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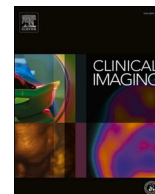
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Intramural diverticulosis and diverticulitis of the colon: Pictorial essay

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ABSTRACT

Diverticulosis of the colon is a gradually progressive disease that usually starts in early adulthood and increases with advancing age in its anatomical extent and the size of diverticula. It is important to recognize the initial stages of diverticular development in young patients in order to properly diagnose and manage the potential complications of this very common intestinal disorder. This article presents the pathological and radiological features of early diverticular formation, when the mucosal outpouchings are very small and contained within the colonic wall as distinct intramural lesions. The subsequent development of intramural diverticulitis and the spectrum of its manifestations on barium enema examination or Computed tomography (CT) are illustrated.

1. Introduction

Diverticulosis of the colon is a common intestinal disease among the aging population of the United States and other industrial countries. Its development follows a gradual and progressive course that often begins in early adulthood and manifests clinically in about 5% of patients by the age of 40 years and over 50% of those older than 60 years [1–3].

The published medical literature deals primarily with the diagnosis and management of advanced diverticulosis and its complications. However, recent studies show an increasing incidence of colonic diverticulitis in patients younger than 40 years in age, particularly in obese individuals [4,5]. Therefore, it would be important to be familiar with the early stages of diverticular formation and its clinical implications. This article presents the pathological and radiological features of intramural diverticula, which initially develop in young adults and later enlarge to appear as the classic diverticulosis in older age groups.

2. Histopathology of intramural diverticulosis

The initial stage of diverticulosis begins with minute protrusions of the mucosa into the muscularis propria, the circular muscle layer of the colon (Fig. 1A–D). These outpouchings are only 1–2 mm in size and totally confined within the colonic wall, which is about 4–5 mm thick in the non-distended segments [6–8]. Therefore, these early lesions are referred to as intramural diverticula.

In a more advanced process, the mucosal pockets penetrate through the circular muscle and appear on the serosal surface of the colon along the borders of 3 longitudinal muscle bands known as tenia mesocolica,

libera, and omentalis. Because the diverticular wall is composed of the colonic mucosa without any muscular component, they are usually classified as pseudo-diverticula [1–3]. They are distinguished from the true diverticula that have all 4 layers of the colonic wall, usually occur in the cecum on congenital basis, and represent a common site of diverticulitis in young Asian patients [3,9].

The anatomical locations which predispose to diverticular formation are the weak points at the entry sites of vasa recta supplying to the colonic wall. However, the actual pathogenesis of diverticulosis has been shown to be multi-factorial and include elevated intraluminal pressure due to disordered colonic motility, and structural abnormalities related to nutritional or genetic effects [2,3,10].

3. Radiological features of intramural diverticulosis

The sigmoid colon is the predominant location of diverticulosis in up to 90% of patients. Hence the earliest development of intramural diverticula can be visible in this segment. The small protrusions of the mucosa result in a serrated saw-like appearance of the colonic wall on barium enema examination (Fig. 2A). The slightly more prominent diverticula can be seen as thorn-like or saccular outpouchings that measure about 1 mm in size (Fig. 2B).

In the more advanced stage of this process, numerous round intramural diverticula measuring only 1–2 mm can be demonstrated more diffusely in the colon when they become opacified during barium enema examination (Fig. 3A and B).

It should be noted that the progression of diverticulosis is usually associated with thickening of the colonic wall due to hypertrophy of its

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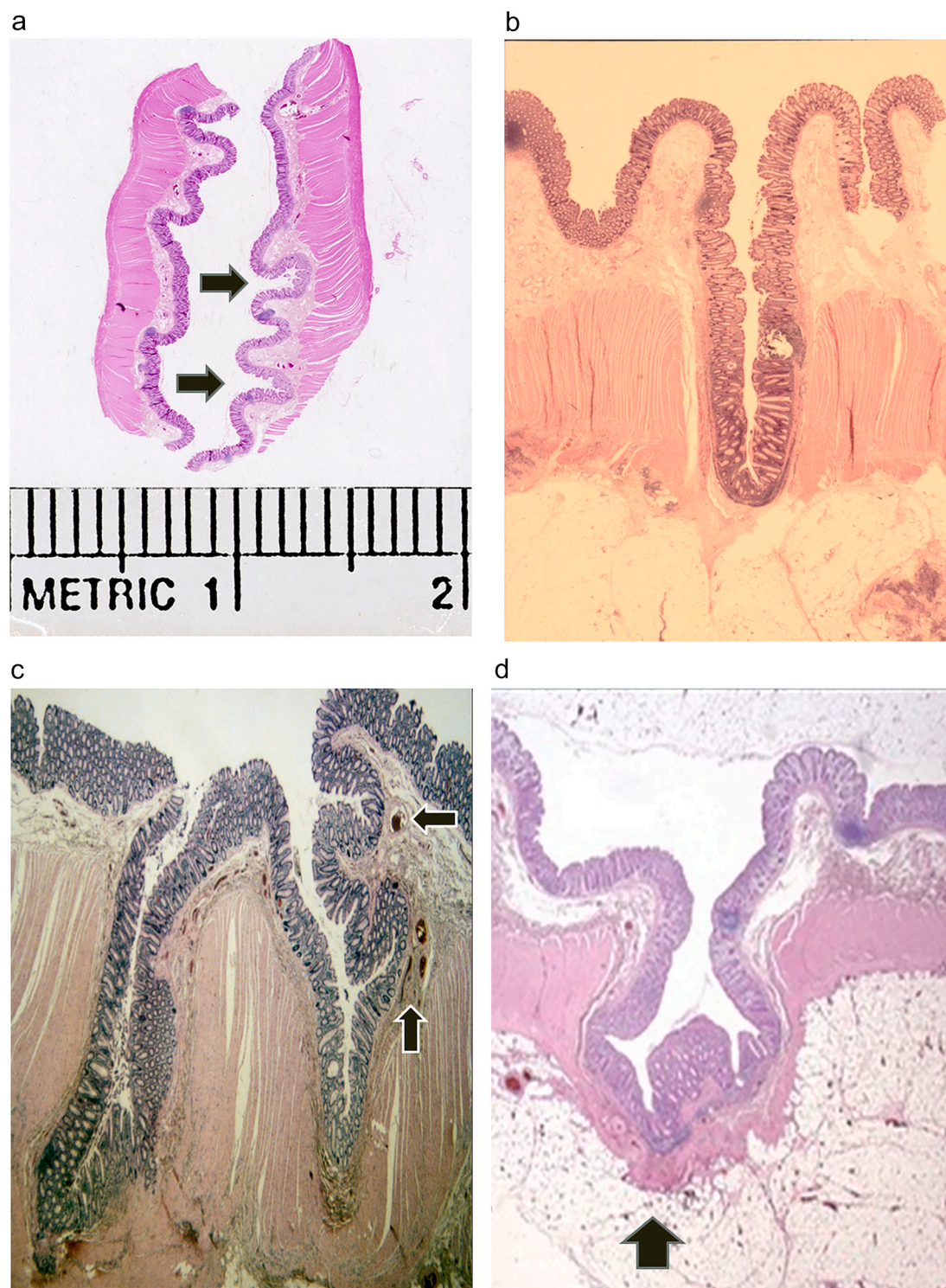


Fig. 1. Histopathology of intramural diverticulosis.

A. Longitudinal cross-section of the sigmoid colon demonstrates multiple 1–2 mm mucosal protrusions in to the wall (arrows). The thickness of the wall itself measures 4–5 mm, mainly due to hypertrophic muscularis propria.

B. Microscopic section shows an intramural diverticulum with finger-like appearance protruding in to the wall (H&E stain, 20× magnification).

C. Two adjacent diverticula are penetrating the muscular layer next to the vasa recta (arrows).

D. A sacular diverticulum is seen bulging towards the external border of the colon (arrow).

circular muscle layer and narrowing of the lumen caused by a pathologic condition known as myochosis [2,3]. Therefore, the evidence for intramural diverticulosis is occasionally detected on the CT of the abdomen as tiny foci of gas or contrast within the colonic wall in contracted or non-distended segments (Fig. 4). This is in contradistinction to

advanced diverticulosis, which is more easily recognized on barium enema study or CT when the bowel lumen is well distended [2,11].

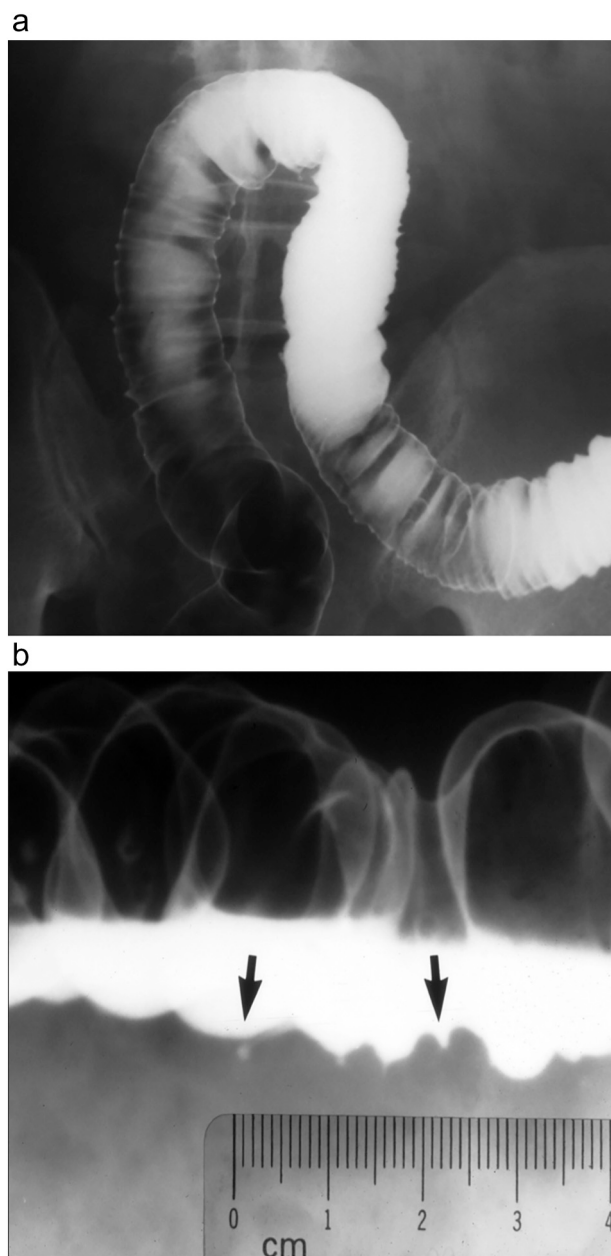


Fig. 2. Radiological appearance of early intramural diverticulosis in a 52 year-old man.

A. Barium enema examination shows the serrated margins of the sigmoid loop caused by thorn-like mucosal protrusions in to the wall. B. Magnified radiograph of the descending colon demonstrates several 1–2 mm diverticula (arrows).

4. Histopathology of intramural diverticulitis

Because the intramural diverticula are bulging mucosal pockets, their wall lacks any muscular component to allow their contraction and emptying. Therefore, their lumen can be filled with stool and incite a micro-perforation causing focal inflammation in and around the diverticulum due to bacterial translocation (Fig. 5).

The resulting inflammatory process associated with dense cellular infiltrates is usually confined within the colonic wall itself, leading to its localized thickening that can be appreciated on the resected specimen. The pericolic fat may not be affected or show minimal edema and hyperemia. This is in contrast to the common type of diverticulitis, whereby the inflamed or perforated diverticulum protrudes from the

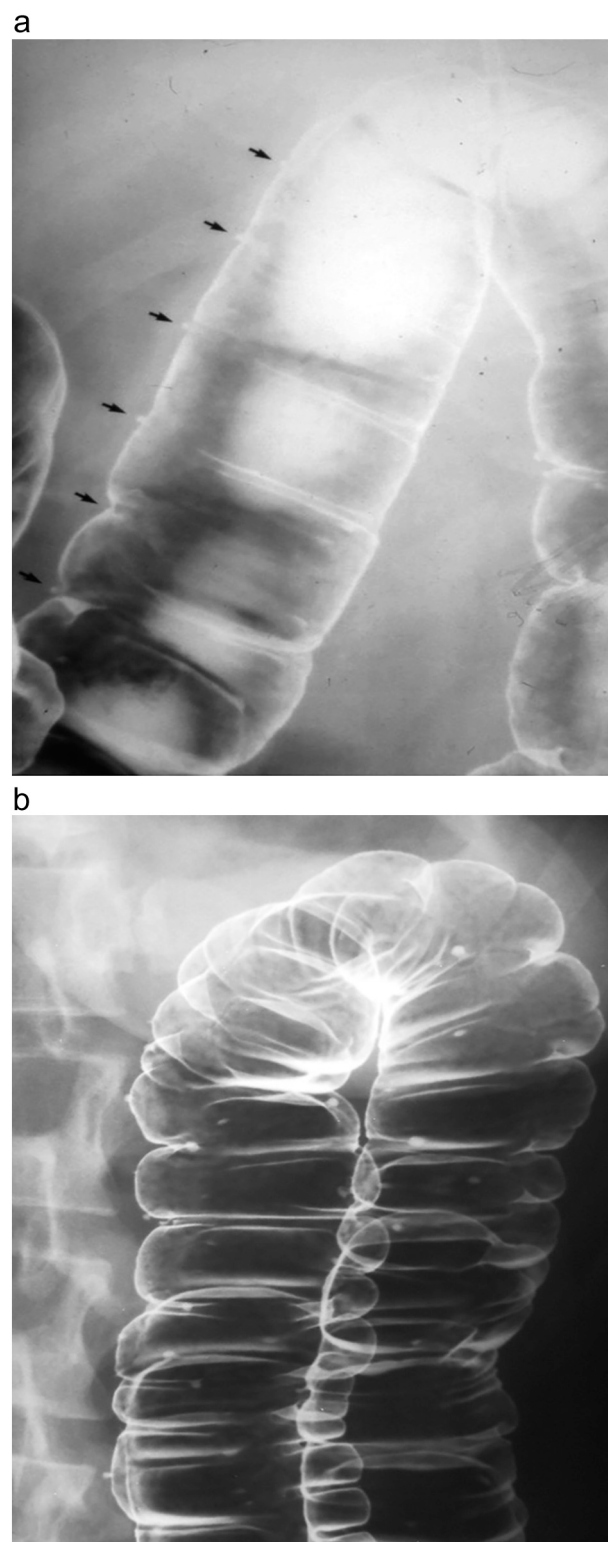


Fig. 3. Progression of intramural diverticulosis. A. Magnified radiograph of an air-contrast examination shows a row of 1 mm outpouchings within the colonic wall of this 33 year-old woman (arrows). B. Numerous small diverticula are visible in the splenic flexure 6 years later. This follow-up study was performed because a cecal cancer had been detected on the initial air-contrast examination.

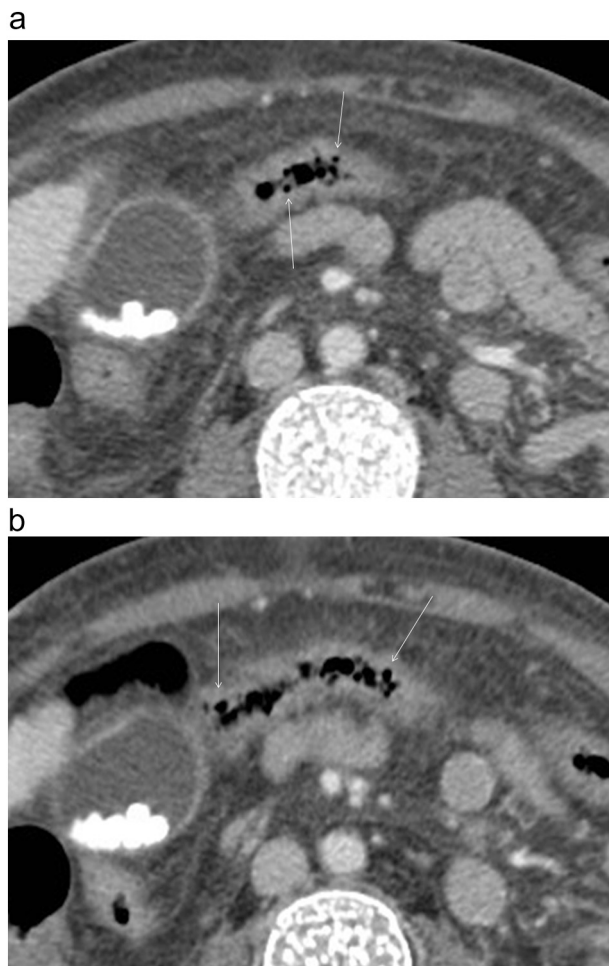


Fig. 4. CT appearance of intramural diverticulosis in a 35 year-old man with thalassemia and gallstones. A and B: CT sections of the upper abdomen show the intramural diverticula as small foci of gas within the thickened and contracted colonic wall (arrows).

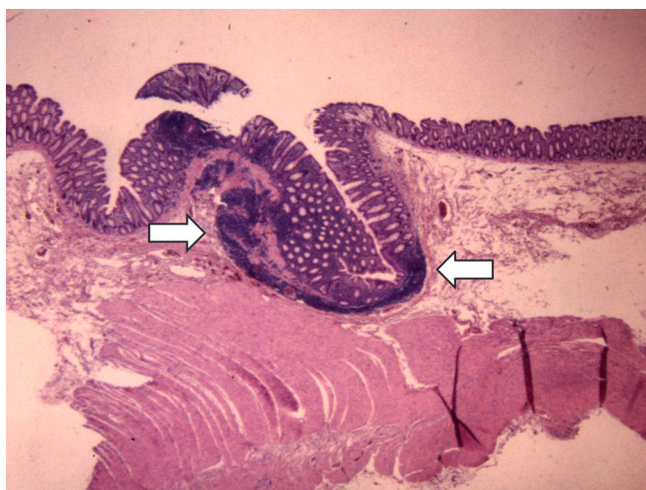


Fig. 5. Histopathology of intramural diverticulitis of the colon. Microscopic section shows the dense aggregates of inflammatory cells around the mucosal pocket protruding in to the muscularis propria (arrows). Note that this pathologic process is confined to the bowel wall at this early stage of its development (H&E stain, 20× magnification).

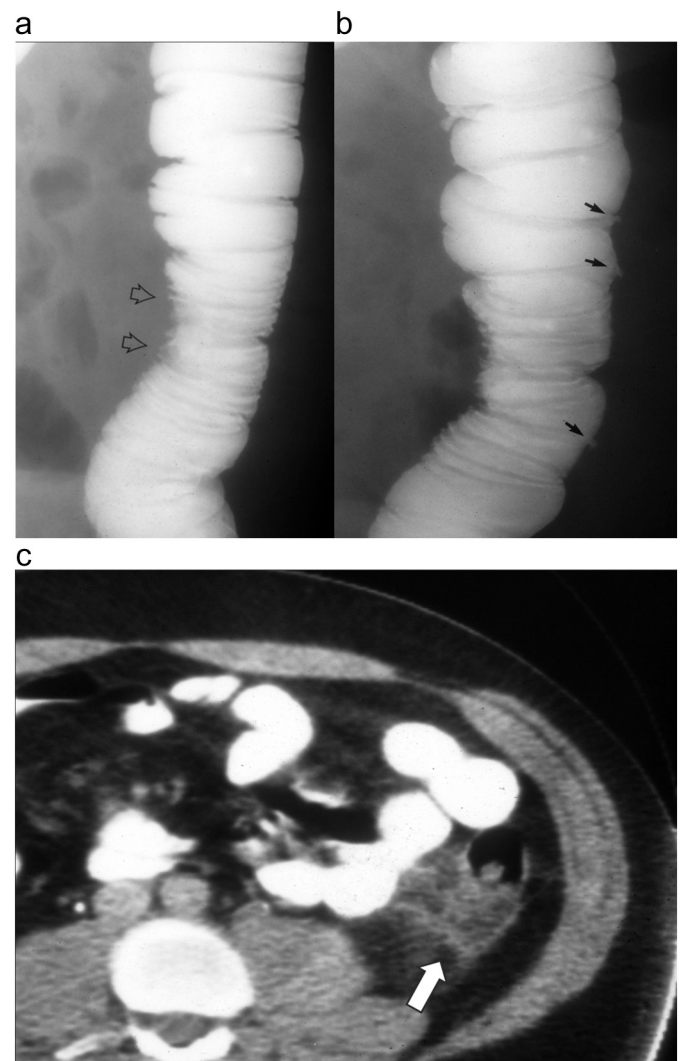


Fig. 6. Acute intramural diverticulitis in a 38 year-old man presenting with left lower abdominal pain and tenderness. A. Barium enema radiograph of the descending colon in frontal projection shows a localized area of mucosal distortion in the medial wall, with slight narrowing of the lumen due to contraction (open arrows). B. Multiple intramural diverticula are visible on the left oblique projection (black arrows). C. CT examination one week later reveals some residual thickening of the posteromedial wall and mild stranding of the adjacent retroperitoneal fat (arrow).

serosal surface of the colon and leads to the involvement of neighboring extra-colonic structures [2,11].

In cases of chronic intramural diverticulitis, an encapsulated soft tissue mass may form within the colonic wall and simulate the appearance of a neoplastic lesion on gross inspection. This type of complicated process is illustrated in the following section.

5. Radiological features of intramural diverticulitis

Despite their very small size of only 1–2 mm, the intramural diverticula represent a potential site for development of diverticulitis. This condition occurs usually in patients younger than 40 years of age, who may experience localized pain and tenderness of the affected area, as well as low-grade fever and leukocytosis [12–14].

The earliest findings of an intramural diverticulitis can be seen on barium enema examination as a focal area of wall thickening, distorted mucosa, and slight narrowing of the lumen due to segmental spasm. The presence of coexisting diverticula in the neighboring parts of the colon

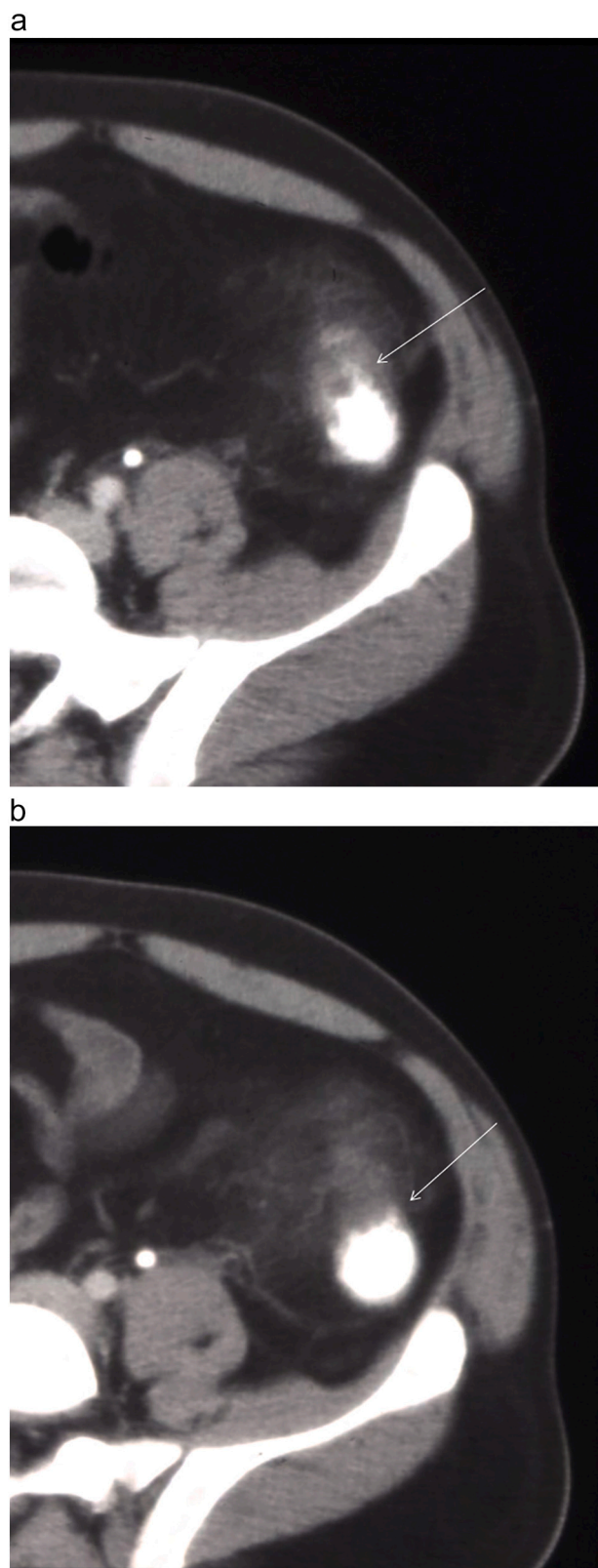


Fig. 7. CT findings of acute intramural diverticulitis in a 40 year-old man. A and B. Close-up of the descending colon after administration of rectal contrast shows the eccentric thickening of the anterior wall associated with very small outpouchings (arrows). There is also mild fat stranding in that region.

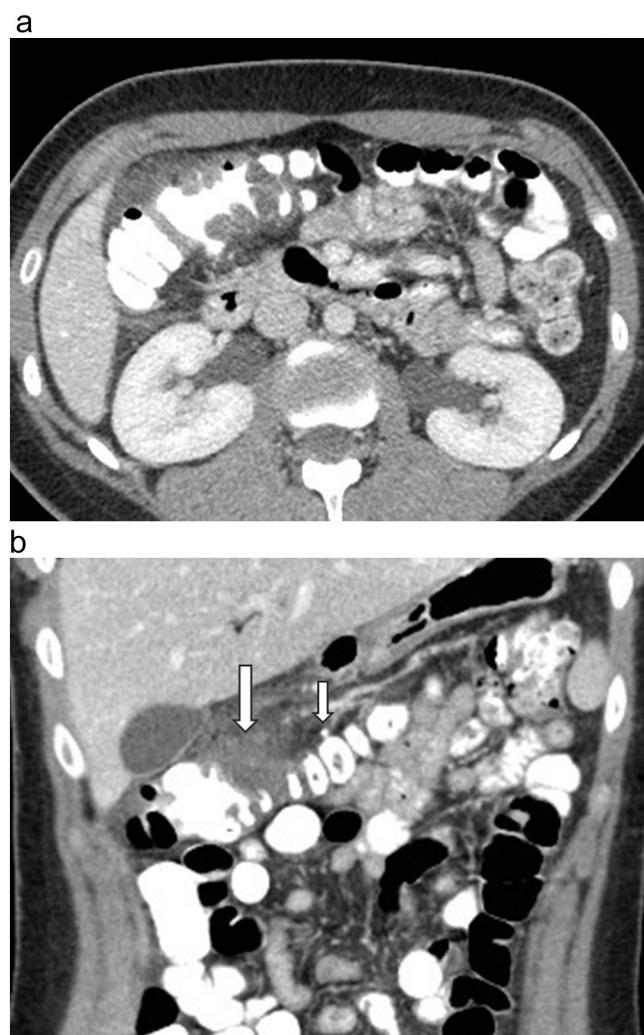


Fig. 8. Intramural diverticulitis of the transverse colon in an 18 year-old woman. A. Axial section of CT study performed with oral and Intravenous contrast reveals a 2 cm long segment of wall thickening around the inflamed intramural diverticula. B. Coronal section shows localized fat stranding of the attached mesentery (large arrow) and an intact intramural diverticulum more distally (small arrow).

can provide an important clue to the correct diagnosis (Fig. 6A and B). CT images of the same region will typically demonstrate the localized wall thickening and associated pericolic fat stranding due to edema or hyperemia (Fig. 6C).

When individuals younger than 40 years in age present with an acute abdominal pain in atypical locations, the possibility of colonic diverticulitis is seldom considered by the clinicians [12–15]. These patients are usually first referred for CT examination, which can then reveal the correct diagnosis of a previously unsuspected condition (Fig. 7).

The inflammation frequently involves several adjacent intramural diverticula, causing a short segment of eccentric wall thickening, irregularly narrowed lumen, and pericolic fat infiltration. The relatively acute onset of symptoms in a young patient and detection of other small diverticula are helpful guides for establishing an accurate diagnosis even if the process involves rather unusual locations such as the transverse colon (Fig. 8). In this context, it should be mentioned that this 18 year-old woman had presented with severe upper abdominal pain and fever, and clinically suspected to have either an acute cholecystitis, pancreatitis, or perforated ulcer. Therefore, the CT findings of transverse colon diverticulitis provided an unexpected diagnosis that surprised both the referring physician and the examining radiologist.

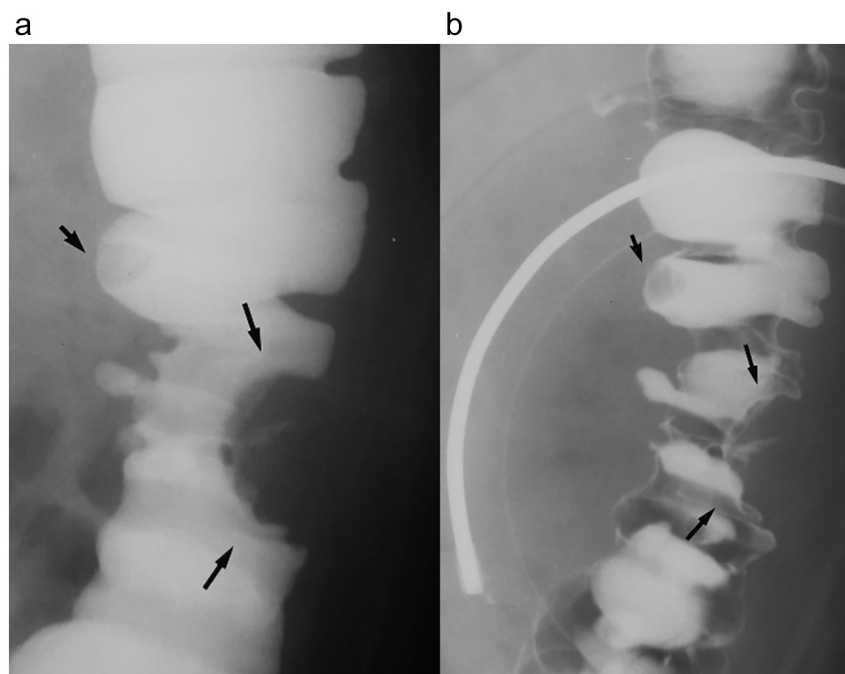


Fig. 9. Chronic intramural diverticulitis of the colon in a 55 year-old man. A and B. Two radiographs from barium enema examination show a well-demarcated 1.5 cm soft tissue mass in the lateral wall of descending colon (large arrows). The neck of perforated diverticulum at the center of this mass is partially visible. There is also a sessile polyp proximal to the lesion (small arrow).

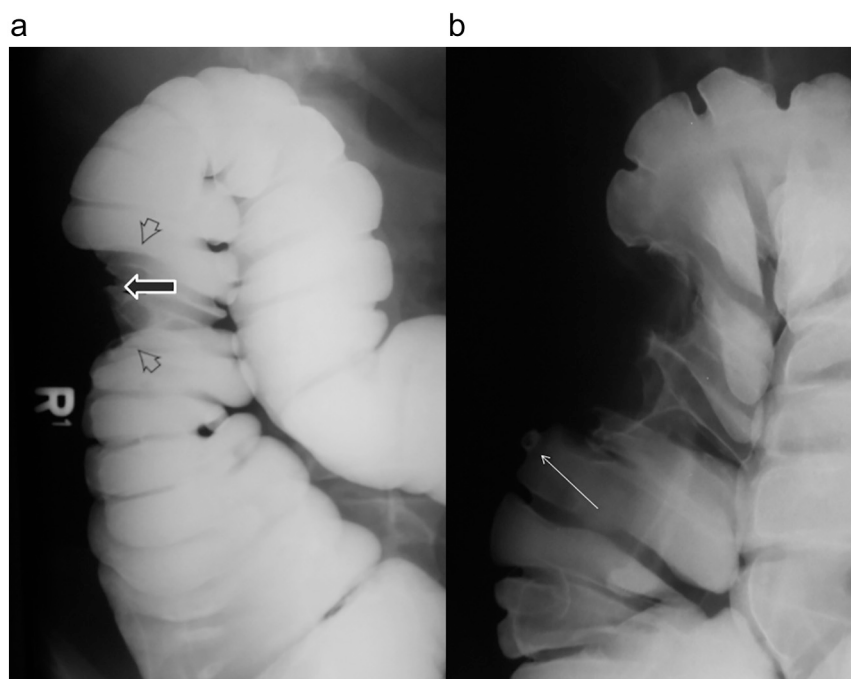


Fig. 10. Intramural mass caused by perforated chronic diverticulitis in a 35 year-old woman.

A. Radiograph from barium enema study show a lobulated mass in the lateral wall of the ascending colon (open arrows), with mucosal folds radiating towards its middle (black arrow).

B. Close-up view after applied compression demonstrates a bi-lobed soft tissue mass around the neck of involved diverticulum, with another small diverticulum seen in the adjacent colonic wall (arrow). The resected surgical specimen showed that 2 edematous epiploic appendages were adherent to the site of intramural diverticulitis, causing the unusual bi-lobed configuration seen on this image.

Most cases of intramural diverticulitis resolve after 1–2 weeks of antibiotic therapy and conservative management. However, recurrence in the same area or elsewhere in the colon is common in many instances. Several studies have documented that diverticulitis in young patients has a high rate of recurrence and complications [12–16].

A perforated intramural diverticulitis with an abscess can become a chronic process that is encapsulated by reactive fibrosis, and may require segmental resection of the colon. Two surgically proven cases of this particular condition demonstrated the findings of a lobulated or

semilunar mass of the colonic wall on barium enema studies (Figs. 9 and 10). The neck of inflamed diverticulum at the center of the soft tissue mass was partially opacified by barium in both instances. However, such lesions may closely resemble an ulcerated tumor and pose as a diagnostic challenge on the preoperative evaluation by barium enema or colonoscopy.

It should be noted that the author had personally encountered 18 patients with intramural diverticulitis, who had their radiological imaging studies performed during the period 1980–2015. This series of

cases included 8 men and 10 women, ranging in age from 18 to 55 years (mean age: 38 years). The sites of inflammation were the descending colon or sigmoid in 14 patients, the transvers colon in 3 and the ascending colon in one them. The acute episode of diverticulitis resolved usually in 10–14 days after conservative treatment with antibiotics. However, 5 patients subsequently underwent surgical resection of the involved colonic segment because of persistent or recurrent diverticulitis, or a coexisting polyp or tumor in the same part of the colon.

6. Discussion

The diagnosis and management of advanced diverticular disease of the colon occurring in older patients are well-described in the medical literature. However, the intramural diverticulosis and diverticulitis have received scant attention. In fact, a Google Scholar search revealed only 2 previous articles about this specific subject. In a 1957 publication, Cohen and associates described the surgical aspects of this entity [17]. In a 1972 paper by Beachley [18], two cases of intramural masses of the colon caused by diverticulitis are reported. Their barium enema findings were somewhat similar to the 2 cases illustrated here (Figs. 9 and 10).

The paucity of published information about intramural diverticular disease of the colon is a rather surprising fact considering the natural history of its evolution and its clinical implications. This is in contrast to the ample number of references concerning two other conditions known as intramural pseudo-diverticulosis of the esophagus or gallbladder [19,20].

The remarkable increase in the incidence of colonic diverticulitis in patients younger than 40 years in age has been documented in multiple recent studies [4,5,12–16]. Its development as related to obesity, particularly during the early adulthood, has also been investigated [3–5]. Several authors have noted that diverticulitis in young patients can have an aggressive and fulminant course, thus often requiring prompt surgical intervention [13–15].

It seems apparent that many young adults are prone to first develop intramural diverticulosis of their colon long before presenting with clinical symptoms of diverticulitis. The inflammatory process in this group of patients may occur in rather uncommon sites, such as the transverse or ascending parts of the colon (Figs. 8 and 10). The relatively indolent nature of some chronic cases of intramural diverticulitis can also lead to delayed clinical presentation and diagnosis (Figs. 9 and 10). Therefore, it would be important for the practicing physicians and abdominal radiologists to be familiar with the pathogenesis and radiological features of intramural diverticular disease as presented in this article. It is hoped that the herein provided information will further enhance their knowledge regarding such a prevalent intestinal disorder and its potential complications.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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