



Research article

Predictors of severity in ischemic colitis: Usefulness of early ultrasonography



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ABSTRACT

Purpose: The main objective was to evaluate the usefulness of early ultrasonography for determining prognosis of patients with ischemic colitis.

Materials and methods: We reviewed the histories of patients with diagnosis of ischemic colitis over a period of 11 years. Two hundred twenty nine patients with ischemic colitis were included. Demographic, clinical, laboratory and sonographic findings were retrospectively analyzed. Patients were divided into two groups according to the outcome: mild (those who improved with conservative treatment) or severe (those who died or required surgery), and the findings of each group were compared.

In addition, we developed a predictive model of multivariate logistic regression analysis, and then it was validated in a different population of 58 consecutive patients with ischemic colitis.

Results: The mild ischemic colitis group consisted of 184 patients (age $74,7 \pm 8,8$ years), and the severe group of 45 patients (age $78,6 \pm 7,7$ years). More pancolitis ($p = 0.005$), altered pericolic fat ($p = 0.032$) and free fluid ($p = 0.013$) was observed in the severe ischemic colitis group compared with the mild group. Severe ischemic group had lower wall thickness ($p = 0.020$) and higher resistive index than mild group ($p = 0.025$).

Multivariate analysis identified as protective factors to severe ischemic colitis: pain ($p = 0.026$), diarrhea ($p = 0.034$), rectal bleeding ($p = 0.000$), and hypertension ($p = 0.001$). Altered pericolic fat ($p = 0.008$) and pancolitis ($p = 0.017$) were sonographic findings significantly related to severe ischemic colitis.

Our model correctly classified 88.4% of the study patients and 89.6% of the population of 58 patients used in validation.

Conclusions: Sonographic features with clinical findings can predict the outcome of ischemic colitis. Our predictive model could differentiate properly between patients with mild or severe ischemic colitis.

1. Introduction

Ischemic colitis is the most common form of intestinal ischemia [1]. Two presentations of ischemic colitis have been described: a gangrenous form associated with transmural necrosis, with a high mortality rate, and a transient form that is characterized by reversible lesions limited to the mucosa or submucosa and that benefit from conservative management [2]. Ischemic colitis frequently occurs in the elderly patient population [1].

The true incidence in the overall population is underestimated because milder forms may be missed [3]. The diagnosis of ischemic colitis is established by clinical data with radiologic, endoscopic and histological findings.

Computed tomography (CT) findings of ischemic colitis have extensively been described in the radiology literature [4–6].

However, few studies have been conducted analyzing the sonographic findings of this disorder [7,8]. Nowadays, in many hospitals sonography is the first diagnostic imaging technique used to evaluate patients with abdominal symptoms. As a result, the sonographic findings of ischemic colitis should be known to radiologists in order to avoid delays in diagnosis and treatment.

In addition, the possibility to know early prognostic factors is very important to decide the best treatment as soon as possible. Many authors have tried to define risk factors to differentiate between gangrenous and non-gangrenous forms. A several clinical factors have been associated with ischemic colitis outcome [2,9–20], but few radiological

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findings have been associated [4,7,21].

The main objective of this study was to evaluate the usefulness of ultrasound for determining prognosis of patients with ischemic colitis.

2. Materials and methods

2.1. Study population

This study was approved by the Institutional Ethics Committee for Clinical Research of our Hospital. The study includes the patients with ischemic colitis recruited for a period of 11 years, between July 1996 and June 2007. All patients with ischemic colitis and ultrasound performed within 3 days from the start of the clinic were included. A search of the databases of our departments of surgery, gastroenterology, and pathology yielded a total of 300 diagnoses of ischemic colitis during the evaluated period. A review was made of the histories of these 300 patients, recording clinical, laboratory, and sonographic data at hospital admission, together with evolution and the surgical and pathologic findings. Patients with combined small-bowel and colonic infarction ($n = 14$), without images or report of ultrasound ($n = 46$) and with histopathological diagnosis different of ischemic colitis ($n = 11$) were not included. The final study population consisted of 229 patients. The following clinical variables were analyzed: age, sex, medical history (hypertension, diabetes mellitus, ischemic heart disease or recent abdominal aorta surgery), and symptoms at onset (abdominal pain, rectal bleeding or diarrhea). White blood cell count was revised and patients were classified into three groups: mild ($< 12,000$ cells/mm³), moderate (12000 cel/mm³–20,000 cells/mm³) and severe ($> 20,000$ cells/mm³).

2.2. Image interpretation

Sonographic findings of ischemic colitis were obtained from the original sonographic reports. In only a few cases, the hard-copy images were reviewed to complete some sonographic characteristic. In these cases, the sonographic findings were assessed in consensus by two radiologists who were blinded to results. Sonography was performed by residents on duty or by experienced sonographers, depending on the time of the request. Sonographic examinations were performed using different US equipments, Sonolayer SSH-140A, PowerVision 5000 or Aplio 80 (Toshiba, Tokyo, Japan), with convex 3–6-MHz, linear 5–10-MHz and transvaginal 8–4-MHz transducers. The following findings were assessed: the location (right: hepatic flexure or ascending colon; transverse: transverse colon isolated; left: splenic flexure, descending colon, sigmoid colon or rectum; pancolitis: entire colon) and length of the involved colonic segment, wall thickness, symmetric versus asymmetric thickening, bowel wall stratification or non-stratification, altered pericolic fat, the presence of tumor associated, peritoneal fluid and intestinal or portal pneumatosis. A wall thickness > 3 mm was considered abnormal. Symmetric involvement was considered when the same degree of thickening was present throughout the circumference of the abnormal segment. The colon wall was considered to be stratified when the mucosa, submucosa, and muscularis propria were visible as separate layers, and was considered non-stratified when all layers were indistinct. Doppler parameters analyzed were presence of parietal vascular flow and calculation of resistive index. Color Doppler flow parameters were optimized for maximal sensitivity using a special presetting (filter at low setting [50 Hz] and lowest velocity scale [2 cm/s]) designed for the detection of low-velocity flow in the bowel wall. Color Doppler flow was considered present when color pixels persisted throughout the observation period. Color Doppler flow was always confirmed by obtaining an arterial or venous signal at the location of the color pixel. Color Doppler flow was subjectively graded as absent, barely visible, or readily visible. The color wall resistive index ($[\text{peak systolic velocity} - \text{end diastolic velocity}] / \text{peak systolic velocity}$) was calculated from the arterial waveforms.

Subsequently, other variables were created from decoding the above: absent Doppler flow, length ≥ 10 cm, IR > 0.60 , clinical triad (pain, diarrhea and rectal bleeding), right location, pancolitis, and segmental localization.

Patients were divided into two groups according to the outcome, mild (those who improved with only conservative treatment) or severe (those who died or required surgery), and the findings of each group were compared to identify factors associated with outcome.

2.3. Statistical analysis

Basic descriptive statistics, including the mean and standard deviation (SD) for continuous variables, and the absolute frequency and percentage for discrete variables, were used to characterize the study patients. Patients were divided into two groups according to the evolution, and the variables observed in each group were compared.

The normal distribution was ascertained by means of the Kolmogorov-Smirnov test before parametric tests were performed. Categorical variables were analyzed using chi-square test and continuous variables were analyzed using Mann-Whitney U and Student's *t*-test as appropriate.

The association measure was the odds ratio, with calculation of the corresponding 95% confidence interval (CI). A *p* value of less than 0.05 was considered to indicate a statistically significant difference.

Finally, a multivariate non-conditional logistic regression model was developed. This model was validated with other 58 patients with ischemic colitis.

Calculations were performed with SPSS, version 15.0 (SPSS Inc., Chicago, IL, USA) and script AllSetsReg for SPSS Statistics.

3. Results

Two hundred twenty nine patients (133 females; age 75.5 ± 8.7 years; range: 47–96 years) with ischemic colitis were included. The diagnosis of ischemic colitis was based on the surgical findings ($n = 22$), endoscopic biopsy ($n = 114$), endoscopic findings ($n = 11$) or clinical evolution ($n = 81$). The diagnosis of ischemic colitis without colonoscopic or surgical confirmation was based on the typical presentation, the sonographic findings, repeated negative stool culture results, and the clinical follow-up examination. The most common symptom was abdominal pain, in 176 patients (82%). Diarrhea was detected in 86 (41%) and rectal bleeding in 149 patients (69%). Only 50 patients (23%) had the classic triad of pain, diarrhea and rectal bleeding. The mean leukocytes was 14850 cells/mm³ (range 3300–97000), 63% of patients were hypertensive, 18% had a history of ischemic heart disease, 25% had diabetes, and 8% had a history of previous abdominal aortic surgery. Thirty-two patients (18%) had mild leukocytosis, 69 patients (38%) moderate and 79 (44%) had leukocytes $< 20,000$ cells/mm³.

Segmental involvement was detected in 217 patients (96%), with left-sided colitis in 186 patients (82%), right-sided colitis in 22 patients (10%), and transverse in 9 patients (4%). Pancolitis was detected only in 9 patients (4%). The mean length of bowel involved was 21.8 ± 15.7 cm. Segmental involvement ≥ 10 cm was seen in 197 patients (93.8%). Symmetric thickening was present in all patients. The thickness of the colon wall in the affected segments ranged from 2 to 16 mm (mean, 7 mm; SD = 2.2). Wall thickness was normal (≤ 3 mm) in three cases, one of them had pneumatosis. Colon wall stratification was preserved in 128 patients (74%). Altered pericolic fat was observed in 89 patients (42.4%) and free fluid in 37 (18.1%). Pneumatosis coli was detected in only three patients. Color Doppler flow was observed in the wall of the affected colonic segment in 140 (82%) of the 171 patients in whom it was evaluated, whereas flow was absent in the other 31 patients (18%). Color Doppler flow was considered to be barely visible in 100 patients (59%) and readily visible in 38 patients (23%). The resistive index could be calculated in 53 patients, with a range of

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