Magnetic resonance imaging in acute appendicitis
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Chapter 7

Right colonic diverticulitis: MR appearance

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Abstract

Background: We evaluated the magnetic resonance (MR) features of right colonic diverticulitis.

Methods: This prospective study was based on five patients selected out of a group of 156 patients admitted to the radiology department for further evaluation because of clinically suspected appendicitis. All five patients had an ultrasound (US) and a magnetic resonance (MR) study, four patients also had a computed tomography (CT) scan.

Results: In all five patients right sided diverticulitis was seen as an outpouching of the right sided colon with associated circumferential wall thickening of the colon and surrounding inflammatory changes.

Conclusions: Our results suggest that MR imaging can be useful in the diagnosis of right colonic diverticulitis. An inflamed diverticulum with adjacent colonic wall thickening and surrounding inflamed fat are characteristic MR signs. MR imaging can be a valuable alternative to a CT scan in young patients and pregnant females, who have suspected appendicitis and an equivocal US result.
Introduction

Right colonic diverticulitis is considered a rare condition in Western countries. Before the advent of ultrasound (US) and computed tomography (CT), the diagnosis was almost exclusively made as an unexpected finding at surgery, in most cases for presumed appendicitis. Until recently right colonic diverticulitis was considered to be rare with a frequency of one case in 300 appendectomies. However due to more frequent use of US and CT, in patients with abdominal pain, and increasing awareness of its imaging features, it is currently diagnosed more often and is reported in 3% of patients clinically suspected of having appendicitis. Misdiagnosis may lead to unwarranted surgical procedures and hospitalization. Recent studies have shown that right-sided diverticulitis has a benign natural history and surgical intervention can be avoided in the vast majority of patients.

In contrast to sigmoid diverticula, which are acquired and are usually multiple, right-sided colonic diverticula are mostly congenital and solitary. Whereas sigmoid diverticula are false diverticula (i.e. herniations of the mucosa through the muscularis), right-sided diverticula are usually true diverticula, (i.e. outpouchings of the colonic wall containing all layers). Not surprisingly, in view of its congenital character, right-sided colonic diverticulitis can be detected at any age with a peak prevalence in patients aged 35 to 45 years.

Presenting symptoms are misleading, leading in the majority of cases to a presumed diagnosis of appendicitis, or an appendiceal mass when a palpable mass is present. US and CT are capable of a reliable diagnosis of right-sided diverticulitis. However US is operator dependent and may therefore have an equivocal result, while CT uses ionizing radiation. This is the first report describing the magnetic resonance imaging (MRI) features of right colonic diverticulitis.
Materials and Methods

From January 2001 to March 2002, a discharge diagnosis of right-sided diverticulitis was established in 5 patients (two male and three female patients; median age, 43 years; age range, 28-83 years) at our 300 bed community hospital. These five patients were selected out of a group of 156 patients who were admitted to the radiology department for further evaluation because of clinically suspected appendicitis in this period. All 156 patients had an US study and a MR study because of an ongoing research project in our hospital. US studies were performed according to the routine policy at our hospital with regard to patients with acute abdominal pain. In four of the five patients a CT scan was done as well. The study was approved by the medical ethical commission of the hospital and written informed consent was obtained prior to the MRI examination.

All MRI examinations were performed, after informed consent for research purposes, on a 1.0 T system (Siemens Harmony Erlangen, Germany). Breathhold T1FLASH (TR 133 msec/TE 5,5 msec/Flip angle 75), T2TSE(3300/108/160) and T2TSE fat suppression (3360/108/160) sequences were obtained using a body phased array receive coil. A multislice imaging technique was used for all patients with 5 mm thick slices with a distant factor of 0,5 mm with acquisition times of 13-24 sec. The FOV chosen was as small as possible, ranging from 260 to 400mm and was dependent on the patients habitus. First, six scout images were obtained. Subsequently, T2TSE-weighted slices were obtained in the coronal plane in the ileocecal region as suggested on the scout images. After this, sequences were made in the axial plane through the cecal pole or the region of interest. If necessary extra sequences (T1FLASH, T2TSE, or T2TSE fat suppression) were obtained in the axial plane when the entire region of interest was not included in the volume. The study protocol was designed to be as non-invasive as possible and to study the value of non-contrast MR, so principally no gadolineum was administered. On
average each MRI examination was completed within 15 minutes. This included: patient registering, preparing the patient on the table, and reviewing the images on the monitor for technical adequacy and preliminary results.

The MRI criteria for right colonic diverticulitis were derived from the CT criteria: visualization of the diverticulum as an outpouching of the right-sided hemicolon at the level of possible maximum circumferential wall thickening of the colon. The surrounding fat adjacent to the diverticulum should be inflamed showing fat stranding in the form of high signal intensity strands on the T2 weighted images and low to intermediate signal intensity strands on the T1 weighted images in the surrounding fat. There should be no signs of appendicitis. The MRI studies were performed within one hour after the US and CT studies. Retrospectively, MRI studies were interpreted by two radiologists experienced in abdominal imaging, who were blinded for the US and CT findings, (JBCMP, LPJC) and consensus about the findings was reached.

**Results**

In all five patients the MR imaging technique could depict the diverticulum on the T1 and T2 weighted sequences, but only in three patients on the T2 fat suppression sequences; the circumferential colonic wall thickening and the surrounding inflammatory fatty changes were seen on all sequences (Fig. 1 and 2).

On T1 and T2 imaging the diverticulum appeared as a low signal intensity outpouching of the colon. Where the colonic wall was thickened there was an intermediate signal intensity on the T1-weighted sequences and a high signal intensity on the T2-weighted sequences. The surrounding inflammatory changes appeared as areas of partially confluent low intensity strands in the surrounding high intensity fat on the T1 weighted images and as intermediate to high signal intensity areas of partially confluent strands on the T2-weighted images, as was best seen on the T2-weighted fat suppression images. There was some mass effect on the colon
and surrounding features in all patients. In two patients there was a suggestion of a small pericolic abscess (as was confirmed by CT), as can be seen in stage 1 of the normal natural course of right-sided diverticulitis (Fig. 2) [2]. In four patients the normal appendix was clearly seen on the T1 and T2 weighted images (Fig. 2a).

Fig 1. -Right colonic diverticulitis in 28-year-old woman who was clinically suspected of appendicitis.  
A Axial US image of the ascending colon (c) shows moderate colonic wall thickening with an adjacent inflamed diverticulum (arrow) surrounded by hyperechoic non-compressible inflamed fat (arrowheads).  
B Corresponding CT image shows the inflamed diverticulum and surrounding inflammatory changes (arrowheads).  
C Axial T2-weighted MR image clearly shows the inflamed diverticulum with hyperintense to intermediate signal changes in the surrounding fatty tissue (arrowheads) representing the inflamed fat.  
D Axial T2-weighted MR image with fat suppression shows the inflamed diverticulum with hyperintense signal changes in the fatty tissue (arrowheads), surrounding the diverticulum and the ascending colon (c).  
E Coronal T2-weighted MR image clearly shows the inflamed diverticulum (arrow) with hyperintense to intermediate signal changes in the surrounding fatty tissue representing the inflamed fat with some mass effect.
Discussion

There are many diseases that can mimic appendicitis. One of these mimickers is right-sided diverticulitis, which is an inflammation of a diverticulum usually associated with an obstructing fecalith. The patient’s history is generally more protracted, when compared with the history in patients with appendicitis. Nausea and vomiting are less frequent, the pain is milder and the point of maximum tenderness is more variable in location (usually more higher up) [2]. This explains why the clinical diagnosis of cholecystitis is occasionally considered. In about one-third of cases, a palpable mass is present, which can be misinterpreted as an appendiceal mass or cecal tumor [4]. Right-sided colonic diverticulitis has a benign natural history with only two reported cases of formation of large abscesses [4]; free perforation to the peritoneal cavity has never been described. Spontaneous resolution of symptoms occurs normally within days or weeks [2]. Treatment is primarily non-surgical and consists of reassuring the patient and, if necessary, the administration of analgesics. A correct diagnosis is necessary as to avoid hospitalization, antibiotic therapy or unnecessary surgery.

The diagnosis of right-sided colonic diverticulitis is far from clear at surgery: In over 40% of cases, a right hemicolectomy is performed because of presumed malignancy [3, 4]. In contrast to the clinical diagnosis, the US and CT diagnosis of right-sided colonic diverticulitis can be made quite confidently [2]. A right-sided colonic diverticulum is seen surrounded by inflamed fat and adjacent circumferential colonic wall thickening. Sometimes a fecalith in the diverticulum can be seen, or the formation of a small abscess.

Conditions mimicking the imaging features of right-sided colonic diverticulitis are appendicitis, appendiceal mass, Crohn’s disease, omental infarction, epiploic appendagitis, colonic carcinoma, or sigmoid diverticulitis. In our study in all five patients there was no doubt that the MR images showed a right-sided diverticulum surrounded by inflamed fat. In four patients the normal appendix was depicted with
Fig 2. Right colonic diverticulitis in a 39-year-old woman with a clinically suspected appendicitis. A Coronal T2-weighted MR image shows a normal appendix (arrow) in a retrocecal position. B Axial CT image of the ascending colon (c) shows colonic wall thickening and a 1 cm diameter pericolic abscess (arrow) with inflammatory changes in the surrounding fatty tissue (arrowheads). C Axial T2-weighted MR image shows the inflamed diverticulum with hyperintense to intermediate signal changes in the surrounding fatty tissue (arrowheads) representing the inflamed fat. D Axial T2-weighted MR image with fat suppression shows hyperintense signal changes in the fatty tissue (arrowheads), surrounding the inflamed diverticulum and the right colon (c). E Axial T1-weighted MR image shows the inflamed diverticulum with hypointense signal changes in the surrounding fatty tissue representing the inflamed fat.

MR imaging. In omental infarction and epiploic appendagitis there is no diverticulum seen and usually no colonic wall thickening. Moreover, since these conditions also have a benign natural history the distinction has no practical implications. An underlying carcinoma may mimic the imaging features of diverticulitis, therefore, in doubtful cases, coloscopy after the symptoms have subsided can be indicated. In a recent study using thin-section helical CT, an inflamed diverticulum and a preserved enhancement pattern of the thickened colonic wall were the two most statistically
significant CT findings distinguishing right colonic diverticulitis from colonic carcinoma [5].

Acute appendicitis is the most common cause of acute abdominal right lower quadrant pain and for emergency abdominal surgery. Because of a high false negative appendectomy rate (25-30%) in patients suspected of having appendicitis, a radiological evaluation to confirm or exclude the diagnosis of appendicitis is often performed. Transabdominal US [6] and abdominal CT [7] have proven to be reliable procedures in detecting or excluding appendicitis with reported sensitivity and specificity of more than 90%. US is inexpensive, quick and easy to perform, but is operator dependent and limited in obese patients. In such cases CT can be performed, however this implies a considerable amount of radiation. A typical dose for an abdominal CT examination is in the order of 10mSv, this means that one CT examination carries about the same radiation risk as 500 chest radiographs [8, 9]. The routine use of diagnostic CT examinations for benign diseases, as in appendicitis, gives rise to question whether the diagnosis can be obtained by other radiological means, especially in young patients and in pregnant women. An abdominal MRI examination of the abdomen appears to be a good alternative. During the past decade MRI has become widely available in the Western world. Technological developments have made ultrafast sequences possible, resulting in shorter examination times and fewer motion artifacts. An MRI examination is a safe and non-invasive diagnostic tool, without the use of ionizing radiation. MR has been described as a useful non-ionizing imaging technique for evaluation of patients with suspected acute appendicitis [10, 11] and has recently also been reported as a feasible diagnostic tool in patients with presumed acute sigmoid diverticulitis [12]. In our group of 156 patients there were no patients who were incorrectly diagnosed as having a right sided diverticulitis i.e. who later turned out to have another condition as appendicitis or cecal carcinoma. It is likely MR use will increase for the evaluation of acute abdominal conditions in a selected group of patients. In our study the MR
examinations took no longer than 15 minutes, and it had no important impact on our routine daily MR program.

Our study is limited by the lack of surgical and histological proof, not unexpected as it concerns a self-limiting disorder. The diagnosis was made on the basis of US and CT findings which were consistent with cases from the literature, combined with a follow-up period in which symptoms spontaneously resolved and no alternative diagnosis emerged.

In conclusion, right colonic diverticulitis is an uncommon but underdiagnosed benign mimicker of appendicitis, for which MRI appears capable of making a correct diagnosis.
References
