Diverticulitis - Imaging helps treatment stratification?

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Purpose

Diverticulosis is one of the most common colonic conditions in Western populations. The exact incidence is unknown but increases with age. Diverticulosis has been considered a rare condition in patients younger than 30 years old and only 5% of the general population younger than 40 years and up to 80% of people older than 80 years are affected by diverticulosis. Diverticulosis is particularly predominant in men below 60 year-old and in women above that age.

Recently, 2 prospective cohort studies (the Health Professionals Follow-up Study and a Swedish study) have shown an association between body mass index (BMI) and diverticular disease.

Ten percent to 25% of the people with diverticulosis will develop diverticulitis, which is localized on the left side of the colon in 95% of cases.

The clinical diagnosis and assessment of acute colonic diverticulitis can be difficult, since it can be mimicked by other acute abdominal conditions and furthermore, clinical evaluation results are limited for the purpose of the extent of pericolic inflammatory process (Table 1), which can lead to inaccurate management of acute colonic diverticulitis.

Computed Tomography (CT) not only establishes the diagnosis but also identifies those patients who are at high risk for developing complications or recurrence after a first episode of acute diverticulitis. Abscess formation is a major determinant in the prognosis and treatment of diverticulitis, as is the visualization of extracolonic contrast or gas on CT. Criteria unrelated to imaging have been reported to correlate with the outcome of acute diverticulitis. Patients with a recurrent attack of diverticulitis may be at high risk (60%) for developing complications, and elective surgery has been proposed as the preferred treatment for this group.

There is a study that shows that US and CT findings provide similar accuracy for the diagnosis of acute colonic diverticulitis, and their results suggest that US may be a valuable as an alternative to CT for the radiologic evaluation in patients with this disease. Potential advantages of ultrasonography (US) over CT in the evaluation of the bowel wall and its environment include wider availability, lower cost, and absence of intravenous injection of iodinated contrast material.
The disease stage in patients with diverticulitis is often determined by using the modified Hinchey classification system (Table 2), in which imaging and/or surgical findings are incorporated.¹

The authors review US and CT features in diverticulitis based on one of our surgery departments database and also correlate those imaging signs with modified Hinchey classification of diverticulitis, and how imaging findings may help (in the adequate clinical setting) in treatment stratification of this acute abdomen cause.
Table 1: Main clinical presentations of diverticular disease


Table 2: Modified Hinchey classification system

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Methods and Materials

We performed a computer search of the medical and radiologic reports of patients admitted for diverticulitis in one surgery section of our hospital between January 2009 and December 2010. The institutional review board did not require patient informed consent. Radiologic evaluation was requested entirely on the basis of clinical’s judgement and almost patients were evaluated with US and CT.

All patients with clinical indication of acute phase diverticulitis underwent US and/or abdominal and pelvic CT if their general condition did not require immediate surgery because of the ready availability of both in our institution. We identified all patients who had a diagnosis of diverticulitis on their admission on US or CT report (acute phase) and those who had a final diagnosis of diverticulitis on their discharge summary - acute and non-acute phase (after resolution of an acute episode). One hundred and thirty seven patients met our search criteria (62 women, 75 men) (Table 1).

The medical discharge reports of these patients were analyzed to record their demographic data (sex and age) (Figure 1) in patients with the diagnosis of diverticulitis confirmed at discharge. In our institution, patients who do not undergo surgery within the first 24 hr after admission are either assigned a nonoperative treatment procedure or recommended for elective surgery.

Nonoperative treatment (conservative) was defined as an attempt to treat the patients with antibiotics only, without scheduling them for elective surgery. A percutaneous drainage procedure was considered nonoperative treatment if it was performed in an attempt to avoid surgery. Of the 137 consecutive patients with a medical discharge diagnosis of diverticulitis, 23 (16.8%) were excluded from further analysis (Figure 2) for the following reasons: were non-acute phase patients that were submitted to elective surgery and most of the imaging exams were not found on hard copies or on PACS (picture archiving and communication system).

US studies were obtained with an Toshiba Aplio imaging unit.

In each patient, the colon and its environment were initially examined by using a broad-band 3,5-MHz convex-array transducer. This evaluation was completed with a sonographic assessment of the colonic wall performed with a broad-band 8-MHz linear-array transducer.

The operator was randomly selected among of radiologists of our department with 3 to 10 years experience in both US and CT of the gastrointestinal tract. No US examination was performed by a technologist. In the patients who presented with clinical symptoms that were localized or predominating in the left lower quadrant, US was initiated by scanning of the area of left iliac fossa, which usually allows the identification of the sigmoid colon as an intestinal segment located between the left iliac crest and the bladder dome anterior.
In continuity with this segment, the descending colon was easily followed by scanning above the iliac crest up to the splenic flexure of the colon. US evaluation of the colon was completed in each patient with an overall abdominal examination performed with the 3.5-MHz convex-array transducer, including a search for intraperitoneal free fluid (especially in paracolic gutters, lower pelvic recesses, perihepatic and perisplenic spaces).

CT examinations were performed in a multidetector CT scanner (Philips Brilliance CT 16 slice). Scanning was routinely performed with IV contrast using a power-injected bolus of 80 to 100 mL of 320 mg I/mL injected at 2 to 2.5 mL/ sec. A uniphasic IV contrast injection with a scanning delay of 60 sec was used. No colonic contrast material was systematically administered since most of the patients were imaged in emergency setting. CT was performed from the lung base to the pelvis with 3-mm contiguous sections and a table speed of 5 mm/sec (pitch=1). All initial US or abdominal CT scans were obtained within 24 hr after admission.

Our assessment of the colonic wall and local environment, which we derived from reports in literature, was based on a set of four criteria, defined before the begining of the study and matched for US and CT evaluation: 1) thickening of the bowel wall, 2) presence of diverticula, 3) inflamatory pericolic fat and 4) pericolic abscess.

For CT evaluation, these criteria were determined as follows:

1) Thickening of the bowel wall was considered to be present when the thickness of the colonic wall exceeded 4 mm (Figs 5,6,10,11,12,13) on a scan obtained perpendicular to or parallel to the long axis of the colon.

2) Diverticula were identified as flask-shaped structures filled with air, barium, or fecal material (Figs 5,6,12,13) that projected from the colonic wall.

3) Inflammatory pericolic fat was defined as a poorly marginated, heterogeneous, hazy area of increased attenuation, with or without linear stranding (Figs 5,6,9,11,12,13), in fat surrounding the colonic wall.

4) A pericolic abscess was considered to present when CT scans depicted a well defined collection that was localized in the peri-colic environment and contained liquid and/or gas components (Figs 6,9,10,11,12).

For US evaluation the same 4 criteria were defined as follows:

1) Thickening of the bowel wall was considered present when the distance from echogenic lumen interface to the hyperechoic pericolic fat exceeded 4 mm on a scan obtained through the long axis of or perpendicular to the colonic lumen (Fig 3 and 4).

2) Diverticula were defined as round foci that protrude from the colonic wall, with focal disruption of the normal layer continuity. The echogenicity of these foci varied from hypoechoic to hyperechoic, with or without internal acoustic shadowing.
3) Inflammatory peri-colic fat was defined as presence of an area of regionally increase echogenicity adjacent to the colonic wall (Fig 3 and 4).

4) Pericolic abcess was present if a well defined predominant fluid hypoechoic colection localized in the pericolic environment with possibly contained central gas (echogenic foci with acoustic shadowing within the colection) was seen, and was differentiated from adjacent bowel loops based on the aperitalsis and absence of bowel layering (Fig. 7 and 8).

The data obtained were analyzed statistically with GraphPad Prism version 5.00 and the p value < 0.05 was considered to be statistically significant.
Table 2: Modified Hinchey classification system

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Fig. 1: Demographic features of patients with diverticulitis

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**Fig. 2:** Type of patients admission: red: patients admitted with acute episode of diverticulitis; yellow: patients admitted in a non-acute phase (after resolution of the acute episode of diverticulitis)

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**Fig. 3:** On US image obtained in the axial plane, the sigmoid colon is thickened and pericolic fat is enlarged and hyperechoic in a patient with known diverticular disease.

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Fig. 4: Sagital US image in the same patient shows thickened sigmoid colon and enlarged hyperechoic pericolic fat.

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Fig. 5: Axial image of CT scan performed with intravenous contrast and oral contrast, shows mural thickening of the left colon with diverticula where the inflamed diverticulum (star) of is well demonstrated and is surrounded by inflammatory fat (fat stranding-arrow)-Modified Hinchey stage Ia diverticulitis.

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Fig. 6: Axial CT scan enhance with contrast administered i.v. shows hypodense of fluid density collection (white arrow) abutting thickened sigmoid colon that presents diverticula (green arrows) pelvic abscess.

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Fig. 7: Transverse US image shows bladder anteriorly (triangle) and a posterior pericolic abscess (arrow) - well-defined, markedly hypoechoic mass with air and fluid components within it (cloud).

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**Fig. 8:** Sagital US image show a pericolic abcess (arrow) posterior and abutting the thickened colonic wall and collapsing the lumen (star). triangle - bladder.

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**Fig. 9:** Axial image of CT scan performed with intravenous contrast and oral contrast, shows a pelvic abscess (arrow) - hypodense of air-fluid collection - abutting thickened sigmoid colon anteriorly. Modified Hinchey stage II diverticulitis

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Fig. 10: Sagittal reconstruction image from contrast-enhanced CT scan shows pericolic abscess (arrows), with air and fluid components within the collection, abutting the thickened colonic wall and collapsing the lumen (star). Triangle - bladder

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**Fig. 11:** Sagital oblique reformatted image from contrast-enhanced CT scan shows pericolic abscess (A), with air and fluid components within the collection, abutting the thickened colonic wall and collapsing the lumen (star) superior to the bladder (triangle).
Fig. 12: Axial image from contrast-enhanced CT scan shows a small pericolic abscess (A), with fluid within the collection, abutting the thickened colonic wall with diverticula (arrows).

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**Fig. 13:** Axial image from contrast-enhanced CT scan shows thickened colonic wall (star) with diverticula (thin arrows) and free intraperitoneal fluid (thick arrow) in a patient with diverticulitis. Modified Hinchey stage III diverticulitis.

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**Fig. 14:** Axial image from contrast-enhanced CT scan shows free perihepatic and perisplenic fluid (arrows) in a patient with diverticulitis (same patient of figure 13). Modified Hinchey stage III diverticulitis

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**Results**

The results show that there is a predominance in males, and in females at later ages for diverticulitis (Fig.1) and there is no evidence of more severe disease in young (Fig. 20).

In 137 patients (Fig. 2) a definite classification of diverticulitis was made and 114 of these patients were classified as having acute diverticulitis and had an elevated serum C-reactive protein (Fig.21) that normalized after specific treatment and 23 were admitted as non-acute patients after resolution of an acute episode.

Of the 114 patients mentioned above, in 45 patients with acute diverticulitis US imaging was true positive for acute diverticulitis with no signs of complication (Fig. 15) and in 54 patients with acute diverticulitis was performed a CT as complementary exam to US for one of following reasons:

a) US imaging revealed a pericolic fluid collection and CT scan was performed to evaluate the extension;

b) complicated diverticulitis could not be ruled out only with ultrasound;

c) patient unfavorable morphotype.

Only 15 CT were performed in all patients that were classified as having acute diverticulitis (n=114), based only in clinical judgment.

Of the 114 patients submitted to US and/or CT with a confirmed discharge diagnosis of acute diverticulitis, most of them (92%) were classified as stage 1 of the modified Hinchey classification, the great majority (n=88) in stage 1a (Fig. 16). All patients that were classified as modified Hinchey classification stage 3 and 4 (3.5%) were submitted to surgery, and only few in stage 1 underwent to surgery (Fig.17).

From the all the imaged patients in acute phase (n=114), 91% received medical treatment (Fig. 18) and only medical 10 went to (urgent) surgery (Fig 19) and 90% of them were older than 50 years (n=9) and only one was younger than 50 years old (Fig. 20).
Fig. 15: Number and type of imaging exams performed in the patients with the diagnosis diverticulitis

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Fig. 16: Number of patients in each stage of modified Hinchey Classification

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Fig. 17: Graphic shows correlation between number of patients that underwent surgery and the stage of the modified Hinchey classification.

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**Fig. 18:** Type of treatment in the acute phase patients: grey: number of patients submitted to medical treatment green: number of patients that underwent surgery

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Fig. 19: Graphic show type of surgery procedures in acute and non acute phase patients.

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**Fig. 20:** Graphic shows the relationship between age of the patients and acute diverticulitis.

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**Fig. 21**: Graphic shows elevated serum C-reactive protein values in acute phase patients and normal serum C-reactive protein values in non-acute phase diverticulitis patients.

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Conclusion

Most of the imaged acute phase cases were classified as modified Hinchey classification stage 1. All of the imaged acute phase patients that were classified as stages 3 and 4 (n=4) of modified Hinchey classification underwent to surgery and 91% of patients (n=104) in acute phase received conservative treatment, which means that there were 6 patients in acute phase that were misclassified by imaging exams (probably because US imaging was the only exam performed, which is an operator and patient dependent imaging technique or eventually the acute episode upstaged because oral diet was initiated early or it upstaged between time that the imaging exam was performed and the medical therapy was received).

With this study, we concluded that ultrasound and CT may help treatment stratification of diverticulitis patients in the adequate clinical setting (acute phase), since all of the patients that were classified, based on imaging findings, as stages 3 and 4 of modified Hinchey classification underwent to surgery and most of the patients that were classified in stage 1 of modified Hinchey classification were submitted to conservative treatment.
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