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ORIGINAL ARTICLE

Clinical characteristics of inflammatory bowel disease associated with primary sclerosing cholangitis

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Abstract
Purpose Only a few studies have documented the characteristics of inflammatory bowel disease (IBD) associated with primary sclerosing cholangitis (PSC). We aimed to clarify the clinical and histopathological characteristics of IBD associated with PSC (PSC-IBD).
Methods Twenty-nine patients with PSC and 60 patients with ulcerative colitis (UC) but without complicating PSC were enrolled in this study. First, the age and sex distribution, affected area, clinical course, number of recurrent attacks, and severity of UC were investigated. Then, mucosal specimens obtained from the right side (cecum and ascending colon), transverse colon, and the left side (descending colon, sigmoid colon, and rectum) during colonoscopy were studied for inflammatory cell infiltration, the presence of crypt abscesses, the degree of goblet cell disappearance, and edema.
Results (1) The incidence of IBD in PSC patients was 68.9% (20/29). There were two peaks in the age distribution of PSC. Male PSC patients demonstrated a first peak and female patients a second peak. Male PSC-IBD patients were in their teens and 20s making the first peak. Female PSC-IBD patients were in their 50s and 60s making the second peak. The PSC-IBD patents were significantly younger than the patients without IBD (33.6 vs. 58.9 years, $p < 0.001$). (2) PSC-IBD showed a right-sided predominance colonoscopically. (3) None of the patients had a severe clinical course, and a half of them were asymptomatic. (4) Histopathological examination demonstrated severe inflammatory cell infiltration in the cecum and ascending colon, whereas the degree was mild in the rectum/descending colon.
Conclusions PSC-IBD shows characteristic clinical, colonoscopic, and histopathological findings.

Keywords IBD · Inflammatory bowel disease · Primary sclerosing cholangitis · PSC · Ulcerative colitis

Introduction

Primary sclerosing cholangitis (PSC) is a chronic inflammatory disease characterized by idiopathic fibrous obstruction. The fibrosis causes diffuse narrowing of the intra- and extrahepatic bile ducts, and the resulting persistent biliary stasis leads to hepatic cirrhosis with a poor prognosis. PSC has recently been attracting attention as a disease treatable by liver transplantation. Ulcerative colitis (UC) is a chronic inflammatory bowel disease (IBD) in which diffuse erosions and ulcers are formed from the rectum. The two diseases are intractable and thought to involve an immune mechanism [1], although the details are still unclear.

In the diagnostic criteria for PSC proposed by the Mayo Clinic group in 1999 [2] and 2003 [3], the presence of IBD

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is important in addition to cholangiographic findings. Previous reports from Europe and America have indicated that IBD complicates a high proportion of PSC cases, ranging from 77 to 100% [4]. In Japan, IBD is found in only 21–37% of PSC cases according to a survey by the Japanese Society of Gastroenterology [5] and the Japan Society of Hepatology [6]. It is known that the incidence of intestinal malignant tumors is high in UC cases with a long duration, and it has been reported that complications of PSC further increase the incidence of colorectal cancer [7, 8]. Therefore, early diagnosis of complicating IBD in PSC patients is important.

IBD associated with PSC (PSC-IBD) patients represents a third phenotype that has to be regarded without presumption in western countries [8]. Backwash ileitis, rectal sparing, and low disease activity seem to characterize IBD when associated with PSC [7, 8]. A Japanese questionnaire revealed that among 125 patients with PSC-IBD, 99 had UC (79%), 12 had non-specific colitis (9.6%), 8 had Crohn's disease (CD) (6.4%), and 6 had others such as eosinophilic colitis and unclassified colitis (4.8%) [6]. Patients with PSC-IBD were younger than the average, creating the first peak in the age distribution [6]. Details of associated IBD have been reported in a small number of cases of PSC-IBD by Uchida et al. [9] and Oshitani et al. [10]. Details of endoscopic findings of PSC-IBD in a comparatively large number of cases have been reported by Yamagishi et al. [11].

In this study, we aimed to clarify the clinicopathological characteristics of PSC-IBD, particularly the age and sex distribution, and the distribution and degree of mucosal inflammation colonoscopically and histopathologically.

Patients and methods

The subjects were 38 patients with PSC treated in our department and at affiliated hospitals between January 1985 and April 2007, and 60 patients with UC but without complicating PSC. Of the 38 patients with PSC, 29 patents who received total colonoscopy on clinical onset of IBD or PSC were included in this study.

This study was approved by the Institutional Human Investigation Committee of Nagoya City University Graduate School of Medical Sciences, and informed consent was obtained from all patients.

PSC was diagnosed according to the diagnostic criteria reported by Lazaridis et al. [2], including the presence of typical abnormal bile ducts on direct cholangiography, an abnormal clinical course, blood chemistry data, and exclusion of secondary sclerosing cholangitis. The PSC patients were aged 12 to 72 years with a mean of 41.4 ± 20.9 years. There were 14 males and 15 females. The UC patients without PSC comprised 32 males and 28 females aged 18 to 70 years with a mean of 39.0 ± 13.2 years.

UC was diagnosed according to the Japanese diagnostic criteria for UC [12]. Briefly, at least three of the following criteria had to be met: (1) a history of diarrhea or blood or pus in the stools; (2) macroscopic appearance on endoscopy of continuous mucosal inflammation affecting the rectum in continuity with some or all of the colon; (3) microscopic features in the biopsy specimen compatible with UC; and (4) no evidence of CD by small bowel radiography, ileocolonoscopy, or biopsy. However, the presence of continuous mucosal inflammation affecting the rectum was ignored in this study because the rectum was spared in some PSC-IBD cases.

Among the PSC-IBD patients, definitive distinction between UC and CD was difficult in two patients, and these cases were regarded as 'indeterminate colitis.' The term indeterminate colitis was originally proposed for unclassified cases of fulminant disease and was essentially a temporary classification before a final diagnosis was established [13, 14]. Recently, the term indeterminate colitis has been used clinically for patients with IBD for whom the nature of the underlying disease cannot be firmly established [15]. In this study, the latter definition of indeterminate colitis was employed. The affected area, clinical course, number of recurrent attacks, and severity were investigated according to the Japanese diagnostic criteria for UC [16].

When classifying the affected area by colonoscopy, patients in whom only the rectum was affected were designated as having the proctitis type, patients in whom inflammation extended from the rectum to the middle of the transverse colon as having the left-sided colitis type, patients with localized inflammation from the cecum to the middle of the transverse colon as the having the right-sided colitis type, and patients with inflammation throughout the entire large intestine as having the total colitis type.

Clinical course was classified as the relapsing–remitting type, chronic continuous type, acute fulminating type, or the single attack only type. The chronic continuous type was defined as persistence of the active stage for 6 months or longer after the initial attack. The acute fulminating type was defined as onset with very fulminant symptoms frequently accompanied by complications such as toxic megacolon, perforation, and sepsis, with very poor prognosis.

Severity was graded into three stages: mild, moderate, and severe. Cases meeting at least four of the following six criteria (including 1, 2, and at least one of 3 or 4) were graded as severe: (1) defecation occurring six times/day or more, (2) occurrence of bloody stools three times/day or more, (3) fever of 37.5°C or higher, (4) pulse rate of 90 bpm or higher, (5) anemia with a hemoglobin level of 10 g/dl or lower, and (6) ESR 30 mm/h or higher. Patients meeting the following criteria were graded as mild:

(1) defecation occurring four times/day or less, (2) occurrence of bloody stools once/day or less, and excluding criteria (3) to (6) mentioned above. Cases that were intermediate between the above definitions of severe and mild were graded as moderate.

For histopathology, specimens of large-intestinal mucosa were obtained from the right side (cecum and ascending colon) transverse colon, and the left side (descending colon, sigmoid colon, and rectum) during colonoscopy, and inflammatory cell infiltration, the presence of crypt abscesses, the degree of goblet cell disappearance, and edema were investigated. Fifteen PSC-IBD patients who received sequential biopsy at clinical onset and 11 UC patients with the total colitis type were included for histopathological study as controls. These were graded using four stepwise categories: −, ±, +, and 2+, and scored as 0–3 respectively for statistical analysis. Two pathologists specializing in the gastrointestinal tract performed the histological examinations separately without knowledge of the clinical findings or outcomes. Diagnoses were determined by consensus.

For statistical analysis, Student's *t* test and chi-squared test were performed. Mann-Whitney *U* test was employed for assessment of clinical severity. The Friedman test and Tukey test were used for assessment of pathological investigations.

Results

Age and sex distribution of PSC-IBD

The incidence of IBD in the PSC patients was 68.9% (20/29). Figure 1 shows the distribution of ages and sex on clinical onset for PSC-IBD patients. There were two peaks in the age distribution of PSC (Fig. 1a). The PSC-IBD patents were significantly younger than the patients without IBD (33.6 ± 17.2 vs. 58.9 ± 18.2 years; $p < 0.001$; Table 1). When we compared the ages of 17 PSC patients <50 years (with IBD: without IBD, 15:2) and 12 PSC patients above 50 years (with IBD: without IBD, 5:7), IBD patients belonged more often to the former group than to the latter group to a statistically significant degree ($p < 0.01$).

Male PSC patients showed a first peak and female patients a second peak (Fig. 1b, c). When we compared the ages of 17 PSC patients <50 years (male:female, 13:4) and 12 PSC patients >50 years (male:female, 1:11), male PSC patients belonged more often to the former group and female PSC patients to the latter group at a significant level ($p < 0.01$). Male PSC-IBD patients were in their teens and 20s. Although the peak for female PSC-IBD patients was in their 50s and 60s, their clinical onset of IBD was distributed over all ages.

Clinical characteristics of PSC patients with and without IBD

Eighteen patients had UC, and none of the patients had CD. Two patients had indeterminate colitis, which was difficult to define as UC or CD, but one of them was finally diagnosed as having UC during the clinical course (Table 1).

The clinical characteristics of PSC were compared between the patients with and without complicating IBD. There were no significant differences in sex, distribution of biliary lesions, or anti-nuclear antibody positivity rate

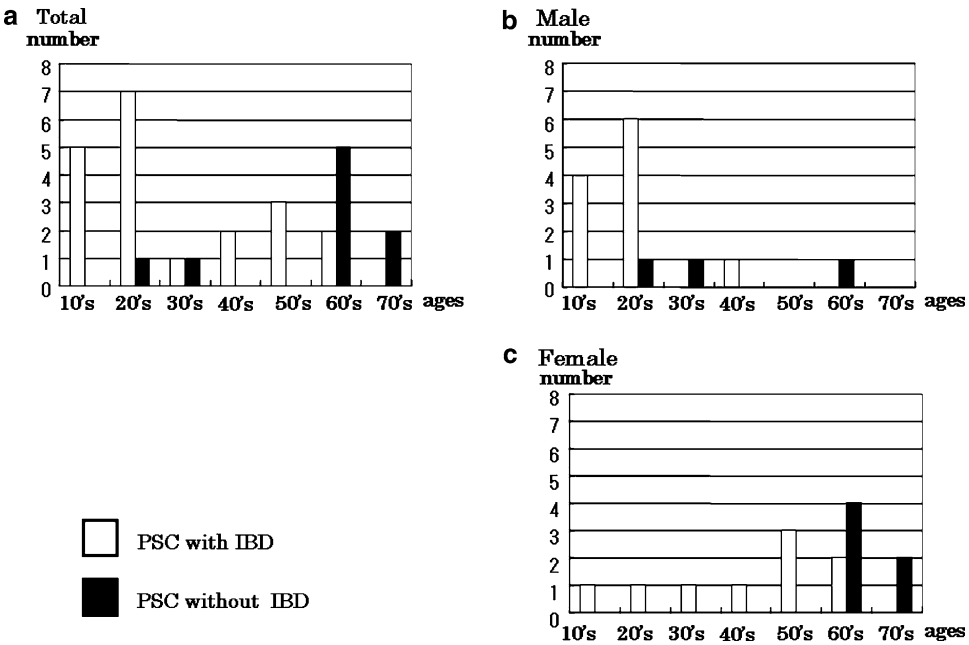

Fig. 1 Age and sex distribution of PSC-IBD. **a** Total PSC with/without IBD, **b** male PSC with/without IBD, **c** female PSC with/without IBD

Table 1 Clinical characteristics of PSC patients with and without IBD

	With IBD ($n = 20$)	Without IBD ($n = 9$)	p value
Age at clinical onset (years)	33.6 ± 17.1	58.9 ± 18.2	<0.001
Gender (M/F)	11/9	3/6	n.s.
Follow-up duration of PSC (years)	1.3–13.6 (5.2)	1.5–11 (4.3)	n.s.
Biliary involvement			
Intrahepatic ducts	1 case	2 cases	n.s.
Intra- and extrahepatic ducts	17 cases	7 cases	n.s.
Small duct PSC	2 cases	0 case	n.s.
Antinuclear antibody	40%	50%	n.s.
Type of IBD			
Ulcerative colitis	18 cases	0 case	
Crohn's disease	0 case	0 case	
Indeterminate colitis	2 cases	0 case	
The order of diagnosis for PSC and IBD			
Ulcerative colitis			
PSC → UC	7 cases		
UC → PSC	2 cases		
Simultaneously	9 cases		
Indeterminate colitis			
Simultaneously	2 cases		

between the two groups except age at clinical onset (Table 1).

Diagnoses of PSC and IBD were made simultaneously in 11 patients, UC was determined during the course of PSC in 7 patients, and PSC was determined during the course of UC in 2 patients (Table 1).

Clinical characteristics of UC patients with and without PSC

The clinical characteristics of UC were compared between the UC patients with and without complicating PSC (Table 2). Sixty patients with UC but without PSC encountered during the same period were selected as controls. There were no significant differences in the age or sex ratio between the patients with and those without PSC.

At the initial diagnosis by colonoscopy, the right-sided colitis type accounted for 55.0% of the patients with PSC, being significantly more frequent than in the patients without PSC (3.3%). During the clinical course in the 20 PSC-IBD patients, 4 patients (20.0%) had a single attack only, 4 (20.0%) were classified as having the relapsing–remitting type, and 2 (10.0%) as having the chronic continuous type, showing a significant difference from the classification of patients without PSC. In addition, ten patients (50.0%) were asymptomatic. With regard to severity, mild cases were most frequent, accounting for 17 (85.0%) of the patients with PSC. There were three moderate cases and no severe cases. The number of recurrent attacks requiring hospitalization was significantly lower among the patients with PSC (0.4 ± 0.9 vs. 1.8 ± 2.1, $p < 0.05$).

Interestingly, all the patients with the total colitis type at initial examination were younger male patients (12, 15, 26, 27, 28, and 40 years old) except for one 58-year-old female. Among the seven patients with the total colitis type at initial examination, three were found to have changed to the right-sided colon type at follow-up colonoscopy.

Comparison of pathological findings of the colonic biopsy specimen between IBD patients with and without PSC

Biopsy specimens obtained by colonoscopy were investigated histopathologically in 26 patients (11 IBD patients, Table 3; 15 PSC-IBD patients, Table 4). No significant differences in its distribution were noted in IBD patients (Table 3). There were significant differences in its distribution of inflammatory cell infiltration for PSC-IBD patients ($p = 0.0012$, Friedman test; Table 4). The distribution of inflammatory cell infiltration of PSC-IBD showed a right-sided predominance. The rate of severe inflammatory cell infiltration (2+) in the cecum and ascending colon was significantly higher in 13 (87%) of 15 PSC-IBD patients than 5 (45%) of 11 IBD without PSC patients ($p = 0.034$). The rate of severe inflammatory cell infiltration (2+) in the rectum/descending colon was significantly lower in 2 (13%) of 15 PSC-IBD patients than 9 (82%) of 11 IBDs without PSC patients ($p < 0.001$).

Table 2 Clinical characteristics of IBD patients with and without PSC

	With PSC ($n = 20$)	Without PSC ($n = 60$)	p value
Age at symptom onset (years)	31.0 ± 15.8	39.0 ± 13.2	n.s.
Gender (M/F)	11/9	32/28	n.s.
Extent of involvement at diagnosis by colonoscopy			
Total colitis type	7 (35.0%)	21 (35.0%)	<0.01
Left-sided type	1 (5.0%)	19 (31.7%)	
Proctitis type	1 (5.0%)	18 (30.0%)	
Right-sided type	11 (55.0%)	2 (3.3%)	
Course of colitis			
Asymptomatic	10 (50.0%)	0 (0%)	<0.01
Only one attack	4 (20.0%)	10 (16.6%)	
Relapse-remitting type	4 (20.0%)	28 (46.7%)	
Chronic continuous type	2 (10.0%)	22 (36.7%)	
Acute fulminant type	0 (0%)	0 (0%)	
Severity of colitis			
Mild	17 (85.0%)	25 (41.7%)	<0.01
Moderate	3 (15.0%)	26 (43.3%)	
Severe	0 (0%)	9 (15.0%)	
Number of recurrences (times)	0.4 ± 0.9	1.8 ± 2.1	<0.05

Table 3 Pathological findings of colonic biopsy specimens with IBD patients

Case no.	Inflammatory cell infiltration			Crypt abscess			Goblet cell disappearance			Edema		
	Ce, A	T	D, S, R	Ce, A	T	D, S, R	Ce, A	T	D, S, R	Ce, A	T	D, S, R
1	+	+	2+	−	−	+	±	±	2+	−	−	±
2	+	2+	2+	−	+	+	−	2+	2+	±	−	±
3	+	+	2+	+	±	+	±	−	2+	+	±	±
4	+	+	2+	−	−	±	−	±	+	2+	2+	2+
5	+	+	+	−	+	−	±	±	±	±	±	±
6	2+	+	2+	±	±	±	+	±	2+	±	+	+
7	+	+	+	−	−	−	±	±	±	2+	2+	2+
8	2+	2+	2+	±	+	+	+	+	2+	−	−	±
9	2+	2+	2+	+	+	+	+	+	+	±	±	2+
10	2+	2+	2+	±	2+	+	2+	2+	2+	±	−	+
11	2+	2+	2+	+	±	+	2+	2+	2+	−	+	±
Friedman test (p value)	0.3359			0.3284			0.1264			0.2500		

Ce, A cecum, ascending colon; *T* transverse colon; *D, S, R* descending colon, sigmoid, rectum

Goblet cell disappearance was observed more frequently in the cecum/ascending colon than in the rectum/descending colon for PSC-IBD patients ($p < 0.05$, Tukey test) (Table 4).

Discussion

The results of this study revealed that the incidence of IBD in PSC patients was higher (68.9%) than the incidence (21,37%) already reported in Japan [5, 6]. Comparison of the clinical features of PSC showed that the patients with IBD were significantly younger than those without IBD. Male PSC-IBD patients were in their teens and 20s. Although the peak for female PSC-IBD patients was in their 50s and 60s, their clinical onset of IBD was distributed over all ages. Colonoscopy at clinical onset and later during the clinical course showed that the area predominantly affected by PSC-IBD was mainly the right-sided colon. Most of the total colitis type patients at initial examination were males younger than 50 years. The number of recurrent attacks requiring hospitalization was

Table 4 Pathological findings of the colonic biopsy specimens of PSC-IBD patients

Case no.	Inflammatory cell infiltration			Crypt abscess			Goblet cell disappearance			Edema		
	Ce, A	T	D, S, R	Ce, A	T	D, S, R	Ce, A	T	D, S, R	Ce, A	T	D, S, R
1	2+	+	+	−	−	−	+	+	+	±	±	±
2	2+	2+	+	−	−	−	+	+	+	±	±	±
3	2+	+	+	−	+	−	+	+	+	±	±	±
4	2+	+	+	−	+	−	+	+	+	+	±	±
5	+	+	±	−	−	−	±	±	±	2+	2+	2+
6	+	+	±	−	+	−	+	±	±	±	±	+
7	2+	+	±	2+	±	−	±	±	−	−	−	−
8	2+	2+	±	+	+	±	+	±	±	−	−	−
9	2+	+	±	−	−	−	±	−	−	+	+	−
10	2+	2+	+	±	±	−	2+	+	±	−	−	−
11	2+	+	+	−	−	−	+	+	+	−	−	−
12	2+	2+	2+	±	±	±	2+	+	±	−	−	−
13	2+	2+	2+	±	+	+	±	±	±	−	−	±
14	2+	+	+	±	±	−	+	−	−	−	−	±
15	2+	2+	+	±	−	−	±	−	±	+	+	+
Friedman test	0.0012**			0.1797			0.0807			0.8607		
Tukey method	Ce, A > D, S, R** T > D, S, R*						Ce, A > D, S, R*					

Ce, A cecum, ascending colon, *T* transverse colon, *D, S, R* descending colon, sigmoid, rectum. * $p < 0.05$, ** $p < 0.01$, Friedman test, Tukey test

significantly fewer in the patients with PSC. In addition, no patient with PSC-IBD showed severe UC during the clinical course. Histopathological examination also demonstrated severe inflammatory cell infiltration in the cecum and ascending colon, whereas the degree was mild in the rectum/descending colon.

The incidence of IBD in PSC patients in the present series was higher (68.9%) than that already reported in Japan (21,37%) [5, 6]. Only PSC patients who had undergone total colonoscopy at clinical onset were enrolled in this study. Fifty percent of PSC-IBD patients were asymptomatic. With regard to severity, mild cases were most frequent, accounting for 17 (85.0%) of the patients with PSC. In mild cases, small changes in the colonic mucosa can sometimes be missed by barium enema, which is why we decided to include only PSC patients who had undergone total colonoscopy. A national survey has also reported that the incidence of IBD in PSC patients increased to 61% when only PSC patients examined by total colonoscopy were enrolled [6]. Yamagishi et al. [11] reported a higher incidence of IBD in PSC patients (93%) examined by colonoscopy.

The first nationwide survey of PSC revealed that PSC patients in Japan had two peaks in age distribution, a characteristic that has never been observed in other countries. However, a recent study from Canada also reported two peaks in the age distribution [17]. The younger patients (first peak) were more frequently complicated with IBD, whereas pancreatitis was often observed in the older patients (second peak) [5]. Therefore, the younger patients in Japan had comparable characteristics to PSC patients in other countries. We have proposed the concept of sclerosing cholangitis associated with autoimmune pancreatitis (SC with AIP) [18, 19]. SC with AIP has been misdiagnosed as chronic pancreatitis associated with PSC. These cases are mainly a second peak. In addition, a second nationwide survey of PSC revealed that a second peak in the age distribution was clearly evident, even after the exclusion of cases of SC with AIP [6]. There were no PSC patients associated with AIP in this study. The serum IgG4 value, which is characteristic for SC with AIP (>135 mg/dl), of 17 PSC patients in this study was 36.3 ± 30.3 mg/dl (mean ± SD). No PSC patients showed a serum IgG4 value higher than 135 mg/dl. There are no significant differences in the serum IgG4 values between PSC patients with IBD versus those without, female versus male, and <50 years versus above 50 years. Our study first revealed that the first peak is made up of mainly male PSC patients and the second peak of female PSC patients. Male PSC-IBD patients were in their teens and 20s, making up the first peak. Female PSC-IBD patients were in their 50s and 60s, making the second peak.

The area predominantly affected by IBD differed between UC patients with and without PSC. In our series, the predominantly affected area was the right-sided colon in the IBD patients with PSC at diagnosis. Generally, the area affected by UC lesions is continuous with the rectum, and regional or localized lesions in the right-sided colon

are rare. The total number of right-sided and segmental UC cases in Japan was reported to be 255 (2.5%) of 10,165 cases [20]. The incidence of right-sided UC among the patients without PSC was also low: 3.3% in this study. A Japanese questionnaire reported that among 99 PSC-IBD cases, 26 (26%) were atypical as UC, with 11 cases of right-sided colon predominant colitis [6]. There have been two Japanese reports of small series of PSC cases. Uchida et al. [9] reported that four out of seven cases of PSC were complicated by unclassified colitis, and Oshitani et al. [10] reported that four out of six PSC cases were complicated by UC. In both series, the main lesions were found colonoscopically in the right-sided colon. Loftus et al. [7] have also reported that PSC-IBD is frequently characterized by rectal sparing and backwash ileitis. In addition, our study showed that the affected area in some patients found to have total colitis at the initial examination changed to the right-sided colon during follow-up. Moreover, in two cases, diagnosis of UC with PSC was difficult at initial colonoscopy. One case diagnosed as indeterminate colitis at initial colonoscopy was found to exhibit typical features of UC in a later examination. Patients who had multiple ulcer scars mimicking tuberculosis in the cecum developed severe inflammation in the right-sided colon. Another patient found to have multiple erosions in the cecum at the first examination later developed inflammation with multiple erosions and redness extending from the cecum to the transverse colon.

The main lesions of PSC-IBD were reported for the right-sided colon as mentioned above. These findings have been observed by colonoscopy until now. The present report is the first describing the distribution of inflammatory cell infiltration of PSC-IBD showing right-sided predominance histopathologically. The rate of severe inflammatory cell infiltration in the right-sided colon was significantly higher in PSC-IBD patients than IBD without PSC patients according to the comparison of the colonic biopsy specimens between IBD patients with and without PSC.

The reason for localization of inflammation in the right-sided colon is not clear. The properties of the large intestine vary from the cecum to the rectum, and the ratios of fecal anaerobic bacteria involved in 7a-dehydroxylation in bile acid metabolism differ [21]. Intestinal pH is lower in the distal than in the proximal colon [22]. It has recently been reported that changes in intestinal pH are involved in bacterial growth in the large intestine and affect the reaction ratio of choloylglycine hydrolase and 7a-dehydroxylase, thus accounting for the variation in content among the regions of the large intestine [23–25]. As a cause of complications of UC in PSC, involvement of hepatotoxic bile acids such as lithocholic acid produced by the intestinal bacterial flora has been reported [26]. Yamada et al. [27]. reported that rectal administration of bacterial leukocyte chemotactic factor induced colitis and inflammatory changes in the liver and bile ducts, mainly the cholangioles.

A nationwide epidemiological survey conducted in Japan [28] showed that the severity of UC was mild in 29.85% of the patients, moderate in 42.69%, and severe in 15.29%. As for the clinical course, the relapsing–remitting type accounted for the highest proportion, 43.14%, and the single attack only and chronic continuous types accounted for 22.05 and 16.69%, respectively. In our study of UC patients without PSC, the severity was mild in 41.7%, moderate in 43.3%, and severe in 15.0%. In contrast, no PSC-IBD patients had severe disease, and 36.4% of them were asymptomatic at diagnosis. PSC-IBD patients showed a better clinical course than those without complications of PSC.

No colon cancer developed in the PSC-IBD cases of our study. Bile duct cancer developed in two PSC cases of our study (one case with IBD and the other without IBD). Unlike the usual form of UC, cancer frequently develops in the right-sided colon in patients with PSC-IBD [29, 30]. Shetty et al. [29] investigated the incidence of colon cancer and dysplasia in UC with (132 cases) and without (196 cases) complicating PSC. The incidence of colon cancer was 25% in the cases with PSC, but only 5.6% in the cases without PSC, and foliate dysplasia and colon cancer frequently originated in the right-sided colon in the former group. Sokol et al. [8] reported that the 25-year cumulative rate of colorectal cancer was 23.4% in PSC-IBD versus 0% in controls, and PSC was the only independent risk factor for the development of colorectal cancer. As for bile duct cancer in PSC, the incidence is high in patients with a long duration of PSC and concomitant UC [31]. Thus, it is important to know the duration of PSC and UC when carrying out surveillance for malignant tumors.

This study showed characteristic features of PSC-IBD. When managing patients with sclerosing cholangitis, total colonoscopy for detection of the characteristics of PSC-IBD should be done. We hope that further study of PSC-IBD will help to clarify the pathogenesis of PSC.

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