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ORIGINAL ARTICLE

Endoscopic Findings and Clinicopathologic Characteristics of Ischemic Colitis: A Report of 85 Cases

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Abstract Ischemic colitis is the most common type of intestinal ischemia and has a clinical spectrum of injury that ranges from mild and transient ischemia to acute fulminant colitis. The aim of this study was to explore endoscopic findings and clinicopathologic characteristics of ischemic colitis and be accurate enough to avoid missed diagnosis or misdiagnosis. A retrospective analysis was undertaken of endoscopy findings and clinicopathologic characteristics of 85 cases of ischemic colitis from March 2005 to April 2008 in the endoscopy center of our hospital. All cases underwent colonoscopy with biopsy within 2 weeks of the onset of symptoms, and all specimens with forceps were stained with hematoxylin–eosin and observed under light microscopy. Of the 85 cases of ischemic colitis (24 men and 61 women, average age 61.36 ± 14.49 years old, range 29–84), 71 were over 50 years of age. These cases were associated with the basal diseases such as hypertension, cardiovascular disorders, diabetes, and hematological diseases as well as a history of abdominal operation. The clinical features usually presented with sudden onset of abdominal pain, diarrhea, and hematochezia. Ischemic lesions were located mainly in the left colon with segmental form (only descending colon affected 16%, only splenic flexure 14%, and only sigmoid colon 23%). The 85 patients consisted of the non-gangrenous type (82), which were composed of reversible IC (76) and chronic IC (6), and the gangrenous type (3). Endoscopic appearance of the transient ischemic colitis consisted of petechial hemorrhages, edematous and fragile mucosa, segmental erythema, scattered erosion, longitudinal ulcerations, and sharply defined segment of involvement. Ischemic colitis of stricture was characterized by full-thickness mucosa, lumens stricture, and diseased haustrations. The mucosa of gangrenous colitis with cyanotic and pseudopolyps was endoscopically observed as well. Clinicopathologic characteristics showed mucosal inflammation accompanied by erosion, granulation tissue hyperplasia and gland atrophy, lamina propria hemorrhage, and macrophages with hemosiderin pigmentation in submucosa in particular. Although endoscopy findings and clinicopathologic characteristics of ischemic colitis are nonspecific, colonoscopy with biopsy plays a vital role in the early diagnosis of ischemic colitis.

Keywords Ischemic colitis · Endoscopy · Clinicopathology

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Introduction

Ischemic colitis (IC) is associated with inadequate blood flow to the colon and the resultant colonic inflammation. Ischemic colitis is the most common vascular disorder of the intestinal tract and the second most common cause of lower digestive bleeding, accounting for approximately 50–60% of all gastrointestinal ischemic episodes [1–4]. During the ischemic period, colonic injury is mediated by hypoxia, followed by reperfusion injury when blood flow returns [5]. It is usually a segmental process, mainly involving the "watershed" areas of the splenic flexure, descending colon, or rectosigmoid junction [3, 6]. Usual clinical manifestation is one of sudden onset of left lower quadrant pain, followed by the passage of bright red blood per rectum. Other presentations include fever, diarrhea, and even necrosis, perforation, peritonitis, and septic shock. In

recent years, with the improvement of diagnostic devices, together with an ageing population, the number of patients with ischemic colitis is on the increase. Regrettably, there are no widely accepted diagnostic criteria for ischemic colitis, so how to improve diagnosis of ischemic colitis plays a role important in therapy and prognosis of ischemic colitis. In this study, we made a retrospective analysis of endoscopy findings and clinicopathologic characteristics of 85 cases of ischemic colitis in the endoscopy center of our hospital in order to avoid missed diagnosis and or misdiagnosis.

Patients and Methods

This retrospective study was performed on 85 consecutive patients in the endoscopy center of Gulou Hospital Affiliated to the Medical School of Nanjing University (Nanjing, China) from March 2005 to April 2008. Diagnosis of ischemic colitis was established from clinical, colonoscopic, and pathologic findings, partly combined with abdominal computed tomography, plain abdominal radiography, and angiography. Patients with inflammatory bowel disease and *Clostridium difficile* colitis were excluded. All patients underwent colonoscopy within 2 weeks from the onset of ischemic colitis. Written informed consent was obtained from each patient before colonoscopic examination (Olympus CF-240I or CF-H260AZI, Tokyo, Japan). When a lesion was detected by standard colonoscopic observation, small biopsy specimens were obtained with forceps.

Clinical variables obtained for all patients included age, gender, and associated risk factors (Table 1). Ischemic colitis is classified as non-gangrenous, involving mucosa and submucosa, or gangrenous. Non-gangrenous ischemic colitis is further subclassified into transient, reversible IC and irreversible IC including chronic and stricture.

All tissue samples from the 85 patients with forceps were fixed in 4% buffered paraformaldehyde, processed routinely, embedded in paraffin, and stained with hematoxylin–eosin (H–E). Two pathologists independently examined the slides under light microscopy (Olympus, Tokyo, Japan).

Table 1 Clinical characteristics of patients with ischemic colitis

Characteristics	Age groups, y							
	All age groups	20–30	31–40	41–50	51–60	61–70	71–80	81–90
Patients per age group	85	2	3	9	24	20	22	5
Gender								
Female	61	1	1	6	18	16	15	4
Male	24	1	2	3	6	4	7	1
Temperature								
<38°C≥37.3°C	15	0	1	2	5	3	2	2
≥38°C	3	0	0	0	2	0	0	1
Use of drugs	38	1	1	4	11	9	8	4
Presentation symptoms								
Hematochezia	65	2	3	6	16	18	16	4
Diarrhea	28	0	1	2	11	6	7	1
Abdominal pain	42	2	3	3	11	14	7	2
Abdominal tenderness	22	0	1	2	5	6	6	2
Associated risk factors								
Diabetes mellitus	8	1	0	1	2	1	3	0
Hypertension	23	0	0	1	6	6	8	2
Cardiovascular disease	20	0	0	0	5	8	6	1
Vasculopathy	5	0	0	0	1	2	1	1
Colonic cancer	7	0	0	0	1	4	2	0
COPD	8	0	0	1	2	2	3	0
Constipation	13	1	2	0	3	3	2	2
IBS	6	0	1	0	2	2	1	0
Abdominal operation	9	0	1	1	3	2	1	0

Values represent number of patients

COPD chronic obstructive pulmonary disease, *IBS* irritable bowel syndrome

Results

Clinical Characteristics

Of the 85 cases of ischemic colitis (24 men and 61 women, average age 61.36 ± 14.49 years, range 29–84), 71 cases were over 50 years of age. Distribution of age consisted of two cases aged from 20 to 30 years, three cases aged 31–40, nine cases aged 41–50, 24 cases aged 51–60, 20 cases aged 61–70, 22 cases aged 71–80, and five cases aged 81–90. The male:female gender ratio was 1:2.54 (females accounting for 71.8%).

The most common presentation symptoms were abdominal pain (49.4%), lower gastrointestinal bleeding (76.5%), diarrhea (32.9%), and abdominal tenderness (25.9%). Fever higher than 38°C was present in only three patients (3.5%) and fever lower than 38°C was present in 15 patients (17.6%). Thirty-eight patients with ischemic colitis (44.7%) had use of drugs associated with ischemic colitis, such as antihypertension agents, digitalis preparations, diuretics, estrogens, neuroleptics, contraceptives, and nonsteroidal antiinflammatory agents. Ischemic colitis associated risk factors included hypertension (27.1%), cardiovascular disease (23.5%), diabetes mellitus (9.4%), vasculopathy (5.9%), chronic obstructive disease (9.4%), constipation (15.3%), colonic cancer (8.2%), and irritable bower syndrome (7.1%) (Table 1).

Endoscopy

Of the 85 patients with ischemic colitis, three were the gangrenous type and 82 were the non-gangrenous type, of which 76 were reversible IC and six were chronic IC. Endoscopic appearances of the transient ischemic colitis included edematous and fragile mucosa, segmental erythema (Fig. 1a), scattered erosion, longitudinal ulcerations (Fig. 1b), petechial hemorrhages interspersed with pale areas (Fig. 1c), purple hemorrhagic nodules (Fig. 1e), obsolescent vascular lakes, and sharply defined segment of involvement. Mucosa with severe ischemic colitis were cyanotic or dark (Fig. 1d). And pseudomembranes (Fig. 1e), pseudopolyps (Fig. 1f), and pseudotumor-like (Fig. 1g) appearances were endoscopically observed as well. Bluish-black mucosal nodules may suggest gangrene (Fig. 1h). Ischemic colitis of stricture was characterized by full-thickness mucosa, lumens stricture, diseased haustrations, mucosa granularity, and armillary intestinal wall (Fig. 1i). Colon segments invovled the right colon (4.7%),

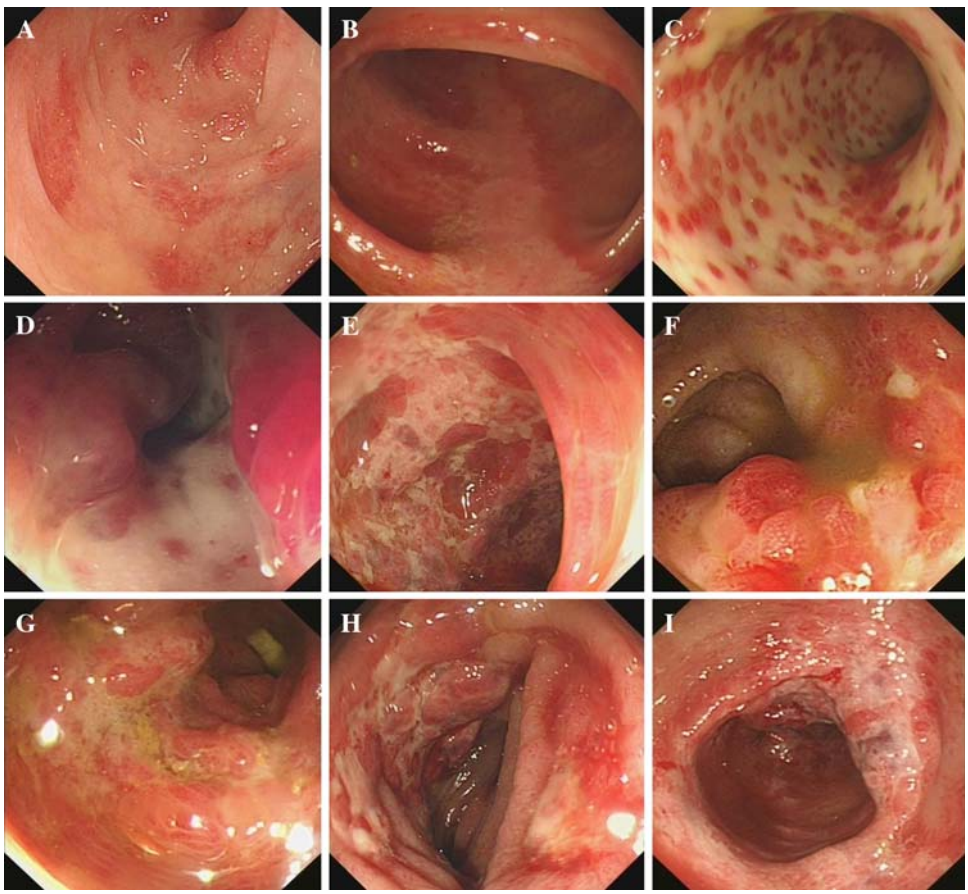

Fig. 1 Endoscopic findings of ischemic colitis. **a** Patchy erythema and mucosal congestion in rectosigmoid junction. **b** A single linear ulcer running along the longitudinal axis of the descending colon. **c** Petechial hemorrhages interspersed with pale areas in the descending colon. **d** Cyanotic, edematous mucosa with scattered ulceration in the sigmoid colon. **e** Pseudomembranes with purple hemorrhagic nodules in the descending colon. **f** Congestive mucosa and pseudopolyps in the descending colon. **g** Mucosal edema, exudate and pseudotumor-like in the descending colon. **h** Bluish-black mucosal nodules with mucosal congestion and hemorrhage in the ascending colon approaching hepatic flexure. **i** Lumen structure and mucosal granularity in the descending colon

Table 2 Location of affected colon

Location of colonic injury	Number of patients	Percentage
Right colon	4	4.7
Transverse colon	3	3.5
Right colon and transverse colon	2	2.4
Left colon and transverse colon	6	7.1
Left colon	68	80
Pancolitis	2	2.4

left colon (68%), transverse colon (3.5%), right colon and transverse colon (2.4%), left colon and transverse colon (7.1%), and pancolitis (2.4%) (Table 2).

In addition, plain abdominal radiography was performed in three patients and showed colic distention. An abdominal computed tomography was performed in six patients, which showed full-thickness of the colonic wall. One patient had an angiographic study that showed a complete superior mesenteric artery occlusion (Fig. 2).

Pathology

An infiltration of edematous mucosa lymphocytes and neutrophilic granulocytes was observed in all patients with ischemic colitis. Erosion and superficial ulceration were seen frequently. The gland in the middle and under layer mucosa was reserved and only surface layer necrosis appeared (Fig. 3b, c). The gland degeneration, atrophy or necrosis, and minor goblet cells were found (Fig. 3a, g). Granulation tissue formed (Fig. 3d, g), and hemorrhage in lamina propria (Fig. 3e, f) was found. Fibrous connective tissue hyperplasia and hemorrhage in lamina propria (Fig. 3e, f) as well as cellulose-like thrombosis in small vessels were also seen. Mucosal atrophy, fibrous scar tissue and abundant fibrous tissue with iron-laden macrophages were also found (Fig. 3h). Occasionally, pseudomembrane and inflammatory or metaplastic polyps were observed.

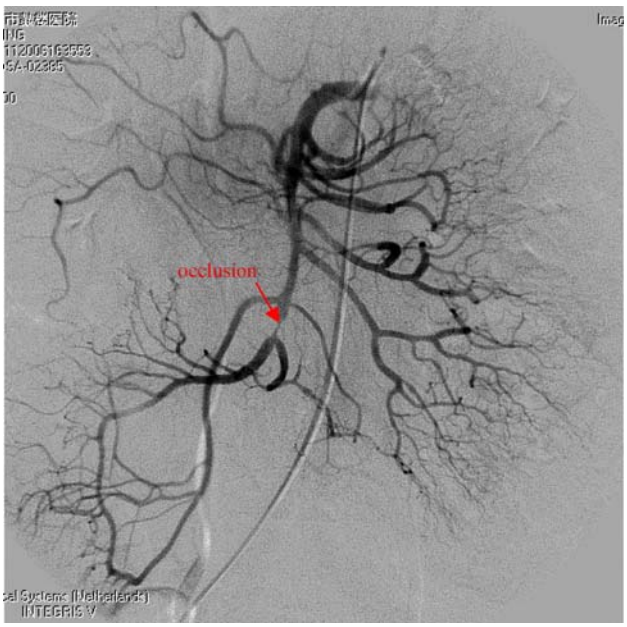

Fig. 2 Arteriography showed superior mesenteric artery occlusion

Discussion

Ischemic colitis was firstly described as reversible vascular occlusion of the colon in 1963 by Boley et al. [7]. It was clinically divided into three types: the transient type, the stricture type, and the gangrenous type in 1966 by Marston et al. [8]. In recent years, ischemic colitis has also been classified as non-gangrenous or gangrenous, and non-gangrenous ischemic colitis is further subclassified into transient, reversible IC, and irreversible IC including chronic and stricture [3, 9]. Ischemic colitis has a wide clinical spectrum resulting from hypo-perfusion which is inadequate for meeting the metabolic demands of a region of the colon; this ranges from transient self-limited ischemia involving mucosa and submucosa, to acute fulminant transmural injury complicated by bowel necrosis leading to death. Clinical presentation is variable, but is typically characterized by abdominal pain over the affected segment of the colon followed by the passage of blood mixed with stools. Ischemic colitis is the most common form of intestinal ischemia and the incidence in the general population has been estimated to range from 4.5 cases to 44 cases per 100,000 person-years [10]. Although frequent in the elderly, younger patients may also be affected. And in recent years, the incidence of ischemic colitis is on the increase with continuing expansion of the aged population, thus gastroenterologists and surgeons are facing the problem of diagnosis and treatment of patients with ischemic colitis.

The incidence of ischemic colitis is associated with risk factors. In this retrospective study, we analyzed several risk factors, and found that hypertension and cardiovascular disease (27.1% and 23.5%, respectively) accounted for 50.6% in all analyzed associated risk factors. We also found chronic constipation accounted for 15.3% and chronic obstructive pulmonary disease (COPD) and abdominal operation each for 10.5%. Thirty-eight of 85 patients with ischemic colitis (44.7%) had a history of drug use, for example, antihypertension agents (e.g., furosemide), digitalis preparations (e.g., digoxin), contraceptives (e.g., norgestre), nonsteroidal anti-inflammatory agents (e.g., indometacin), 5-HT_3 receptor antagonists (arosetron), and so on. This suggested that some drugs may increase the incidence of ischemic colitis. But the association of 5-HT_3

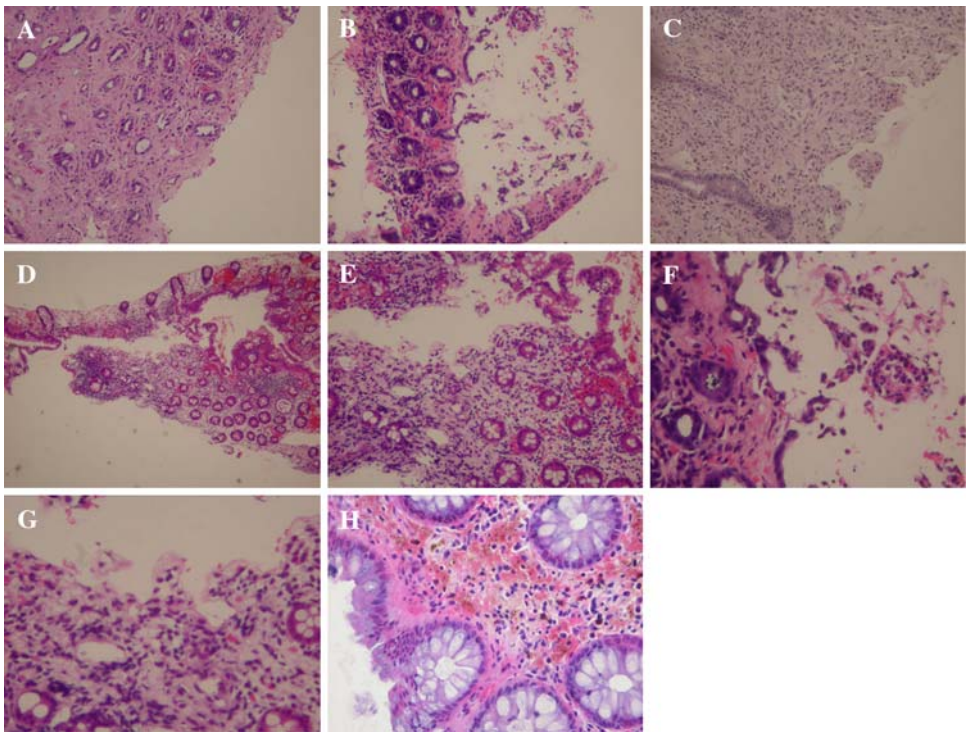

Fig. 3 Pathology of ischemic colitis (H–E staining). **a** Epithelium mucosae necrosis and abscission in surface layer; reserved gland with atrophic changes in middle and under layers and collagen fibers in lamina propria (original magnification ×100). **b** Epithelium mucosae necrosis in surface layer and reserved gland in middle layer (original magnification ×100). **c** Same view as **c**, at different magnification (original magnification ×200). **d** Mucosal epithelium necrosis and granulation tissue formed (original magnification ×100). **e** Partially mucosal epithelium necrosis and abscission, hemorrhage in lamina propria (original magnification ×200). **f** Same view as **e**, at different magnification (original magnification ×100). **g** Mucosal superficial epithelium necrosis and abscission; residued gland with atrophic changes in middle layer and granulation tissue formed (original magnification ×100). **h** Hemorrhage and hemosiderin deposition in lamina propria (original magnification ×400)

receptor antagonists (e.g., alosetron, cilansetron) and incidence of ischemic colitis is still unclear, although the Food and Drug Administration Adverse Events Reporting System estimated that the risk of ischemic colitis associated with alosetron was significantly higher than placebo (0.15% vs. 0.0%) [11, 12]. Six of 85 patients (7.1%) took alosetron in the short term in our study. Whether there is a causal relationship between alosetron and ischemic colitis or is not needs to be deeply studied.

Of note in our study, 71 of 85 patients with ischemic colitis (83.5%) were over 50 years of age and 72% were female (male vs female: 24 vs 61). Cole et al. [13] also found an approximately 1.5–2× higher incidence of ischemic colitis for females versus males in the irritable bowel syndrome and no-irritable bowel syndrome populations. Our study, combined with Coles' study, indicated that age and female gender also seemed to increase the risk of ischemic colitis. MacDonald et al. [14] considered that older women have a higher incidence rate than men, probably because they supplement estrogen for so long. However, up to now, statistical comparisons related to age or gender were not presented in all studies.

The diagnosis of ischemic colitis mainly depends on clinical presentations, combined with laboratory testing, radiographic images, endoscopy, and pathology. Laboratory testing for markers of ischemic damage such as increased serum lactate, LDH, CPK, and amylase levels may be present, although they are not sufficiently specific to allow accurate diagnosis of colonic ischemia [15]. Plain abdominal films (classic thumbprinting along the colonic wall) are generally insensitive and nonspecific, but they are important to exclude other serious conditions [16–18]. Computerized axial tomography typically shows circumferential wall thickening in a segmental pattern, but this finding is also nonspecific for colonic ischemia and could be useful, particularly in a clinical context suggestive of ischemic colitis [17]. Although laboratory tests and radiographic images may suggest the diagnosis of colonic ischemia, endoscopic visualization of colonic mucosa with histologic analysis of biopsies is the gold standard for identification of ischemic colitis [19].

Endoscopy has largely taken the place of barium enema to diagnose ischemic colitis. This is mainly true because of the advantages that endoscopy offers including higher

sensitivity to detect mucosal injury and the capability of acquiring biopsies when necessary [1, 20]. Also, because of residual contrast of barium enema, barium enema makes visualization obscure when arteriography or endoscopy is later used, and may also affect plans for urgent surgical intervention. Meanwhile, over-distention and associated high intraluminal colonic pressures should be avoided during colonoscopy since they may worsen ischemic damage.

The findings of colonoscopy depend on the stage and severity of ischemia. In the early stages of ischemia, pale, friable or edematous mucosa alone with petechial hemorrhages, scattered erosion, segmental erythema, with or without ulcerations and bleeding, may be observed. A single linear ulcer or inflamed colon strip running along the longitudinal axis of the colon may characterize milder disease [21]. With more severe ischemia, blue–black mucosal nodules with a darker, dusky background are seen. Pseudopolyps, even pseudotumor-like and pseudo-membranes, may be found as well. A chronic stage of ischemia is characterized by stricture, diseased haustrations, and mucosal granularity [22]. As to endoscopic findings of ischemic colitis, Favier et al. [23] classified endoscopic patterns into three stages in 1974: stage I, patchy erythema separated by normal mucosa; stage II, submucosal hemorrhage areas with non-necrotic ulcerations and edematous mucosa; stage III, deep necrotic ulcerations. Clinicians also make a reasonable analysis and judgement upon the stage and severity of ischemic colitis according to the patterns by Favier in 1974.

The colon is perfused by the superior mesenteric artery (SMA), the inferior mesenteric artery (IMA), and branches of the internalliac arteries [24, 25]. Once colonic blood flow declines, intestinal blood pressure below 40 mmHg may be compromised by changes in the systemic circulation or by anatomic or functional changes in the regional mesenteric vasculature, and colonic ischemia could ensue [19]. Although any portion of the colon may be affected by ischemic damage, the most vulnerable regions are the "watershed" areas of the splenic flexure, the descending colon, sigmoid colon or rectosigmoid junction, because these areas have limited collateral networks and also are vulnerable to low flow states [3, 15, 26]. A study of more than 1,000 patients with ischemic colitis demonstrated that the left colon was involved in approximately 75% of patients, with about one-quarter of lesions affecting the splenic flexure [3, 6]. In our study, the segment mainly involved the left colon, with the descending colon affected in only 16%, the splenic flexure in 14%, and the sigmoid colon in 23%.

Notably, endoscopic findings are nonspecific for ischemia, and diagnosis of ischemic colitis needs to consider the clinical setting and clinicopathology. But endoscopic appearances of ischemic colitis (especially segmental involvement, abrupt transition between normal and affected mucosa, rectal sparing, and rapid resolution) may help differentiate ischemia from inflammatory bowel disease [19, 27].

Pathohistologic changes of biopsies taken from affected areas may show nonspecific changes such as edema, inflammatory infiltrate, hemorrhage, crypt destruction, intravascular thrombosis, necrosis, granulation tissue with crypt abscesses, and pseudopolyps, which may mimic Crohn's disease [28]. In the chronic phase of ischemic colitis, mucosal atrophy, granulation tissue and abundant fibrous tissue with iron-laden macrophages may be found. Biopsy of a post-ischemic stricture is marked by extensive transmural fibrosis and mucosal atrophy. Moreover, we may find differences between ischemic colitis and *Clostridium difficile* colitis. And hyalinization, hemorrhage and hemosiderin deposition in the lamina propria, full-thickness mucosal necrosis, and scattered pseudo-membranes are seen more frequently in ischemic colitis than in *Clostridium difficile* colitis [29, 30].

Conclusion

An intimate knowledge of endoscopic findings and pathologic characteristics of ischemic colitis plays a pivotal role in decreasing the misdiagnosis rate of ischemic colitis. But endoscopic findings and pathologic characteristics of ischemic colitis are nonspecific, so clinical presentations and patient history must be combined with them so as to improve further diagnosis. Otherwise, endoscopic findings or histologic changes of some IC patients are similar to those of *Clostridium difficile* colitis or inflammatory bowel disease, so these diseases must also be attentively discriminated.

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References

1. Sreenarasimhaiah J. Diagnosis and management of intestinal ischemic disorders. *BMJ*. 2003;326:1372–1376. doi:10.1136/bmj.326.7403.1372.
2. Newman JR, Cooper MA. Lower gastrointestinal bleeding and ischemic colitis. *Can J Gastroenterol*. 2002;16:597–600.
3. Gandhi SK, Hanson MM, Vernava AM, et al. Ischemic colitis. *Dis Colon Rectum*. 1996;39:88–100. doi:10.1007/BF02048275.
4. MacDonald P. Ischaemic colitis. *Best Pract Res Clin Gastroenterol*. 2002;16:51–61. doi:10.1053/bega.2001.0265.
5. Greenwald DA, Brandt LJ. Colonic ischemia. *J Clin Gastroenterol*. 1998;27:122–128. doi:10.1097/00004836-199809000-00004.

6. Greenwald DA, Brandt LJ, Reinus JF. Ischemic bowel disease in the elderly. *Gastroenterol Clin North Am*. 2001;30:445–473. doi:10.1016/S0889-8553(05)70190-4.
7. Boley SJ, Schwartz S, Lash J, et al. Reversible vascular occlusion of the colon. *Surg Crynecol Obstet*. 1963;116:53–60.
8. Marston A, Pheils MT, Thomas ML, et al. Ischaemic colitis. *Gut*. 1966;7:1–15. doi:10.1136/gut.7.1.1.
9. Chang L, Kahler KH, Sarawate C, et al. Assessment of potential risk factors associated with ischaemic colitis. *Neurogastroenterol Motil*. 2008;20:36–42.
10. Higgins PD, Davis KJ, Laine L. Systematic review: the epidemiology of ischaemic colitis. *Aliment Pharmacol Ther*. 2004;19:729–738.
11. Camilleri M. Is there an experimental basis for the development of ischaemic colitis as a result of 5-HT3 antagonist treatment? *Neurogastroenterol Motil*. 2007;19:77–84.
12. Grundy D, Mclean P, Stead R. Impact of 5-HT3 receptor blockade on colonic haemodynamic responses to ischaemia and reperfusion in the rat. *Neurogastroenterol Motil*. 2007;19:607–616.
13. Cole JA, Cook SF, Miller DP, et al. The risk of colonic ischemia among patients with irritable bowel syndrome. *Dig Dis Week*. 2002; A91 (abstract 726).
14. MacDonald PH. Ischaemic colitis. *Pract Clin Gastroenterol*. 2002;16:51–61.
15. Brandt LJ, Bole SJ. Colonic ischemia. *Surg Clin North Am*. 1992;72:203–229.
16. Wolf EL, Sprayregen S, Bakal CW. Radiology in intestinal ischemia: plain film, contrast, and other imaging studies. *Surg Clin North Am*. 1992;72:107–124.
17. Philpotts LE, Heiken JP, Westcott MA, Gore RM. Colitis: use of CT findings in differential diagnosis. *Radiology*. 1994;190:445–449.
18. Iida M, Matsui T, Fuchigami T, et al. Ischemic colitis: serial changes in double–contrast barium enema examination. *Radiology*. 1986;159:337–341.
19. Sreenarasimhaiah J. Diagnosis and management of ischemic colitis. *Curr Gastroenterol Rep*. 2005;7:421–426.
20. Bryan TG, David AT. Ischemic colitis: a clinical review. *South Med J*. 2005;98:217–222.
21. Zuckerman GR, Prakash C, Merriman RB, et al. The colon single stripe sign and its relationship to ischemic colitis. *Am J Gastroenterol*. 2003;98:2018–2022.
22. Scoweroft CW, Sanowski RA, Kozarek RA. Colonoscopy in ischemic colitis. *Gastrointest Endosc*. 1981;27:156–161.
23. Favier C, Bonneau HP, Reboul F. Le diagnostic endoscopique descolites ischémiques régressives. A propos de 21 cas. *End Dig*. 1976;1:44–148.
24. Otttinger LW. Mesenteric ischemia. *N Engl J Med*. 1982;307:535–537.
25. Rosenblum GD, Boyle CM, Schwartz LB. The mesenteric circulation: anatomy and physiology. *Surg Clin North Am*. 1997;77:289–306.
26. Cappell MS. Intestinal (mesenteric) vasculopathy II. *Gastroenterol Clin North Am*. 1998;27:827–858.
27. Rogers AI, David S. Intestinal blood flow and diseases of vascular impairment. In: Haubrich WS, Schaffner F, Berk JE, eds. *Gastroenterology*. 5th ed. Philadelphia: WB Saunders; 1995:1212–1223.
28. Mitsudo S, Brandt LJ. Pathology of intestinal ischemia. *Surg Clin North Am*. 1992;72:43–63.
29. Scharff JR, Longo WE, Vartanian SM, et al. Ischemic colitis: spectrum of disease and outcome. *Surgery*. 2003;134:624–630.
30. Dignan CR, Greenson JK. Can ischemic colitis be differentiated from *C difficile* colitis by biopsy specimens? *Am J Surg Pathol*. 1997;21:706–710.