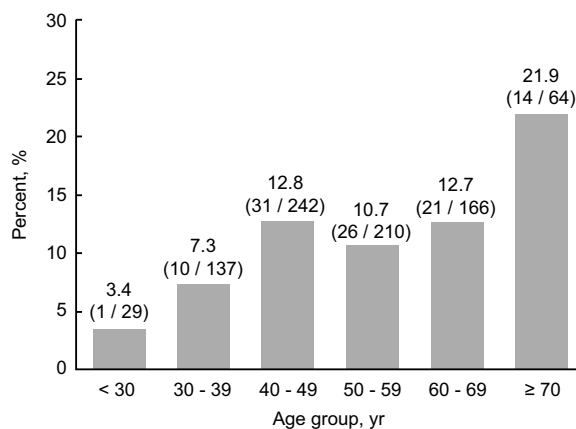


Figure 1. Prevalence of colonic diverticulosis by age group. The prevalence of colonic diverticulosis increased with age (*p* = 0.007). Figures in parentheses indicate the number of patients with diverticula and the total number of subjects in each group.

Table 4. Multivariate analysis of the factors associated with colonic diverticulosis

Factors	OR (95% CI)	p value
Age, yr		
< 40	1	
40 - 49	1.996 (0.907 - 4.394)	0.086
50 - 59	2.310 (0.972 - 5.490)	0.058
≥ 60	2.563 (1.030 - 6.375)	0.043
Sex		
Female	1	
Male	1.212 (0.608 - 2.417)	0.585
BMI, kg/m ²		
< 22	1	
22 - 25	1.209 (0.604 - 2.420)	0.593
≥ 25	1.571 (0.773 - 3.194)	0.212
Fat, MDA score		
≥ 7	1	
≤ 6	1.763 (1.044 - 2.977)	0.034
Hypertension		
Absent	1	
Present	1.603 (0.881 - 2.916)	0.123
Alcohol		
Nondrinker	1	
Drinker	2.195 (1.091 - 4.416)	0.027
Smoking		
Nonsmoker	1	
Smoker	1.324 (0.761 - 2.301)	0.320

OR, odds ratio; CI, confidence interval; BMI, body mass index; MDA, mini dietary assessment.

diverticulosis in this group was 12.1% (103 cases total, 79 men and 24 women, mean age 54.1 ± 12.4 years). Colonic diverticulosis prevalence increased with age (Fig. 1). About 60% of patients with colonic diverticulosis were asymptomatic. Those with symptoms (40%) complained of abdominal pain and discomfort (11.1%), diarrhea (6.2%), constipation (4.9%), and weight loss (1.2%).

Diverticula were located in the right side of the colon in 84.5% of patients (87 / 103), the left side in 8.7% (9 / 103), and both sides in 6.8% (7 / 103). Patients whose diverticula were located on the left side of the colon were significantly older than those with diverticula on the right (63.1 ± 11.2 vs. 52.6 ± 12.0 years, $p = 0.014$). Among those subjects in whom diverticula were detected, a single diverticulum was observed in 39.8% (41 / 103), and multiple diverticula in 60.2% (62 / 103). No significant difference was found in the mean age of subjects with single and those with multiple diverticula (54.4 ± 12.9 vs. 53.9 ± 12.2 years, respectively; $p = 0.836$).

Complications of colonic diverticulosis

Of the 103 patients with diverticula, one (female, 27 years) was diagnosed by abdomino-pelvic CT scan with diverticulitis. Symptoms reported were abdominal pain and fever. These symptoms improved after antibiotic therapy, and she underwent colonoscopic examination. She had no underlying disease, and her MDA score for fiber intake was 10, meaning that her diet contained sufficient fiber. The diverticulum in this patient was located in the ascending colon. Diverticular bleeding was not detected in any subject during the study period.

Factors associated with colonic diverticulosis

The mean fiber MDA score was not significantly different between those with and those without diverticula (7.0 ± 2.0 vs. 7.1 ± 2.2 , respectively; $p = 0.803$). In contrast, the mean fat MDA score was significantly lower in patients with diverticula than in those without (6.5 ± 2.3 vs. 7.3 ± 2.2 , respectively; $p = 0.005$). Patients with diverticula had, on average, a higher BMI than those

without (24.6 ± 2.8 vs. 23.4 ± 3.2 , $p = 0.002$). No correlation between colonic diverticulosis and DM was observed ($p = 0.246$). However, positive associations between colonic diverticulosis and hypertension, alcohol consumption, and smoking were detected by univariate analysis (Table 3). Of the factors related to colonic diverticulosis detected by the univariate analysis, only age over 60 years, a high-fat diet, and alcohol consumption were found to be associated with colonic diverticulosis by multivariate analysis (Table 4).

DISCUSSION

The prevalence of colonic diverticulosis is lower in Korea than in Western countries. However, many studies have reported that the incidence of colonic diverticulosis in Korea is increasing [9-16]. The incidence of other colonic diseases such as colon cancer and inflammatory bowel disease is also increasing in Korea [18,19]. Indeed, colon cancer is now the second most common type of cancer in Korea [20]. This trend is associated with an increasingly Westernized diet; this may also be responsible for the increased incidence of colonic diverticular disease in Korea. We reported previously that the prevalence of colonic diverticulosis in Korea was 9.8% based on a retrospective review of colonoscopic findings [21]. However, due to their retrospective design, that study could not provide a true picture of the epidemiology of colonic diverticulosis in Korea. To our knowledge, this is the first prospective study of the prevalence of colonic diverticulosis in Korea based on colonoscopic findings; diverticulosis in the majority of previous studies was detected by barium enema. In this study, the overall prevalence of colonic diverticulosis was 12.1%, which was higher than any previous study. Study design (prospective vs. retrospective), mean ages, and gender ratios of the study populations may all affect the apparent prevalence of colonic diverticulosis. However, although age is an important risk factor for colonic diverticulosis, the majority of previous studies did not describe the mean age of the study population [9-16]. Therefore, a direct comparison with the data presented here is impossible. No gender difference in the prevalence of colonic diverticulosis has been reported in studies of Western populations. In contrast, most reports in Korea showed that males tend to have colonic diverticulosis more frequently than do females (Table 1) [9-16]. In this study, the gender ratio of the study population was 1.57

(Male/Female) and the prevalence of colonic diverticulosis in males (15.3%) was also higher than in females (7.3%). However, in the multivariate analysis, gender was not shown to be significant. In previous Korean studies, the gender ratio of study populations was correlated with the prevalence of colonic diverticulosis, although this correlation was not statistically significant in the present sample (correlation coefficient = 0.6, $p = 0.91$, Table 1). The data presented herein suggest that gender is an important factor in colonic diverticulosis in Korea. The incidence of colonic diverticulosis appears to increase with increasing age [2-6,8]. In Western countries, the prevalence of colonic diverticulosis was less than 10% in individuals younger than 40 years and greater than 50% in individuals older than 70 years [3]. This phenomenon is explained by the fact that the tensile strength of the colon wall declines as an individual ages [1]. In our study, the prevalence of colonic diverticulosis also increased with age (6.6% in individuals younger than 40 years vs. 21.9% in individuals older than 70 years). Nevertheless, prevalence in elderly Koreans remains lower than that in Western countries. Another interesting finding arising from the data presented here is that even in younger individuals (those in their forties or fifties), the prevalence of colonic diverticula is greater than 10%. This means that in the near future, the prevalence of colonic diverticulosis in elderly people may increase sharply as those currently in their forties and fifties age. Consequently, the prevalence of complications of colonic diverticulosis and medical expenses will also increase. For this reason, colonic diverticulosis represents a potentially highly significant future health concern for elderly Koreans, and so further research and/or screening is essential.

The location of colonic diverticula in patients from Asia is also different from that of Western patients [2-6,8]. In Western countries, diverticula occur mainly within the left side of the colon; only 15% occur in the right side [2]. In this study, diverticula were primarily located in the right side of the colon (84.5%), and only 8.7% were in the left side. This is similar to previous reports of Korean patients [9-16]. In other Asian countries, diverticula are also predominantly located in the right side of the colon (about 70%) [22-26]. A study in Japan reported that right-side colonic diverticula were associated with low fiber intake, as is the case for left side colonic diverticula in Western countries [27]. The authors concluded that the location of colonic diverticula may reflect genetic, rather than environmental, differences in the morphology of the large

intestine between Asians and Westerners [27]. In our study, the mean age of patients with right-side colonic diverticula was lower than that of patients with left-side diverticula ($p < 0.05$), suggesting a difference in the site-specific pathogenesis of diverticulosis. It is possible that the right side of the colon of Asians is less strong than the left, a phenomenon perhaps caused by genetic factors.

The pathogenesis of colonic diverticulosis remains unknown. However, many authors have suggested that dietary habits, changes in colonic motility, and colonic structural alterations are responsible for diverticulum formation [2,4,5]. Painter and Burkitt [7] hypothesized that a low-residue diet aggravates colonic segmentation and causes colonic diverticulosis. In this study, we investigated factors potentially associated with colonic diverticulosis in Korea, including age, gender, symptoms, BMI, dietary style, alcohol and smoking habits, and medical history before colonoscopic examination. In the multivariate analysis, age over 60 years, a high-fat diet, and alcohol consumption were all found to be associated with colonic diverticulosis.

Several other studies have also suggested that a low-fiber diet causes colonic diverticulosis [28-30]. However, in this study, colonic diverticulosis and dietary fiber intake were not significantly correlated. Several possible explanations exist for this finding. First, the questionnaire may have been too simple to detect a correlation between a low-fiber diet and diverticulosis. However, in order to obtain accurate information from subjects, we considered that a simple questionnaire would be best. Second, this study was performed for three months prospectively; the number of subjects with colonic diverticulosis was only 103. This may be insufficient to draw firm conclusions about a possible role of fiber intake in development of diverticulosis.

In contrast, our data suggest that a high-fat diet is associated with a high prevalence of colonic diverticulosis. Aldoori et al. [28] suggested that a high-fat intake is a potential risk factor for symptomatic colonic diverticulosis. However, when adjusted for physical activity and dietary fiber, the association of colonic diverticular disease and fat intake was no longer significant. Although the exact mechanism underlying this association remains unclear, a high-fat diet may influence stool bulk, colonic motility, and/or colonic wall strength. Further studies are necessary to define precisely the relationship between high fat intake and the development of colonic diverticulosis. A high-fat diet may be associated with high BMI; however, other

factors such as differences in the amount of physical activity and basal metabolic state also influence BMI. Interestingly, in our study, BMI was not associated with development of colonic diverticulosis.

Alcohol has been identified as a risk factor in several digestive diseases including gastritis, pancreatitis, alcoholic liver disease, and colorectal cancer. Alcohol and colonic diverticulosis were positively correlated in the data presented here, implying that alcohol intake is linked to development of diverticula. One limitation of this study is that the amount and duration of alcohol intake were not recorded, but only whether the individual was a 'drinker' or 'non-drinker.' Further studies are required for any association between alcohol intake and development of colonic diverticula to be positively identified.

In conclusion, we present here the first prospective study of colonic diverticulosis in Korea based on colonoscopic findings. The data suggest that the prevalence of colonic diverticulosis in Korea is increasing, as indeed is the case for other colonic diseases. Therefore, colonic diverticulosis and the complications thereof will become an increasingly important medical problem in Korea in the future. Colonic diverticulosis in Koreans, in contrast to that in Western populations, is located more frequently in the right side of the colon. Our data also suggest that both a high-fat diet and high alcohol consumption may be associated with development of colonic diverticulosis.

Conflict of interest

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

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