Role of MDCT Enterography in Diagnosis of Crohn’s Disease

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Abstract

Purpose: To evaluate the ability of multi-detector computed tomography MDCT small intestinal enterography in diagnosis of the small intestinal Crohn’s disease (CD).

Material and Methods: Ten patients suspected to have small bowel Crohn’ disease had undergone contrast enhanced multidetector CT for detecting the involved segment, extension of the disease, activity of the disease, extra-enteric manifestations and complication of the disease.

Results: Enteric and extra-enteric manifestations of Crohn’s disease were diagnosed in all patients with MDCT enterography.

Conclusion: MDCT can detect bowel wall abnormalities, mesentery, vasculature and surrounding structures changes related to Crohn disease and most important it can judge on its activity based on specific MDCT criteria.

Key Words: Crohn’s disease CD – MDCT (multi-detector computed tomography).

Introduction

CROHN’S disease or regional enteritis is an idiopathic chronic inflammatory disease which may affect any part of the gastrointestinal tract from the mouth to the anus. In nearly half of patients, Crohn’s disease is seen in both the small and large bowel. In approximately one third of patients, inflammation is isolated to the small bowel (mostly in the terminal ileum). Inflammation is confined to the colon in up to 20% of patients [1].

The greatest age incidence is in the second and third decades of life but can occur after 50 years of age. Males are affected more frequently than females. Its etiology is not well-understood, but is likely multifactorial; genetic, autoimmune, and infectious. The cardinal histological features are the non caseating granuloma, collection of epithelioid histiocytes and giant cells [2]. Crohn’s disease is characterized by aphthous ulceration, cobblestoning, strictures and fistula formation. The changes in the bowel wall are typically discontinuous and asymmetric [3]. In a typical case the changes are patchy; the involved areas being separated by varying lengths of normal bowel (skip lesions). Crohn’s disease is a transmural process involving the mucosa, submucosa, intermuscular septa, and subserosa [2].

A single gold standard for the diagnosis of CD is not available and the diagnosis of CD is confirmed by clinical evaluation and a combination of endoscopic, histological, radiological, and/or biochemical investigations. In recent years, many studies have been performed to investigate the diagnostic potential of less invasive and more patient-friendly imaging modalities in the evaluation of Crohn’s disease including conventional enteroclysis, ultrasonography, color-power Doppler, contrast-enhanced ultrasonography, multidetector CT enteroclysis, MRI enteroclysis, and 99mTc-HMPAO-labeled leukocyte scintigraphy [4]. Small bowel follow-through and enteroclysis are widely used for small-bowel imaging; however, these examinations provide only indirect information about the bowel wall and surrounding structures and are prone to problems caused by overlapping bowel loops. To overcome the limitations of previous techniques, CT enteroclysis, a technique combining the advantages of enteroclysis and CT, has been extensively investigated [5,6]. Although CT enteroclysis profits from excellent distention of the entire small bowel and precise evaluation of the extent of extraluminal disease, it has the major drawbacks of invasiveness and high radiation exposure. Recently, the role of wireless capsule endoscopy to assess small-bowel disease has been reported. The value of this technique is well documented for diagnosing obscure gastrointestinal bleeding and early Crohn’s disease [7,8]. However, problems with this technique include capsule obstruction by bowel strictures and battery
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failure in prolonged transit. The technique may provide false-negative results if there is rapid peristalsis at a lesion site or if there is bowel angulation at a lesion that impairs the camera view [9,10].

Currently, the availability of MDCT and the continuous refinement of the 3D imaging process have greatly expanded the utility of CT for evaluating patients with small-bowel disease.

MDCT has transformed CT from a trans-axial cross sectional technique into a truly three dimensional imaging modality [11]. The technique enables the acquisition of a volume of data, rather than slices. Advantages of the technique include the rapid acquisition and three dimensional rendering of images. The spatial resolution is improving and so is the diagnostic confidence [12].

**Patients and Methods**

Our study was included 10 patients (6 males and 4 females, their ages ranged from 32 years up to 75 years old with a mean of 47.4 years) suspected to have Crohn’s disease who had undergone multidetector CT enterography in Radiodiagnosis Department of Assiut University during the period from January 2011 till October 2013. Patients complaining of unexplained abdominal pain with recurrent or persistent watery diarrhea were included in this study. Patients had history of allergy to iodinated contrast agents or impaired renal functions or pregnant patients were excluded from the study.

**Technique of MDCT small intestine examination:**

**Patient preparation:** All patients had a low-residue diet, ample fluids, laxative on the day prior to the examination, and they fasted for 4 hours before the examination. Patients were given water as a neutral oral contrast agent so that the degree and pattern of small bowel enhancement can be well analyzed. On arrival at the imaging center, patients ingested 500ml, ten minutes later patients ingested another 500ml. Twenty minutes later patients ingested 225ml. Finally, on entering the scanning room, the patient drank a 225ml of water to distend the stomach and duodenum.

**Steps of MDCT:** Intra venous contrast enhancement was used in all patients. Two-phase CT (arterial and delayed phase) was performed. A 20-gauge cannula was inserted into an arm vein and a 1.5ml/Kg of iodinated contrast material (Ultravist 360mg) was injected at a rate of 3-4ml/sec using an automated power injector. The delay between the start of the IV contrast injection and the start of the scanning was 25 seconds to achieve the arterial phase, and 60 seconds for the delayed phase (also named enterography phase where the small bowel wall enhancement was optimum). Images were obtained from the dome of the liver to the lower margin of the symphysis pubis during a single breath-hold.

**Image acquisition and parameters:** All patients were imaged with a 64-MDCT scanner (Toshiba Aquillion-Japan) using the following scanning parameters: 64x0.75mm detector configuration, 600 millisecond gantry rotation, 0.8mm slice width, 16 volume-pitch, 120kVp, 180 effective mAs and 6 seconds total scan time.

A dose modulator, which automatically decreases the radiation exposure to thinner areas of the patient, was used and reduced the dose up to 30%. The technologist generated a set of axial 3-mm sections and a set of 3-mm thick coronal multiplanar reformatted images at 3-mm intervals encompassing the entire bowel using the suitable reconstruction parameters.

**Image analysis:** The thin slices were sent to the workstation (Vitrea workspace which is diagnostic viewing and processing workstation), where 3D volume-rendering (3DVR), multiplanar reformatted (MPR), maximum-intensity-projection (MIP) and MDCT angiography displays. All small-bowel abnormalities included pattern of intestinal wall enhancement, length of the loop involvement, degree of wall thickening, types of thickness either symmetrical or asymmetrical, location of the affection, mesenteric changes and associated abdominal abnormalities were reported.

**Results**

All patients complained of recurrent abdominal pain and watery diarrhea. Two patients (20%) complained of alternating diarrhea and constipation. Eight patients (80%) complained of associated loss of weight.

**MDCT enteric findings:** All ten (100%) patients’ small bowel showed segmental symmetric wall thickening. Eight (80%) patients showed moderate wall thickening with wall thickness from 5mm to 10mm and two (20%) patients showed mild wall thickening from 3mm up to 5mm. Eight (80%) patients showed the characteristic segmental target appearance (mural stratification patterns) of enhancement. Five patients had bilaminar appearance with mucosal hyperenhancement and decreased intramural attenuation. Three patients had trilaminar appearance with mucosal and serosal hyperenhancement and decreased intramural enhancement (Fig. 1).
The attenuation of the intramural portion of the bowel were water attenuation indicates active inflammation or intramural soft tissue attenuation represented an inflammatory infiltrate in active patients while in chronic patients were intramural fat density. The submucosa of the small intestine was involved in six (60%) patients while the mucosa and submucosa were involved in the other four patients. Jejunum and ileum were involved in all (100%) of the patients showing the specific “skip lesions” feature and the duodenum was also involved in four (40%) of them. Four (40%) patients showed hyper enhancement of the wall suggesting active disease (Fig. 2). Therefore four (40%) patients were diagnosed according to MDCT criteria as Active Crohn disease and six (60%) patients as chronic Crohn disease.

Six (60%) patients showed significant lumen narrowing (striction) of the involved bowel segments two of them were associated with reduction in wall thickness indicated irreversible fibrotic stricture and four patients associated with moderate wall thickening of reversible stricture.

Extra-mural findings: Four (40%) patients were associated engorged vasa recta that penetrate the bowel wall perpendicular to the bowel lumen create the comb sign (Fig. 3). Six (60%) patients were associated with fibro-fatty proliferation along the mesenteric border of involved bowel segments. Six (60%) patients were associated with multiple enlarged mesenteric lymph nodes.

Extra-enteric findings and complications: Four (40%) had perianal fistula. One patient had entero-colic fistula and one female patient had enterovaginal fistula. Fistulas were seen as hyperenhancing tracts that arise from involved sections of bowel. One female patient complicated by pelvic abscess. Four (40%) patients showed associated mild ascites and bilateral sacroilitis and one (10%) patient showed renal stones (Fig. 4).

Six (60%) patients had done upper endoscopy prior to MDCT examination, two of them showed gastritis and duodenitis with Crohn disease ulcers, the other two showed atrophic gastritis and the last two were free. MDCT diagnosis was confirmed by upper endoscopy and biopsy in two patients, the rest were clinically followed-up after medical treatment.
Discussion

The bimodal distribution of age at diagnosis classically refers to a peak incidence in the second and third decades (15-25 years old), followed by a second smaller peak in the sixth or seventh decade [13]. However, in our study, the mean age was 47.4 years for an age range of 32-75 years. Our all patients were all above the age of 30 years, with four of them above the age of 50 years. This may be attributed to the late onset of diagnosis and our smaller sample size. However, our mean age was 47.4 years.

According to Jaffe et al., 2007 [13], the classic presentation of Crohn’s disease is that of abdominal pain, weight loss, and diarrhea. This applies to our study, as all of our patients complained of recurrent abdominal pain and watery diarrhea and eight of the ten patients complained of associated loss of weight.

Crohn disease according to Macari et al., 2007 [14] may lead to mild, moderate or marked wall thickening. In our study, 80% of the patients showed moderate wall thickening, while only two (20%) patients showed mild thickening. Also, 80% of our patients showed the characteristic target sign of enhancement which according to Macari et al., 2007 [14] and Paulsen et al., 2006 [15], results from mucosal and serosal enhancement surrounding a prominent low-attenuation submucosa. It was first described as a specific sign for Crohn’s disease, but it is now recognized that any nonneoplastic condition may lead to a target appearance in the small bowel.

Macari et al., 2007 [14] and Paulsen et al., 2006 [15] stated that segmental homogeneous mural hyper enhancement correlates significantly with histological findings of active Crohn disease. This was confirmed in our study, as four patients showed hyper enhancement of the wall, two of them with homogenous enhancement and the other two with target appearance of enhancement.

Typically, Crohn disease results in segmental symmetric involvement of the affected small bowel in Macari et al., 2007 [14] study and this was found in our study as all the patients showed this criterion. Although Crohn’s disease has a predilection for the terminal ileum, it may affect any segment of the gastrointestinal tract [14]. In our study, jejunum and ileum were involved in all the patients showing the specific sign of skip lesions. However, the duodenum was also involved in four of them.

Although the fine mucosal detail of a small-bowel series or the actual visualization of the mucosal surface on endoscopy is superior to that on MDCT, the location can be often inferred by typical MDCT signs. Crohn disease affects and disrupts the small-bowel mucosa and can be seen on MDCT [14]. In our study, 40% of the patients showed mucosal affections.

Paulsen et al., [15] stated that the comb sign is created by engorged vasa recta, vessels that penetrate the bowel wall perpendicular to the bowel lumen and they indicate active inflammation. This was found in our study in the four patients with active Crohn disease.

Macari et al., 2007 [14] stated that Crohn disease is associated with soft-tissue attenuation lymph nodes enlargement. In this study, six patients showed multiple enlarged mesenteric lymph nodes.

Extra-enteric manifestations of Crohn disease are readily identified with CT enterography. Paulsen et al., [15] study, including sacroilitis and renal stones. In our study, four patients showed associated bilateral sacroilitis and two showed associated renal stones. According to Hong et al., 2006 [16], small-bowel series and enteroclysis have had a primary role in the diagnosis and management of patients with suspected inflammatory bowel disease of the small intestine. However, these imaging techniques do not offer any important information about extraluminal extension of the disease or changes in surrounding structures. CT can overcome this limitation, but its effectiveness is limited because it lacks the ability to depict fine mucosal changes of the affected bowel. And according to Maglinte et al., 2007 [17], capsule endoscopy has a low retention rate of 1%-2% in patients suspected of having (and previously undiagnosed) Crohn disease and higher diagnostic yield than small-bowel barium study, conventional CT, CT enteroclisis, or CT enterography. After negative colonoscopy and ileoscopy findings, capsule endoscopy is considered to be the first-line examination in the investigation of suspected non-stricturing Crohn disease. Imaging tests are usually considered first. Paulsen et al., 2006 [15] also mentioned that capsule endoscopy yields exquisite images of the small bowel mucosa and has been shown to be superior to...
radiologic examinations in the diagnosis of many small bowel diseases. Because of the unavailability of capsule endoscopy in our hospital, we agree with Paulsen et al who stated that the accuracy and noninvasive nature of CT enterography make it a primary tool in the setting of suspected Crohn disease. Lee et al., 2009 [18] have found that MR enterography yielded significantly more motion artifacts than did CT enterography. However, this technique can be used as a radiation-free alternative for evaluation of patients with Crohn disease, especially those who are young and may require repeated examinations.

Boudiaf et al., 2004 [19] stated that in cases of Crohn disease, MDCT accurately demonstrated the mural and extramural inflammatory changes that are caused by the disease. It also helped to determine the length of the affected portion of the small bowel.

CT enterography exquisitely demonstrates active Crohn disease and its complications because of its higher spatial resolution and its superior capacity to display the small bowel wall [15].

**Conclusion:**

MDCT can detect bowel wall abnormalities, mesentery, vasculature and surrounding structures changes related to Crohn disease and most important it can judge on its activity based on specific MDCT criteria. However, other radiation-free modalities such as contrast-enhanced ultrasonography and magnetic resonance imaging are preferred to be used in follow-up of young patients.

**References**


