SIRIRAJ MEDICAL LIBRARY

Computed Tomographic Findings in Differentiating between Diverticulitis and Colon Cancer

Aphinya Charoensak, M.D., Marayart Tongintarach, M.D., Nithida Na Songkhla, M.D.

Department of Radiology, Faculty of Medicine, Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand.

ABSTRACT

Objective: To determine the computed tomographic (CT) findings associated with diverticulitis or colonic cancer, and to evaluate the CT signs that may help in distinguishing between these two diseases.

Methods: Fifty-five CT scans of patients with colonic diverticulitis (n=17) or colonic cancer (n=38) between January 2002 to October 2005 were retrospectively and independently evaluated by two abdominal radiologists who were blinded to the proved diagnosis. Discrepancies of each CT finding were resolved by consensus opinion. CT findings were assessed as follows: location of involved colon, length of involved segment, degree of pericolonic inflammation, pericolonic lymph nodes, thickness and pattern of bowel wall thickening, presence or absence of simple diverticula at the involved colonic segment, inflamed diverticula, intramural sinus tract, fistula, muscular wall hypertrophy, "arrowhead" sign, extraluminal air and bowel obstruction. The inter-observer agreement was assessed with the kappa statistic. The association of consensus opinion of each CT findings with the final diagnosis of colonic diverticulitis or colon cancer were evaluated by using chi-square test and odds ratios.

Results: Bowel wall thickness less than 1 cm ($p < 0.0001$, odds ratio 32.89, 95% CI 3.31,798.5), presence of simple diverticula at involved segment ($p < 0.001$, odds ratio 28.13, 95% CI 4.56, 266.11), presence of inflamed diverticula ($p = 0.003$, odds ratio 15.42, 95% CI 1.46, 386.32) and symmetrical pattern of bowel wall thickening ($p < 0.0001$, odds ratio 13.07, 95% CI 2.66, 73.36) were the statistically significant CT findings which are found more frequently in colonic diverticulitis than in colon cancer. On the other hand, bowel wall thickness 1 cm or greater, eccentric pattern of bowel wall thickening without evidence of simple diverticula or inflamed diverticula at the involved colonic segment were the statistically significant CT findings seen more frequently in colon cancer than in diverticulitis.

Conclusion: Bowel wall thickness less than 1 cm, presence of simple diverticula at the involved segment, presence of inflamed diverticula and symmetrical pattern of bowel wall thickening were the helpful CT findings in distinguishing colonic diverticulitis from colon cancer. Bowel wall thickness 1 cm or greater, eccentric pattern of bowel wall thickening without evidence of simple diverticula or inflamed diverticula at the involved colonic segment were the useful CT findings in distinguishing colon cancer from colonic diverticulitis.

Keywords: Colon cancer, CT findings, differentiation; diverticulitis

Siriraj Med J 2007; 59: 232-236
E-journal: http://www.sirirajmedj.com

Colonic diverticulitis occurs in 10-35% of patients with known diverticulosis[1-2]. It occurs when inflammatory changes have occurred in and around the diverticula. Clinical manifestations vary widely depending upon the extent of inflammation and peritonitis.

Nowadays, Computed Tomography (CT) has become the imaging modality of choice for the diagnosis of diverticulitis and other colonic diseases including colon cancer. However, a few reports[3-5] have showed that the imaging appearance of diverticulitis and colon cancer overlaps in approximately 10% of cases. Diffentiating colonic diverticulitis from colon cancer is crucial for achieving optimal patient management. We performed this study to determine the CT findings associated with diverticulitis or colonic cancer, and to evaluate the CT signs that may help in distinguishing between diverticulitis and colon cancer.

Correspondence to: Aphinya Charoensak
E-mail: ch_aphinya@yahoo.com

MATERIALS AND METHODS

Patient population

This retrospective study was approved by our institutional ethics review board and informed consent was not

necessary. We searched our hospital database from January 2002 to October 2005 for patients with a final diagnosis of colonic diverticulitis or colon cancer. Only those who were sent for CT examination of the abdomen were selected. We excluded patients who met the exclusion criteria: (a) patients who had obtained prior treatment such as surgery, radiation therapy or chemotherapy (b) patients who had no available CT images to review.

A total of 55 patients (34 women and 21 men) were included in this study.

There were 17 patients (age range, 31-84 years; median age, 61 years) with a final diagnosis of colonic diverticulitis and 38 patients (age range, 30-89 years; median age, 71 years) with proven colon cancer. The final diagnosis of colonic diverticulitis was obtained by clinical follow-up in 9 patients, clinical follow-up and colonoscopic findings in 4 patients, and surgical findings with pathological diagnosis in 4 patients. All patients with colon cancer were proven by pathological diagnosis.

CT technique

Thirty-five patients were examined with a 16 slice multi-detector CT scanner (LightSpeed 16; General Electric Medical Systems, Milwaukee, WI) using 1.25 mm collimation at a pitch of 1.375:1. The scans were reconstructed at 7.5 mm slice thickness. CT examination of the remaining 20 patients were performed using a single-slice helical CT scanner (Tomoscan AV; Philips Medical Systems, Shelton) with 10 mm collimation and pitch 1:1. All CT studies were performed with oral, rectal and intravenous contrast administration. In all patients, 100 ml of contrast medium was administered intravenously at a rate of 2 ml / sec.

Imaging analysis

All CT scans were randomly distributed and retrospectively reviewed by two abdominal radiologists who did not receive the clinical or pathological data. Each interpreter reviewed all CT examinations independently and the discrepancies were determined by consensus.

CT findings were assessed as follows: location of involved colon, length of involved segment, degree of pericolonic inflammation, pericolonic lymph nodes, thickness and pattern of bowel wall thickening, and presence or absence of simple diverticula at the involved colonic segment, inflamed diverticula (diverticula with thickened enhancing wall surrounded by peridiverticular inflammation), intramural sinus tract, fistula, muscular wall hypertrophy (sawtooth like thickening of the colonic haustra), "arrowhead" sign, extraluminal air and bowel obstruction. The length of the involved colonic segment was classified as less than 5 cm, 5-10 cm and greater than 10 cm. The degree of pericolonic inflammation was classified into grade I (mild pericolonic haziness or strands) and grade II (ill-defined soft tissue mass or abscess). The largest pericolonic lymph node was measured in short axis diameter and classified as less than 1 cm, 1-2 cm and greater than 2 cm. The pattern of bowel wall thickening was classified as symmetrical thickening and eccentric wall thickening. The maximum bowel wall thickness was recorded as less than 1 cm, 1-2 cm and greater than 2 cm. The definition of arrowhead sign is an arrowhead-shaped collection of contrast material found at the orifice of the diverticulum.



Fig 1. Sigmoid diverticulitis. The axial CT image showed rather symmetrical wall thickening of sigmoid colon with pericolonic fat stranding and pericolonic abscess (A). Presence of simple diverticula at the involved segment was noted (arrowheads). Inflamed diverticula was not observed in this case.

Statistical analysis

The inter-observer agreement was assessed with the kappa statistic. A kappa (k) value less than 0.2 was considered to indicate poor agreement, 0.21-0.4 was considered to indicate fair agreement, 0.41-0.6 was considered to indicate moderate agreement, 0.61-0.8 was considered to indicate good agreement, and greater than 0.8 was considered to indicate very good agreement, as suggested by Altman[6]. The discrepancies of each CT finding were resolved by consensus opinion of the two interpreters.

A univariate statistical analysis was performed for the consensus interpretations of CT findings to determine their association with the final diagnosis of colonic diverticulitis or colon cancer by using chi-square test and odds ratios with a 95% confidence interval (CI). For CT findings (length of involved segment, pericolonic lymph nodes and bowel wall thickness) which were divided into 3 levels, we regrouped these findings according to our hypotheses to determine the significant findings associated with either diverticulitis or colon cancer. We had the hypotheses that the length of the involved segment greater than 10 cm, pericolonic lymph nodes less than 1 cm and bowel wall thickness less than 1 cm were the CT findings associated with colonic diverticulitis; and length of involved segment less than 5 cm, pericolonic lymph nodes greater than 2 cm and bowel wall thickness greater than 2 cm were the CT findings associated with colon cancer.

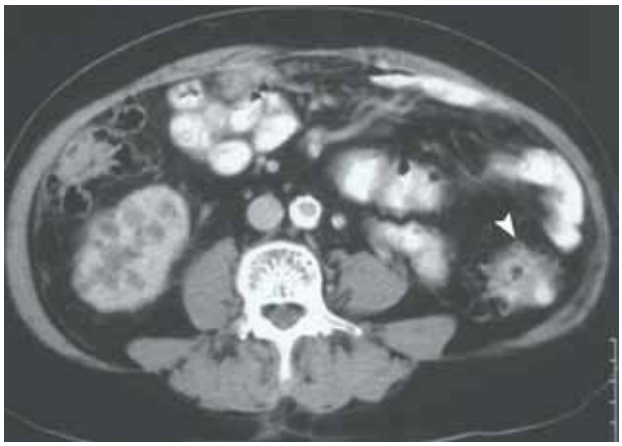


Fig 2. Diverticulitis at descending colon. Enhanced thicken wall diverticulum or inflamed diverticulum (arrowhead) was noted along with mild pericolonic inflammation.

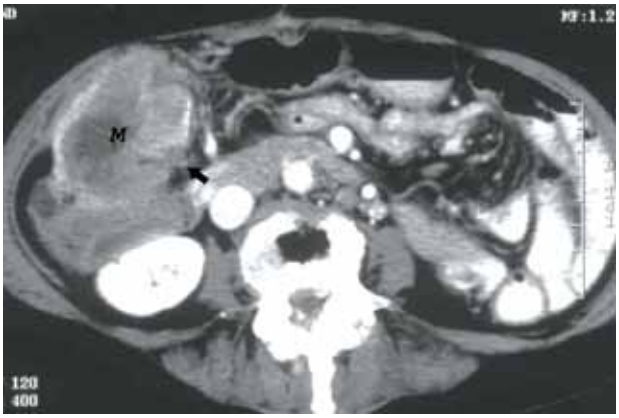


Fig 3. Ascending colon cancer. The axial CT image revealed eccentric pattern of marked thickened colonic wall (M) with pericolonic inflammation, grade II (presence of pericolonic abscess was not demonstrated in this picture). A small pericolonic lymph node (less than 1 cm) was depicted (arrow).



Fig 4. Colon cancer at proximal sigmoid. Rather symmetrical wall thickening of proximal sigmoid colon (arrow) with mild pericolonic inflammation was detected. A small pericolonic lymph node (less than 1 cm) was also observed (arrowhead).

Statistical analysis was computed using SPSS version 13.0 for Windows (Microsoft). An odds ratio of 1.0 indicates no difference between groups. A p value less than 0.05 was considered to indicate a statistical significance.

RESULTS

The inter-observer agreement was very good for location of involved colon (k = 1.0), pattern of bowel wall thickening (k = 1.0), presence of simple diverticula at involved segment (k = 1.0), intramural sinus tract (k = 1.0), fistula (k = 1.0), muscular wall hypertrophy (k = 1.0), arrowhead sign (k = 1.0), extraluminal air (k = 1.0), bowel obstruction (k = 1.0), length of involved segment (k = 0.91), pericolonic lymph nodes (k = 0.91), and bowel wall thickness (k = 0.91). Moderate agreement was obtained for pericolonic inflammation (k = 0.47) and presence of inflamed diverticula (k = 0.47).

Diverticulitis was found in the sigmoid colon in 13 patients (76.5%), cecum in 3 patients (17.6%) and transverse colon in 1 (5.9%) patient. Colonic carcinoma was located at the sigmoid colon in 18 patients (47.4%), ascending colon in 7 patients (18.4%), cecum in 5 patients (13.2%), descending colon in 4 patients (10.5%), transverse colon in 3 patients (7.9%) and hepatic flexure in 1 (2.6%) patient.

The most frequent CT findings in diverticulitis were pericolonic lymph nodes less than 1 cm diameter (100%), presence of simple diverticula at the involved segment (88.2%) and a symmetric pattern of bowel wall thickening (82.4%). CT findings which had a statistically significant association with colonic diverticulitis were bowel wall thickness less than 1 cm, presence of simple diverticula at involved segment, presence of inflamed diverticula and symmetrical pattern of bowel wall thickening. On the other hand, CT findings which had a statistical significant association with colon cancer were bowel wall thickness 1 cm or greater than 1 cm, absencet of simple diverticula at the involved segment, absence of inflamed diverticula and an eccentric pattern of bowel wall thickening. The details of CT findings along with statistical analysis in patients with colonic diverticulitis or colon cancer were shown in Table 1. All extraluminal air found in five patients were depicted in pericolonic abscesses. No free intraperitoneal air was observed.

DISCUSSION

Differentiation between colonic diverticulitis and colon cancer is important in patient care. Diverticulitis is a benign condition and most cases can be treated with standard medical therapies of bowel rest and antibiotics. On the other hand, colon cancer is a malignant process and operable cases must be treated with surgery.

CT is the imaging modality of choice in evaluating patients suspected of colonic diverticulitis and colon cancer. Despite considerable overlap between the CT features seen in colonic diverticulitis and those seen in colon cancer, some distinguishing signs have been reported. Jang et al.[7] reported that inflamed diverticula and preserved enhancement pattern of the thickened colonic wall were the statistically significant CT findings of acute diverticulitis in distinguishing diverticulitis from colonic carcinoma. In study by Palidar et al.[8], two CT findings of sigmoid mesenteric inflammation (fluid at the root of the mesentery and vascular engorgement) were the useful signs in differentiation of sigmoid diverticulitis from carcinoma of the sigmoid colon. Chintapalli et al.[9] suggested that the presence of pericolonic lymph nodes in patients suspected of having diverticulitis should raise the suspicion of underlying colonic cancer. In a study by Rao et al.[10], the arrowhead sign and an inflamed diverticulum were the specific CT signs of colonic diverticulitis. Those studies, however, included few CT signs or were limited to a specific colonic location.

In this study, bowel wall thickness less than 1 cm, presence of simple diverticula at the involved segment, presence of inflamed diverticula and symmetrical pattern of bowel wall thickening were the statistically significant CT findings found more frequently in colonic diverticulitis than in colon cancer. Conversely, bowel wall thickness 1 cm or greater than 1 cm, absence of simple diverticula at the involved segment, absence of inflamed diverticula and an eccentric pattern of bowel wall thickening were the statistically significant CT findings detected more frequently in colon cancer than in diverticulitis. Inflamed diverticula has previously been reported to be a specific sign in diagnosis of colonic diverticululitis with sensitivity and specificity of 30-86.8% and 92.9-100% respectively[7,11]. In our results, this sign was visualized less frequently (about 30%) than it was in previous studies. This could be from

TABLE 1. Consensus CT findings in patients with colonic diverticulitis or colon cancer with statistical analysis (chi-square test and odds ratios).

CT findings	Diverticulitis (n=17) No. (%)	Colon cancer (n=38) No. (%)	*p* value	Odds ratios (95%CI)
Sigmoid colon	13 (76.5)	18 (47.4)	0.04	3.61 (0.86,16.17)
Length of involved segment			0.25	2.12 (0.5, 9.53)
< 5 cm	4 (23.5)	15 (39.5)		
≥ 5 cm	13 (76.5)	23 (60.5)		
Length of involved segment			0.49	1.64 (0.32, 8.25)
≤ 10 cm	13 (76.5)	32 (84.2)		
> 10 cm	4 (23.5)	6 (15.8)		
Pericolonic inflammation			0.34	2.03 (0.38, 10.83)
grade I	13 (76.5)	33 (86.8)		
grade II	4 (23.5)	5 (13.2)		
Pericolonic lymph nodes			0.06	NA
< 1 cm	17 (100)	31 (81.6)		
≥ 1 cm	0 (0)	7 (18.4)		
Pericolonic lymph nodes			0.5	NA
≤ 2 cm	17 (100)	37 (97.4)		
> 2 cm	0 (0)	1 (2.6)		
Pattern of bowel wall thickening			<0.0001	13.07 (2.66, 73.36)
Symmetric	14 (82.4)	10 (26.3)		
Eccentric	3 (17.6)	28 (73.7)		
Bowel wall thickness			<0.0001	32.89 (3.31, 798.5)
< 1 cm	8 (47.1)	1 (2.6)		
≥ 1 cm	9 (52.9)	37 (97.4)		
Bowel wall thickness			0.07	3.25 (0.78, 14.53)
≤ 2 cm	13 (76.5)	19 (50)		
> 2cm	4 (23.5)	19 (50)		
Presence of simple diverticula	15 (88.2)	8 (21.1)	<0.001	28.13 (4.56, 266.11)
at the involved colonic segment				
Presence of inflamed diverticula	5 (29.4)	1(2.6)	0.003	15.42 (1.46, 386.32)
Intramural sinus tract	0 (0)	0 (0)	NA	NA
Fistula	1 (5.9)	2 (5.3)	0.93	1.13 (0, 17.82)
Muscular wall hypertrophy	3 (17.6)	0 (0)	NA	NA
Arrowhead sign	0 (0)	0 (0)	NA	NA
Extraluminal air	3 (17.6)	2 (5.3)	0.14	3.86 (0.45, 37.89)
Bowel obstruction	0 (0)	4 (10.5)	NA	NA

NA = not assessed

the thicker collimation used in patients who were examined with a single slice helical CT scanner. Simple diverticula represent diverticula without inflammation and can be coincidentally found in colon cancer[12]. However, in our results detection of simple diverticula at the involved colonic segment was a helpful finding in differentiation of diverticulitis from colon cancer.

Muscular wall hypertrophy and arrowhead signs were previously reported[10,11] as relatively specific signs for colonic diverticulitis. They were found in this study less frequently than in previous study. Muscular wall hypertrophy was detected in only 3 patients (17.6%) with diverticulitis and in no patient with colon cancer, No patient in this study was found to have an arrowhead sign. Muscular wall hypertrophy represents the adaptation of the muscular layers of the colonic wall to long-standing increased intraluminal pressure which is an important pathogenesis of diverticulosis. It needs adequate colonic distention with colonic opacification for differentiating true colonic wall thickening from incomplete luminal distention and distinguishing muscular wall hypertrophy from inflammatory wall thickening[13]. Optimum luminal opacification is also an important factor needed for good visualization of an arrowhead sign. Although all patients in this study received rectal contrast, we did not evaluate the degree of colonic distention and luminal opacification which were the important factors needed in detection of these findings. Furthermore, an arrowhead sign is detected only if the imaging plane cuts through contrast material funneling into an edematous orifice of an inflamed diverticulum[11]. This might explain why no patient in this study had an arrowhead sign.

In this study, the degree of pericolonic inflammation, the length of involved colonic segment, and the size of pericolonic lymph nodes showed no statistically significant difference between the two groups of patients. This differs from previous studies[14,15]. It was widely accepted that the degree of pericolonic inflammation varies depending on the size of perforation, bacterial contamination, and host response. So the differences in severity of diseases and studies population could be the possible explanation. Moreover, the measurement of the length of the involved colonic segment in this study may not represent well the exact length of the underlying colon cancer. Many investigators have reported wall thickening of the segment proximal to colonic carcinoma due to obstructive colitis, with a prevalence of 1%-7% of colonic carcinomas[16-19]. Recently, Jang et al has reported that approximately 10% of colon cancers had wall thickening distal to colonic carcinoma by CT, which represented edema or colitis at

histopathologic examination[20]. We believe that wall thickening of the segment proximal or distal to colonic cancer was the important cause resulting in over measurement of the involved colonic segment in our study. The measurement of the lymph node less than 2 cm in diameter is not accurately measured in patients who were studied with 10 mm slice thickness by a single-slice helical CT scanner. The further study using a thin slice CT scanner should be performed.

This study had some limitations. First, different CT scanners and CT techniques were used in this study. Approximately 36% of patients were studied by single-slice helical CT scanner which some findings could be missed by CT using a thick collimation. Second, we selected only the patients who were sent for CT examination of the abdomen and we did not record the reasons or indications for sending for CT examination of each patient. Therefore, applying our results in practical clinical setting should be done with caution. Further prospective study should be performed to validate our results. Third, radiologists, although blinded from the final diagnosis, knew that patients had one of the two diseases. Thus, the frequency of some findings might be either higher or lower than it would be.

In conclusion, bowel wall thickness less than 1 cm, the presence of simple diverticula at the involved segment, the presence of inflamed diverticula and the symmetrical pattern of bowel wall thickening were the helpful CT findings in distinguishing colonic diverticulitis from colon cancer. Whereas, bowel wall thickness 1 cm or greater, absence of simple diverticula at the involved segment, absence of inflamed diverticula and an eccentric pattern of bowel wall thickening were the useful CT findings in distinguishing colon cancer from colonic diverticulitis.

ACKNOWLEDGEMENTS

This study was supported by the Faculty of Medicine, Siriraj Hospital. We are deeply indebted to Kullathon Thephamongkol, M.D., Mr. Suthipol Udompunturak and Mr. Anek Suwanbundit for their constructive support in statistical analysis.

REFERENCES

1. Chappuis CW, Cohn I. Acute colonic diverticulitis. Surg Clin North Am 1988; 68: 310-3.
2. McKee RF, Deignan RW, Krukowski ZH. Radiological investigation in acute diverticulitis. Br J Surg 1993; 80: 560-5.
3. Balthazar EJ, Megibow A, Schinella RA, Gordon R. Limitations in the CT diagnosis of acute diverticulitis: comparison of CT, contrast enema, and pathological findings in 16 patients. AJR 1990; 154: 281-5.
4. Neff CC, vanSonnenberg E. CT of diverticulitis diagnosis and treatment. Radiol Clin North Am 1989; 27: 743-52.
5. Balthazar EJ. Diverticular disease. In: Textbook of GI radiology. Gore RM, Levine MS, Laufer I, eds. Philadelphia, Pa: Saunders, 1994; 1072-95.
6. Altman DG. Practical statistics for medical research, London: Chapman and hall,1991.
7. Jang HJ, Lim HK, Lee SJ, Lee WJ, Kim EY, Kim SH. Acute diverticulitis of the cecum and ascending colon: the value of thin-section helical CT findings in excluding colonic carcinoma. AJR 2000; 174: 1397-402.
8. Padidar AM, Jeffrey RB, Mindelzun RE, Dolph JF. Differentiating sigmoid diverticulitis from carcinoma on CT scans: mesenteric inflammation suggests diverticulitis. AJR 1994; 163: 81-3.
9. Chintapalli KN, Esola CC, Chopra S, Ghiatas AA, Dodd GD. Pericolic mesenteric lymph nodes: an aid in distinquishing diverticulitis from cancer of the colon. AJR 1997; 169: 1253-5.
10. Rao PM, Rhea JT. Colonic diverticulitis: evaluation of the arrowhead sign and the inflamed diverticulum for CT diagnosis. Radiology 1998; 209: 775-9.
11. Kircher MF, Rhea JT, Kihiczak D, Novelline RA. Frequency, sensitivity, and specificity of individual signs of diverticulitis on thin-section helical CT with colonic contrast material: experience with 312 cases. AJR 2002; 178: 1313-8.
12. Ponka JL, Fox JD, Brush C. Coexisting carcinoma and diverticula of the colon. Arch Surg 1959; 79: 373-84.
13. Rao PM, Rhea JT, Novelline RA, et al. Helical CT with only colonic contrast material for diagnosing diverticulitis: prospective evaluation of 150 patients. AJR 1998; 170: 1445-9.
14. Shen SH, Chen JD, Tiu CM, et al. Differentiating colonic diverticulitis from colon cancer: the value of computed tomography in the emergency setting. J Chin Med Assoc 2005; 68: 411-8.
15. Chintapalli KN, Chopra S, Ghiatas AA, Esola CC, Fields SF, Dodd GD. Diverticulitis versus colon cancer: differentiation with helical CT findings. Radiology 1999; 210: 429-35.
16. Ko GY, Ha HK, Lee HJ, et al. Usefulness of CT in patients with ischemic colitis proximal to colonic cancer. AJR1997; 168: 951-6.
17. Toner M, Condell D, O'Briain DS. Obstructive colitis: ulceroinflammatory lesions occurring proximal to colonic obstruction. Am J Surg Pathol 1990; 14: 719-28.
18. Ganchrow MI, Clark JF, Benjamin HG. Ischemic colitis proximal to obstructing carcinoma of the colon: report of a case. Dis Colon Rectum 1971; 14: 38-42.
19. Feldman PS. Ulcerative disease of the colon proximal to partially obstructive lesions: report of two cases and review of the literature. Dis Colon Rectum 1975; 18: 601-12.
20. Jang HJ, Lim HK, Park CK, Kim SH, Park JM, Choi YL. Segmental wall thickening in the colonic loop distal to colonic carcinoma at CT: importance and histopathologic correlation Radiology 2000; 216: 712-7.