Acute mesenteric ischemia: an emergency that requires a comprehensive diagnostic approach.

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Abstract

BACKGROUND: Acute mesenteric ischemia is a vascular emergency with mortality over 60%, which requires timely treatment. However, due to its heterogeneous pathophysiology and differences in degree and extent of ischemic damage, the clinical and radiological manifestations are varied and often nonspecific; consequently, a thorough analysis of medical background, laboratory studies, and clinical and radiological findings is recommended in order to establish a timely diagnosis.

OBJECTIVE: Identify the most common findings, direct and indirect, by computed tomography and determine low, intermediate, and high probability of a patient suffering from acute mesenteric ischemia on the basis of risk factors and clinical, biochemical, and radiological findings.

MATERIAL AND METHODS: We performed a retrospective, observational, cross-sectional study, with analysis of findings from computed tomography images of a series of cases of patients with diagnosis of acute mesenteric ischemia in a period of 9 years, 3 months and literature review. The purpose was to analyze the risk factors and clinical and biochemical data most commonly associated with acute mesenteric ischemia.

RESULTS: Our universe included tomographic studies of 27 cases of acute mesenteric ischemia, with average age of 60.8 years. The most common clinical finding was acute abdominal pain syndrome in 19 patients (70%); the most commonly associated history was type 2 diabetes mellitus and systemic high blood pressure in 7 (26%) patients each; 13 patients (48%), according to the clinical file, had laboratory studies, of whom 11 (85%) had leukocyte values of 9,200 to 68,000; the most commonly identified findings were: arterial filling defect 48%, intestinal pneumatosis 29%, venous filling defect 22%, bowel obstruction syndrome 22%, and identification of free fluid 22%.

CONCLUSION: It is advisable to conduct a quantitative analysis giving a specific value to the different findings, including risk factors, physical examination, laboratory studies, and image findings, to determine the risk of acute mesenteric ischemia in a patient with acute abdominal pain syndrome. CTA is the study with the greatest diagnostic precision. KEYWORDS: mesenteric vascular occlusion; superior mesenteric artery; emission computed tomography

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INTRODUCTION

Acute mesenteric ischemia is not an isolated clinical entity but rather involves a complex group of abnormalities that include mesenteric artery embolic thrombosis, mesenteric venous thrombosis and non occlusive mesenteric ischemia. Table 1 and Figures 1-2.

Acute mesenteric ischemia is a disease that mainly involves patients over 60 years of age, with a male gender predominance occurring in 1 of every 1,000 hospital admissions; some series report up to 5% hospital mortality. Among the multiple factors that account for an increased incidence we find a more frequent diagnosis due to the growing elderly adult population as well as an increase in the number of patients in critical condition. In spite of advances of knowledge in pathophysiology, laboratory diagnosis and imaging studies, acute mesenteric ischemia is a potentially lethal vascular emergency, associated to a mortality over 60% if diagnosis takes more than 12 hours, and over 90% if it takes longer than 24 hours; its diagnostic approach is a clinical challenge.

The challenge is to establish a timely and reliable diagnosis, in order to have a rapid intervention allowing to re-establish the mesenteric blood flow, thus preventing intestinal necrosis. Due to the heterogeneity in its pathophysiology and to the differences in grade and extension of ischemic damage, the clinical and radiological manifestations are diverse and often nonspecific. The key to an efficient management of this syndrome follows three principles: 1) high clinical suspicion; 2) proper selection of available imaging techniques to establish the diagnosis; 3) knowledge of factors that increase surgical efficacy when indicated. This approach must prevail to have a better outcome in caring for this disease.

Table 1. Three causes of acute mesenteric ischemia

<table>
<thead>
<tr>
<th>Types of mesenteric ischemia</th>
<th>Acute mesenteric arterial embolism</th>
<th>Acute mesenteric arterial thrombosis</th>
<th>Mesenteric venous thrombosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease</td>
<td>Atrial fibrillation, myocardial infarction, valvular disease, left ventricular aneurysm</td>
<td>Atherosclerotic disease, trauma, infection</td>
<td>Hypercoagulable state, closed trauma, infection, portal hypertension, pancreatitis, malignant focal liver lesion</td>
</tr>
<tr>
<td>Clinical findings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early</td>
<td>Sudden onset of abdominal pain, irrelevant physical findings</td>
<td>Gradual postprandial pain, nausea, intestinal changes, irrelevant physical findings</td>
<td>Subacute onset of abdominal pain, irrelevant physical findings</td>
</tr>
<tr>
<td>Late</td>
<td>Increased abdominal pain, distention, absent bowel sounds, disturbances in mental status, peritoneal signs, sepsis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diagnostic test</td>
<td></td>
<td>Angiogram</td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td></td>
<td>Superior mesenteric embolectomy, chronic anticoagulation</td>
<td>Surgical revascularization</td>
</tr>
<tr>
<td>All sorts of hemodynamic support, correction of acidosis, antibiotics, gastric decompression</td>
<td>Surgical revascularization</td>
<td>Anticoagulant treatment (heparin)</td>
<td></td>
</tr>
<tr>
<td>Intestinal infarction</td>
<td>Surgery</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Pathophysiology

Acute mesenteric ischemia involves an inadequate condition of tissue perfusion that prevents from meeting the metabolic demands from one or more of the organs included in the mesenteric circulation. It is estimated that the main cause of acute mesenteric ischemia is arterial occlusion with a thrombus in approximately 50% of cases. Most of the thrombi originate in the atrium or left ventricle from detachment of a mural thrombus or from valvular lesions. These thrombi are often associated with cardiac arrhythmias such as atrial fibrillation or hypokinetic regions resulting from a previous infarction. Around 15% of embolisms lodge in the origin of the superior mesenteric artery (Figures 1 and 2, Table 2) while the rest can lodge 3 to 10 cm distal to the origin of the middle colic artery. In up to 20% of cases the embolism that originates in the superior mesenteric artery is associated with concurrent emboli in some other vascular bed. Modified Table 2. It is important to consider that intestinal ischemia due to an embolism can be found with reactive mesenteric vasoconstriction reducing the collateral flow with exacerbation of the ischemic damage.

Risk factors

The risk factors that most often have been associated, in different case series, with this disease are atherosclerosis (90%), heart disease (85%), systemic hypertension (85%), atrial fibrillation (75%), smoking (50%), digitalis use (50%) and obesity (40%).

Clinical presentation

Acute mesenteric ischemia involves a complex group of abnormalities that include mesenteric arterial embolic thrombosis, mesenteric venous thrombosis and non-occlusive mesenteric ischemia. The clinical picture is nonspecific.
Tables 1 and 3\cite{12} and Figures 1 and 2. Some authors have called it “acute mesentery artery syndrome”\cite{13} and in our hospital the term mesenteric stroke is used, which we try to include and recognize as acute mesenteric ischemia in the current paper, referring to the symptoms that most frequently are associated to this disease:

1. In the initial phase, hyperperistalsis, characterized by rapid intestinal transit, with severe abdominal pain syndrome and no clinical correlation with other abdominal diseases, diffuse, and location can be related to the ischemic site; for example, if it is found in the anterior bowel: periumbilical; middle bowel:

Table 2. Bowel regions, irrigation and collateral connections

<table>
<thead>
<tr>
<th>Region</th>
<th>Irrigation</th>
<th>Collateral connections</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anterior bowel</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distal esophagus to the ampulla of Vater</td>
<td>Celiac artery</td>
<td>Pancreatoduodenal arteries and distally the arc of Buhler</td>
</tr>
<tr>
<td><strong>Middle bowel</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duodenal region of the ampulla of Vater to the splenic flexure of colon</td>
<td>Superior mesenteric artery</td>
<td>Pancreatoduodenal arteries and proximally the arc of Buhler, marginal artery of Drummond and the arc of Riolan</td>
</tr>
<tr>
<td><strong>Posterior bowel</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Splenic flexure to the distal portion of the sigmoid colon</td>
<td>Inferior mesenteric artery</td>
<td>Marginal artery of Drummond and the proximal arc of Riolan. Distally, superior and middle hemorrhoidal arteries</td>
</tr>
<tr>
<td>Cloacal origin</td>
<td>Branches of the inferior hypogastric artery</td>
<td>Proximally the superior and middle hemorrhoidal arteries</td>
</tr>
</tbody>
</table>

Table 3. Clinical features and CT findings in mesenteric ischemia

<table>
<thead>
<tr>
<th>Features</th>
<th>Arterial occlusion</th>
<th>Venous occlusion</th>
<th>Non occlusive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incidence</td>
<td>60-70% of AMI</td>
<td>5-10% of AMI</td>
<td>20% AMI</td>
</tr>
<tr>
<td>Onset</td>
<td>Acute</td>
<td>Subacute</td>
<td>Acute or subacute</td>
</tr>
<tr>
<td>Risk factors</td>
<td>Arrhythmia, myocardial infarction, valvular diseas, atherosclerosis, prolonged hypertension</td>
<td>Portal hypertension, venous hypercoagulopathy, right heart failure</td>
<td>Hipovolemia, low heart output, digoxin, hypotension, alpha adrenergic agonists</td>
</tr>
<tr>
<td>Abdominal wall</td>
<td>Thin, unchanged or thickened with reperfusion</td>
<td>Thickenured</td>
<td>Unchanged or thickened with perfusion</td>
</tr>
<tr>
<td>Attenuation of the abdominal wall in simple phase</td>
<td>Not characteristic</td>
<td>Low with edema; high with bleeding</td>
<td>Not characteristic</td>
</tr>
<tr>
<td>Enhancement of the abdominal wall in contrast phase</td>
<td>Reduced, absent, in target or high with reperfusion</td>
<td>Reduced, absent, in target or increased</td>
<td>Reduced, absent, with heterogenous distribution</td>
</tr>
<tr>
<td>Intestinal dilatation</td>
<td>Not evident</td>
<td>Moderate to prominent</td>
<td>Not evident</td>
</tr>
<tr>
<td>Mesenteric vessels</td>
<td>Defect or defects in arteries, arterial occlusion, SMA diameter &gt; SMV</td>
<td>Defect or defects in veins, congestive veins</td>
<td>No defects, arterial constriction</td>
</tr>
<tr>
<td>Mesentery</td>
<td>Homogenous until an infarction occurs</td>
<td>Heterogenous with ascites</td>
<td>Homogenous until an infarction occurs</td>
</tr>
</tbody>
</table>

SMA: superior mesenteric artery; AMI: acute mesenteric ischemia; SMV: superior mesenteric vein.
infraumbilical; posterior bowel: pelvic; pain does not increase with palpation and is not associated with abdominal stiffness. It is accompanied by nausea, vomiting (75% and abdominal distention (25%).

2. All this makes an early diagnosis of this condition difficult because of the similarity to other intra-abdominal processes.

Laboratory tests

They can be useful in the diagnosis of acute mesenteric ischemia, but only in its late stage. Total leukocyte count above 20 000 may be useful, with 80% sensitivity and 50% specificity, metabolic acidosis (38% sensitivity, 84% specificity) and high D dimer (40% sensitivity, 89% specificity). It has also been shown that low lactate concentrations can help to rule out the possibility of acute mesenteric ischemia and avoid unnecessary laparotomies, especially in elderly patients. Enzymes such as creatinine kinase, lactate dehydrogenase (LDH) and alkaline phosphatase may be useful in the diagnosis of a transmural infarction, but they have low sensitivity in early stages of acute mesenteric ischemia. In current times, the role of laboratory markers in acute mesenteric ischemia is limited. Table 3. Lactate dehydrogenase has been said to be a marker that suggests acute mesenteric ischemia; it originates from bacteria such as Escherichia coli in the intestinal lumen. The hypothesis is that concentrations are increased during acute mesenteric ischemia due to bacterial translocation and bacterial overgrowth after a lesion in the intestinal mucosa. However, in a recent review, sensitivity and specificity of lactate dehydrogenase proved to be only 0.82 y 0.48, respectively.

Imaging studies

A simple X-ray can be normal in up to 25% of cases with nonspecific findings in 50% and, in the remaining 25%, it is feasible to identify 12 hours after the initiation of acute mesenteric ischemia, mural digital impressions resulting from edema or bleeding, pneumatosis, pneumobilia and gas in the portal vein. Evaluation with positive oral contrast agent (barium) is contraindicated.

Ultrasound plays a limited role in the evaluation of acute mesenteric ischemia due to the fact that an important number of patients have air distention and dilated bowel loops making this imaging method technically difficult or impossible. It can be more useful in the on invasive evaluation can be more useful in patients with symptoms of chronic acute mesenteric ischemia. Doppler ultrasound can show the stenotic area, the occlusions in the celiac trunk or in the superior mesenteric artery with 92-100% sensitivity and 70-89% specificity. Doppler ultrasound is not a recommended study in patients with high suspicion of acute mesenteric ischemia.

CT scan with intravenous contrast, called CT angiography (CTA), facilitates the diagnosis of primary acute mesenteric ischemia with 83.3% sensitivity and 95.5% specificity. It is considered to be the method of choice to reach this diagnosis: it is a non invasive study, with 100% positive predictive value and a negative predictive value of 94%. Figure 3. Images are obtained from the lung base to the symphysis pubis with a collimation of 0.5 a 2.5 mm and a 1.0-2.0 pitch. For reconstruction, images should have sections of 0.7 mm thickness. The thinnest 1-2 mm sections, in arterial phase, will be used in the multiplanar reconstructions to evaluate the origin of the mesenteric arteries and their variants. For the arterial phase, 100-150mL of IV non ionic contrast at a rate of 2-3.5 mL/s, scanning is started with 30 and 60 second delays. The study must be multiphasic, since it is necessary to recognize indirect findings starting from the simple phase, such as vascular calcification sites, increased vascular density from clotting and in-
tramural bleeding, findings that are not possible to characterize in contrast phase.\textsuperscript{20-24} The vascular study includes images in the axial, sagittal and coronal planes, and it is important to examine 3D planes and to do volumetric reconstructions.\textsuperscript{3}

When the cause for the clinical picture is the arterial occlusion, the initial response is the reversible vasodilation of the splancic bed, that in CTA is shown as an increased attenuation of the bowel loop walls, visible in arterial as well as in venous phase.\textsuperscript{3} If the obstruction persists, a vasoconstriction may be originated that in CTA will lead to a decreased loop enhancement, thickening of the intestinal wall, mural edema, diminished peristalsis and distended and dilated bowel loops.\textsuperscript{3}

If the acute mesenteric ischemia is caused by a venous obstruction, there will be greater mural thickness in the involved bowel loop\textsuperscript{2} with a target appearance due to the submucosal edema.

In the contrast phase, intraluminal filling defects are intentionally identified, characteristic for thrombi in mesenteric arteries and veins, em-

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**Table 4.** Sensitivity, specificity and odds ratio for findings in laboratory tests classically associated with acute mesenteric ischemia

<table>
<thead>
<tr>
<th>Marker</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Positive odds ratio (95% CI)</th>
<th>Negative odds ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leukocyte count</td>
<td>0.80</td>
<td>0.50</td>
<td>1.57 (1.97, 2.27)</td>
<td>0.41 (0.20, 0.83)</td>
</tr>
<tr>
<td>pH</td>
<td>0.38</td>
<td>0.84</td>
<td>2.49 (0.82, 7.51)</td>
<td>0.71 (0.45, 1.14)</td>
</tr>
<tr>
<td>D-dímer</td>
<td>0.89</td>
<td>0.40</td>
<td>1.48 (1.28, 1.71)</td>
<td>1.48 (1.28, 1.71)</td>
</tr>
<tr>
<td>Lactate</td>
<td>0.86</td>
<td>0.44</td>
<td>1.67 (1.37, 2.05)</td>
<td>0.20 (0.01, 2.86)</td>
</tr>
</tbody>
</table>

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**Figure 3.** Flow chart for diagnosis and treatment approach in acute mesenteric ischemia.
bolisms and infarctions in other organs, plus an abnormal enhancement of the intestinal wall, since acute mesenteric ischemia leads to diverse patterns of intestinal wall attenuation.25

Out of the acute mesenteric ischemia cases, 40 to 50% are arterial in origin and embolic in nature leading to a filling defect in the superior mesenteric artery, after detachment of a fragment of an atrial mural thrombus or a left ventricular thrombus.26 Other causes include: thrombosis within an atheroma plaque in the non occlusive mesenteric artery and mesenteric venous thrombosis. Thrombosis of the superior mesenteric vein is the cause of the intestinal ischemia in less than 15% of cases. Finding a thrombus in the superior mesenteric vein is much less serious than arterial occlusion.26

Non surgical management of patients with acute mesenteric ischemia must be considered as the first treatment step and correction of risk factors that most often have been associated in different case series to this disease: atherosclerosis, heart disease, systemic hypertension, atrial fibrillation, smoking, digitalis use and obesity.1,2,6,9

When there are acute complications such as perforation, peritonitis and intestinal necrosis, the surgical approach is indicated.2 Splenic, liver or kidney infarction are findings for poor prognosis in patients with intestinal ischemia even without intestinal vascular involvement.26 These variations depend on the pathogenesis of the intestinal ischemia, duration, location and extension, collateral circulation, added infections or whether it is perforated or not.

Acute mesenteric ischemia leads to different patterns of intestinal wall attenuation, besides the abnormal enhancement of the intestinal wall.25 The thickening of the intestinal wall may be due to different diseases and is not correlated with the severity of the intestinal ischemia.21-22,26-28

A very common finding of acute mesenteric ischemia is the thickened intestinal wall.26 The intestinal wall has a normal thickness of 0.3 to 0.5 cm, depending on the degree of distention, so a thickened wall is not a specific finding. Nevertheless, in some series, it is the most frequently identified pattern and it is caused by the mural edema, bleeding or added infection of the ischemic intestinal wall. Initially, the intestinal wall becomes thinner instead of thicker because there is no arterial flow, no mural edema, nor bleeding.28 A thinner intestinal wall is due to a loss of volume in the intestinal wall vessels and to the loss of intestinal muscle tone. More than 0.3 cm is abnormal and must be evaluated in loops with maximal distention. Abnormal distention, more than 3.0 cm, is also common in acute intestinal ischemia. However, both findings are nonspecific.26 Ascites and mesenteric edema may be identified in acute mesenteric ischemia.26

Overall, at least one of the mesenteric signs is present in the patient with acute mesenteric ischemia. In all patients with acute mesenteric ischemia following arterial occlusion and in 68% of those that have non occlusive mesenteric ischemia, the number of arterial vessels is reduced ($p = 0.067$). Pneumatosis in mesenteric vessels and reduction in the number of venous vessels is associated with higher mortality ($p = 0.027$ y $p = 0.042$, respectively). Reperfusion signs are associated with a reduced mortality (28.7 vs. 65.5%).29

In view of the characteristic findings and prognostic value, a thorough evaluation of the mesentery will provide additional information in the study and diagnosis of acute mesenteric ischemia using CAT scan.29

Portal pneumatosis or mesenteric venous gas are not always of intestinal origin. In most cases the gas comes from the intraluminal gas that crosses from the damaged mucosa to the intramural
space.\(^{27}\) The integrity of the mucosa, gas and the intestinal intraluminal pressure, as well as the bacterial flora, interact with each other in the formation of intestinal pneumatosis. Intestinal pneumatosis is highly suggestive of acute mesenteric ischemia in symptomatic patients with a sensitivity ranging from 22 to 72\%.\(^{26,27}\) Intestinal pneumatosis is not a diagnosis, it is a radiological finding that results from an underlying disease process. The importance of intestinal pneumatosis will depend on its nature and severity of the disease that causes it. Therefore, intestinal pneumatosis involves a very broad spectrum of diseases ranging from benign cause to abdominal sepsis and death.\(^{30}\)

The identification of intestinal pneumatosis characterized by air bands and the combination with portomesenteric venous gas in the CTA is associated with transmural intestinal infarction. On the other hand, the isolated identification of intestinal pneumatosis mainly characterized by bubbles or portomesenteric venous gas in the CTA may be related to a partial intestinal mural ischemic event, which happens in 1/3 of cases. Also, even though in acute mesenteric ischemia the identification of portomesenteric venous gas in the CTA is associated with a 56% mortality rate, this association is presumably indirect. Therefore, the ominous feature of the finding in CTA seems to be justified only in those patients with extensive transmural infarction and their clinical outcome will mainly depend on the severity and extension of the underlying disease.\(^{31}\)

Although the identification of portomesenteric venous gas leads to the suspicion of acute mesenteric ischemia or intestinal necrosis, this finding in CT may be associated to a wide variety of causes and non ischemic pathogenesis. Knowledge of these conditions will avoid erroneous considerations when faced with this finding in CT, as well as inadequate diagnosis and certainties and unnecessary surgery, in some cases.\(^{33}\)

In the emergency services, the evaluation of patients must be fast and efficient. From our perspective, this does not often happen because of multiple factors. Such fact motivated this study. It is well known that a high number of patients with acute abdominal pain syndrome are referred to the Radiology and Imaging Service to undergo different studies under the diagnostic suspicion of acute mesenteric ischemia, with little clinical correlation and with negative results at most times. When a patient refers acute abdominal pain syndrome, severe and disproportionate with respect to clinical findings and risk factors, acute mesenteric ischemia must be considered as a diagnosis.\(^1\) It is necessary to select the imaging studies in order for patients with acute abdominal pain syndrome and with the clinical suspicion of a probable acute mesenteric ischemia, according to the clinical background, laboratory studies and imaging findings that will allow to establish the diagnosis accurately.

The goal of this study was to identify the direct and indirect most common findings with CTA and through risk factors, clinical finding biochemical and radiological and imaging results to determine low, intermediate or high possibility that a patient suffers from acute mesenteric ischemia.

**MATERIAL AND METHODS**

Study design: observational, cross sectional, descriptive and ambispective study. Clinical, radiological and tomographic clinical data were
analyzed in all patients admitted to the hospital with a diagnosis of acute mesenteric ischemia who had a CT scan at the time of admission.

Study period: from August 1, 2005 to December 31 2014 (9 years 4 months).

Universe: Clinical and radiology files of patients during the above mentioned study period were reviewed.

Study site: Hospital Central Militar (Central Military Hospital). The hospital is a referral hospital (teaching and institutional hospital, with approximately 680 basic beds and 25 high complexity beds). The CTA report was classified according to the identification of signs of intestinal ischemia involvement, acute mesenteric ischemia, with a subsequent correlation with definitive intestinal ischemia and need of surgery.

Two certified radiologists from this institution interpreted the different studies, assigning and establishing the diagnostic possibility of acute mesenteric ischemia, as well as the identification of intestinal ischemic involvement signs with imaging analysis using CTA in a case series of patients with clinical diagnosis of acute mesenteric ischemia, in a time period of 9 years 4 months, reviewing the specialized literature with the purpose of looking into the risk factors and clinical and biochemical data most frequently associated with acute mesenteric ischemia. Both radiologists reviewed the cases jointly or separately with the preliminary interpretation made by residents from the Specialty course and Radiological Diagnostics Residency of the Escuela Militar de Graduados de Sanidad (Military School Healthcare Graduates) with feedback and correction of the pertinent findings in each case to ultimately have a meaningful and timely report and with joint clinical work of residents from the Specialty course and General Surgery of the Escuela Militar de Graduados de Sanidad. The findings to be mentioned and evaluate were: direct finding of identification of arterial and/or venous filling defect.

Indirect findings such as wall thickening, greater mural thickening in the wall of the involved loop of bowel with a “target” appearance, dilated loops and/or air-fluid level, increased attenuation and heterogeneity of the mesenteric fat, ascites, reduced enhancement with low attenuation of the bowel loop wall, greater enhancement of the bowel loop, intestinal pneumatosis, portomesenteric gas, free gas, total or partial occlusion of the superior mesenteric artery and total or partial occlusion of the superior mesenteric vein.

The degree of intestinal obstruction was established in the following way: high grade: distention of the bowel loops greater or equal to 2.5 cm; moderate grade: combination of fluid loop distention, the sign of fecalization of intestinal content, but with no distal collapse; low grade: distention of bowel loops with no sudden change in size; without pseudostools and with distal bowel loops of normal size.

The most common direct and indirect findings in CTA and according to risk factors, clinical findings, biochemical and radiological and imaging results, stating a low, intermediate or high possibility of a patient having acute mesenteric ischemia are noted. Tables 3 and 5.

Inclusion criteria: All the patients with a complete clinical and radiological file with clinical suspicion of acute mesenteric ischemia who had a CTA with a diagnosis of acute mesenteric ischemia; patients with CTA study with diagnosis of acute mesenteric ischemia and surgery.

Exclusion criteria: Patients with incomplete radiological and imaging incomplete files; patients with incomplete CTA study, not available in the picture archive and communication system.
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PACS. archive and imaging transmission system (PACS).

Materials: Philips 64 detector scanner and Siemens 16 detector scanner with injectors for CT angiography; computer equipment for creating, recording and analyzing the study project.

Human: Radiology medical staff with postgraduate studies on Sectional Imaging, responsible for the interpretation of CT/CTA scans; resident physicians of the specialty from the Specialty Course and Radiology and Imaging Specialty and General Surgery from the Escuela Militar de Graduados de Sanidad, Hospital Central Militar; nursing staff and Radiology technicians with CAT training.

Statistical Analysis: Graphs, tables and % rates were used for this study.

RESULTS

During the study period, 27 (100%) patients admitted to the Hospital Central Militar were identified, with radiological studies requested from the CAT subsection due to diagnostic clinical suspicion of acute mesenteric ischemia, accounting for 1 patient with acute mesenteric ischemia every 126 days or every 4 months. The 27 (100%) patients admitted to the Hospital Central Militar had clinical features of acute abdominal pain syndrome in 19 cases (70%) and in 1 case, also rectorrhagia, that ultimately belonged to a picture of ischemic colitis. 7 patients (26%) had diabetes mellitus, 5 of them with acute abdominal pain syndrome. 7 patients (26%) had long term arterial hypertension, 4 of them with diabetes mellitus and 1 of them with pseudomembranous colitis; 7 patients (26%) had long term arterial hypertension and another patient had arterial hypertension and hereditary thrombophilia from antithrombin III and protein C deficiency with anticoagulation. 2 patients (8%) had heart disease and one of them with low heart output, according to the clinical record. Table 5. Figures 4-11

During the study period, 13 patients (48%), according to a clinical note, had laboratory studies and results such as: in 11 patients (85%) leukocytes 9 200 to 68 000, in 6 (46%) lactate 2.3 to 10.9 mmol/L and only in 1 (8%) of them the D dimer was 2 490; in 2 (15%) of patients metabolic acidosis was reported.

During the study period, 1 (4%), with a study requested from the CAT subsection and with clinical diagnostic suspicion of acute mesenteric ischemia, had a history of previous acute mesenteric ischemia that required surgical management with intestinal resection and intestinal postblock status.

Table 5. CT findings in patients with acute mesenteric ischemia (N = 27)

<table>
<thead>
<tr>
<th>Arterial thrombus</th>
<th>Venous thrombus</th>
<th>Portal pneumatosis</th>
<th>Gastric pneumatosis</th>
<th>Gas in portosplenic confluence</th>
<th>Gas in mesenteric vessels</th>
<th>Pneumobilia</th>
<th>Intestinal obstruction syndrome</th>
<th>Splenic infarction</th>
<th>Free fluid</th>
<th>Abnormal enhancement, reduced, mucosal thickening</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 (48%)</td>
<td>6 (22%)</td>
<td>4 (15%)</td>
<td>1 (3.7%)</td>
<td>10 (37%)</td>
<td>1 (3.7%)</td>
<td>5 (19%)</td>
<td>2 (7.4%)</td>
<td>6 (22%)</td>
<td>4 (15%)</td>
<td>6 (22%)</td>
</tr>
</tbody>
</table>
Of the total number of patients, 14 (51%) were females and 13 (49%) were males, with a mean age of 60.8 years (range 26-90); 2 (8%) had previous abdominal surgery. During their hospital stay 11 patients (41%) required surgery, which included those with previous surgery, of which 2 patients died in spite of treatment (18%) and 1 (9%) died before the surgical procedure; 4 patients (15%) had an invasive radiological procedure and of these,
Figure 6. A) Case number 16, female, 62 years old, with acute abdominal pain syndrome who had a CTA, axial view with findings secondary to an acute mesenteric ischemia: total obstructive filling defect in the origin of the superior mesenteric artery. B) Coronal multiplanar reconstruction in arterial phase: filling defect of the superior mesenteric artery of up to 2.5 cm and partially obstructive defect in the celiac trunk. C) Abdominal angiogram: no opacification of the superior mesenteric artery. D) Surgical correlation that depicts the abnormal transition between the normal color and the diminished reddish color, abnormal for the small bowel loops from the vascular involvement in acute mesenteric ischemia.

Figure 7. A) Case number 26, male, 57 years old, with acute abdominal pain syndrome who had CTA, axial view with secondary findings to an acute mesenteric ischemia: partially obstructive venous filling defect in the portal vein. B) Partially obstructive venous filling defect in the confluence of the portosplenic vein. C) Partially obstructive venous filling defect in the superior mesenteric vein. D) Surgical correlation that depicts the abnormal transition between the normal color and the diminished reddish color, abnormal for the small bowel loops from thrombotic venous vascular involvement that led to the acute mesenteric ischemia.

3 patients died (75% of those who underwent this procedure).

Out of the 27 patients who had studies requested from the Department of Ionizing Radiation of the Hospital Central Militar, 3 (11%), besides the CAT scan, had simple radiological studies including chest and abdomen X rays; 3 (11%) had an abdomen and pelvis ultrasound study; 2 (8%) had simple radiological studies, abdomen and pelvis ultrasound and CAT scan, 1 was simple phase and the other was a CTA.

The requested studies were analyzed and it was found that only 27 had been performed because of diagnostic clinical suspicion of acute mesenteric ischemia; 6 (22%) studies were performed in simple phase due to kidney function failure, 8 (29%) were made in simple and venous phase only, and 13 (48%) had a CTA on admission. From the 27 patients who had the studies requested from the department of Ionizing Radiation of the Hospital Central Militar, from August 1, 2005 to December 31, 2014, 2 were included from 2005, 3 del 2006, 3 from 2007, 3 from 2008,
none from 2009, 1 from 2010, 1 from 2011, 2 from 2012, 4 from 2013 and 7 from 2014.

The contrast studies (21, 78%) allowed to define an acute mesenteric ischemia. The simple phase
studies (6.21%) showed indirect findings, after the acute mesenteric ischemia. In our universe of patients, in 19 (90% of the contrast studies) the direct findings such as filling defects, either arterial or venous thrombosis were identified; out of the 14 simple phase and venous phase studies in 6 patients (43% of those with this technique) the filling defects, arterial or venous thrombosis, were shown; and from the 13 patients (62) who had the CTA on admission, in 12 patients (92% of those with this technique) showed the filling defects, arterial or venous thrombosis.

The direct or indirect findings identified with CAT scan in order of frequency were: arterial filling defect 13 (48%, of which 7 were partial, 3 total and 2 arterial and venous), venous filling defect 6 (22%), intestinal pneumatosis 8 (29%), intestinal obstruction syndrome 6 (22%, all high grade), free fluid 6 (22%), abnormal low enhancement or mucosal thickening 5 (19%), portal pneumatosis 4 (15%), splenic infarction 4 (15%), pneumobilia 2 (7%), gastric pneumatosis 1 (4%), portosplenic gas 1 (4%), liver infarction 1 (4%) and pulmonary thromboembolism 1 (4%).

As patients were followed during admission to emergency and their hospitalization 8 (30% of the total number of patients), in 7 (88%) of them arterial and venous thrombotic filling defects were identified, of which in 5 (64%) arterial thrombotic filling defects were identified; in 1 (13%) a venous thrombotic filling defect and in 1 (13%) a venous and arterial thrombotic filling defect.

The most common clinical finding was acute abdominal pain syndrome in 70%, the most common associated medical history was type 2 diabetes mellitus and systemic arterial hypertension in 26%. 48% had laboratory studies, according to the clinical record, of which 85% had 9 200 to 68 000 leukocytes.

The possibility of a patient having acute mesenteric ischemia is low if he has abdominal pain syndrome with low grade intestinal obstruction, that subsides with hydration and rest. The possibility of a patient having acute mesenteric ischemia is intermediate if he has diabetes, increased blood pressure, abdominal pain syndrome and moderate intestinal obstruction, with no hemodynamic decompensation. The possibility for a patient to have acute mesenteric ischemia is high if diabetic, hypertensive, with heart disease or arrhythmia, with abdominal pain syndrome.
syndrome and high grade intestinal obstruction, with hemodynamic decompensation, laboratory abnormalities that include leukocytosis, extensive aortosclerosis and a history of acute mesenteric ischemia.

The most frequent findings with CTA were direct (arterial filling defect in 48%) and indirect (intestinal pneumatosis 29%, venous filling defect 22%, intestinal obstruction syndrome in 22% and free fluid 22%). Increased vascular density from coagulation or intramural bleeding was not recognized in any case. Other nonspecific findings were vascular calcification sites.

DISCUSSION

In this series of patients, arterial filling defects, venous filling defects, intestinal pneumatosis, abdominal obstruction syndrome, and free fluid were most commonly found. Contrast studies in arterial phase provided the greatest diagnostic information, thus the importance of using contrast studies in arterial and venous phase. Laboratory tests still do not play a preponderant role for diagnosis, however all data should be analyzed in order to reach an accurate and timely diagnosis.

Acute mesenteric ischemia is a clinical entity with multiple causes resulting from the sudden interruption of blood supply to a given bowel segment, initially causing reversible damage that, if untreated for a given time, will lead to bowel death and eventually the wall becomes completely necrotic. This process involves high mortality rate, which in our series was 30%, so early clinical suspicion is crucial, since survival directly depends on how fast treatment is given. In treated patients the mortality rate with surgery is 18% and 75% in patients treated with invasive radiology.

Classification according to etiology: four types of acute mesenteric ischemia were used, according to the triggering factor. Tables 1 and 3, Figures 3-11.

Arterial occlusion

The most frequently involved artery is the superior mesenteric. The celiac trunk and the inferior mesenteric can also be occluded, but, thanks to collateral circulation, they do not tend to produce an acute ischemic lesion unless the superior mesenteric artery is involved as well.

Arterial embolism: It is the most common cause of acute mesenteric ischemia (50%). In 90% of cases it originates from embolic heart disease and there may a history of previous embolisms elsewhere. The most common site is the superior mesenteric artery, distal to the outlet of the middle colic artery, affecting the right colon and the ileocecal area. The resulting ischemia is very severe because of its sudden onset and because there is no collateral flow.

Arterial thrombosis: It involves 25% of acute mesenteric ischemias. Patients usually have a vascular history (typically a previous history of chronic mesenteric ischemia) and arteries have reduced flow and collateral circulation. Thrombosis of the superior mesenteric artery tends to be found at its origin or in the first 3 centimeters and mortality is very high because, in spite that collateral circulation may maintain some flow, the affected territory is extensive.

Venous occlusion

The impossibility of having venous return leads to edema and increased venous pressure, and when it is equal to arterial pressure, ischemia or hemorrhagic infarction ensues.

Mesenteric venous thrombosis: The portosplenic-mesenteric axis is very severely affected and even in these cases it is exceptional for a
venous thrombosis to produce an acute intestinal infarction. It usually precedes hypercoagulation or deep venous thrombosis.

Non occlusive ischemia

Constant low output, hypotension or local vasoconstriction can prevent the minimally required blood supply for intestinal viability.

Non occlusive mesenteric insufficiency: It accounts for 20% of the acute mesenteric ischemia. Patients have a reduced basal splenic flow due to generalized atherosclerosis or the use of vasoactive drugs such as digitalis. and when there is reduced overall perfusion, triggered by an acute process, the necessary blood flow for the intestinal territory cannot be maintained. The triggering factors for non-occlusive mesenteric insufficiency range from cardiogenic shock to dehydration leading to hypovolemia. Exceptionally, consumption of toxic agents with sympathetic activity such as cocaine or ergotamine may lead to isolated visceral vasoconstriction and trigger non-occlusive mesenteric insufficiency.11

Acute mesenteric ischemia10,36-40 is an acute disturbance of intestinal circulation that, if not identified on time and treated efficiently, an intestinal infarction will occur and eventual death of the patient. Acute mesenteric ischemia may be caused by different diseases that compromise visceral circulation, either focally or diffusely, in arteries, capillaries and veins. The main challenge for the physician is to identify the acute mesenteric ischemia before intestinal necrosis occurs, with acute abdominal manifestation.

The most common cause of acute mesenteric ischemia is embolic occlusion. The sudden occlusion of the superior mesenteric artery is accompanied by abdominal pain syndrome, generally as a colic, location in the periumbilical or supraumbilical region. The patient refers nausea and the increased intestinal tone triggers profuse vomiting and diarrhea. After a few hours, due to the intestinal atony, there is transient alleviation of pain, until signs of peritoneal irritation arise from transmural damage and pain becomes permanent.

6.3% of peripheral embolisms involve the superior mesenteric artery. An embolism must be suspected in every patient with a sudden abdominal pain syndrome, profuse vomiting and diarrhea, with a history of heart disease or arrhythmias in physical examination, even more so if a history of embolisms is referred or there is a picture of concomitant embolism in another territory. If an arrhythmia is not identified at the time of physical examination, it does not rule out an embolism (the patient may have paroxistic atrial fibrillation, intracavitary thrombus after a myocardial infarction, intracardiac tumor, etc.). The clinical picture may be confused with gastroenteritis, mechanical ileus, pancreatitis or any other cause of an acute abdominal pain syndrome.

Thrombosis of the superior mesenteric artery10,36-40 almost always happens on an atheroma plaque located in its origin, also from atherosclerosis and other less frequent causes. If the obstruction has given time to grow collateral circulation, it may be asymptomatic, as seen in some cases of Takayasu arteritis. 50% of patients with thrombosis of the superior mesenteric artery have a previous history of mesenteric angina, significant weight loss and signs of arterial disease in other vascular territories.

Mesenteric venous thrombosis occurs in approximately 10% of acute mesenteric ischemias, it is generally segmental, produces mucosal edema, hemorrhagic congestion in the wall and mesentery and luminal bleeding. The clinical presentation typically includes a fever syn-
drome, intermittent abdominal pain syndrome (sometimes colic-like), for several days with preservation of intestinal transit. Vomiting, diarrhea and bleeding have a late onset. On physical examination there is abdominal distention and in certain cases there is peritoneal irritation. More than 80% of patients have a predisposing or associated factor among which the following stand out: recent abdominal surgery, visceral inflammatory disease, portal hypertension, hypocoagulability states, neoplasms and use of estrogens.

Non occlusive acute mesenteric ischemia is intestinal necrosis with mechanical vascular obstruction. It is generally found because of low cardiac output in patients with heart disease or in critical patients after surgery. Any disturbance that leads to redistribution of heart output may induce splenic vasoconstriction and, when it is prolonged, it may trigger a non occlusive acute mesenteric ischemia.

CTA is very useful for the differential diagnosis and with very good sensitivity to find indirect signs of acute mesenteric ischemia and intestinal infarction: intestinal pneumatosis, distended loops of bowel, edema of the wall. In many cases it points to etiological diagnosis without having to resort to an arteriogram.

1. Embolic occlusion or arterial thrombotic occlusion: It finds up to 78% of the occlusions of the superior mesenteric artery, although if the occlusion is very distal, an angiogram is still better.

2. Mesenteric vein thrombosis: Currently it is the procedure of choice. There is a delay in passage of contrast to the venous system, a thickened wall and no opacification of the vena porta.

3. Non occlusive mesenteric insufficiency: It rules out other possible diagnoses and finds the advanced intestinal infarction, but it is not useful to see the arteriolar spasm.

As soon as a diagnosis of acute mesenteric ischemia is suspected, treatment will be immediately initiated, since it must be considered a vascular emergency, comparable to an acute myocardial infarction. Mesenteric vascular disease leads to a painful abdominal syndrome and significant morbidity and mortality if not diagnosed and treated right away. Since intestinal viability depends on the mesenteric vasculature, a timely diagnosis is crucial. CTA provides a noninvasive, fast and available method to evaluate mesenteric arteries and veins and intra-abdominal and pelvic viscera. In view of the current value of CTA in the diagnosis of vascular disease, it is important that the radiologist should understand the technical aspects and imaging findings of an acute mesenteric ischemia. Therefore, a successful diagnosis depends on the familiarity of CTA, extending to the ability to use multiplanar and volumetric reconstruction.

It is feasible to shorten the time to diagnose acute mesenteric ischemia when it is immediately established as a target shooting action: in those cases where occlusive mesenteric ischemia is suspected, either arterial or venous, a CTA must be performed.

An early diagnosis and prompt treatment decision will improve survival. Figure 3 In patients with multiple morbidities the quick use of invasive radiology is an option to recanalize the vascular structures immediately. In cases of peritonitis the bowel portions with irreversible damage should be resected with surgical vascularization. Venous thrombosis is treated with thrombolysis through a transhepatic jugular catheter.

Acute mesenteric ischemia is mainly caused by a thrombotic superior mesenteric or embolic
occlusion, mesenteric venous thrombosis or non-occlusive mesenteric ischemia. The emergency treatment of choice of acute mesenteric ischemia in thrombotic or embolic arterial occlusion is surgery. Non-surgical treatment is the treatment of choice of venous thrombosis in acute mesenteric ischemia and in non occlusive mesenteric ischemia.

As shown in the results of the work-up requested to the CAT scan subsection of the Hospital Central Militar, with diagnostic suspicion of acute mesenteric ischemia, 6 (23%) of the studies were done in simple phase due to kidney function failure, 8 (30%) of the studies were done in simple phase and venous phase only 12 (62%) had a CTA on admission. The contrast studies, 20 (77%) allowed identification of the acute mesenteric ischemia. The 6 (23%) simple phase studies showed indirect findings, secondary to the acute mesenteric ischemia. The CTA facilitates finding the vascular abnormalities, such as filling defects, obstructive or not, as well as stenosis when the total vascular mapping is done.42-44

Among our patients, filling defects were identified, either thrombotic arterial or venous in 15 (58%); 8 (30%) of the studies done in simple and venous phase showed in 4 patients (50% of the ones in which this technique was used) the filling defects, either thrombotic arterial or venous, and 12 patients (62%) who had a CTA on admission showed the filling defects, either thrombotic arterial or venous in 11 (92% of those in which this technique was used).

When the filling defects are identified, either thrombotic arterial or venous, both techniques are useful. 42-44

The number of patients included and the clinical information obtained have limitations in showing with certainty the usefulness of this grading into low, intermediate or high grade. Nevertheless, we believe that it is a preliminary step for future studies with a greater number of patients and with complete, comprehensive and adequate clinical information for an ambispective study design, that involves errors in the retrospective review of the studies and in the nomenclature used in our hospital when talking about acute mesenteric ischemia, more commonly know as mesenteric vascular stroke, and in spite of having a PACS/RIS/HIS system, when key words are searched in the radiological report obtained from 2011 to 2014 only 51 patients are shown, with no access to images.

This is our first institutional study involving this group of patients, with studies made as requested and with their clinical and pathological correlation. The use of multidetector CT and injectors for CTA has improved our ability to find the acute mesenteric ischemia and thereby its inherent surgical management, as reflected on the number of scans made in 2013 and 2014, 10 patients (39% of the total number of patients), were all studied with CTA and in whom with the technical and administrative capabilities of the present time, the CTA was performed even during weekends or during the night shift, 365 days of the year, 24 hours a day.

CONCLUSION

In this study it is recommended to conduct a quantitative analysis assigning a specific value to the different findings, either risk factors, physical examination, laboratory studies and imaging findings, in order to establish the risk for a patient with abdominal pain syndrome to suffer from acute mesenteric ischemia.

The number of patients and the clinical information are limited in showing the usefulness of this scale with certainty; however, we believe that it is a preliminary step for future studies with a greater number of patients and with complete, comprehensive and adequate information.
Acute mesenteric ischemia is a diagnostic challenge, it involves high clinical suspicion by the fact that, even though patients have a severe abdominal pain syndrome with an unrevealing physical examination, and few signs, suspicion must be weighed according to risk factors: cardiac arrhythmia, history of thrombotic events, heavy smoking and antithrombotic medication.

An early diagnosis and aggressive management in this situation is crucial. If there is clinical suspicion of the diagnosis and there are signs of peritonitis, or any other abdominal emergency condition, laparotomy is indicated. If these abdominal signs are not present, then a diagnostic approach by imaging may help to support the identification of the problem before irreversible changes take place Our intention is that the following recommendations help to make decisions for a successful treatment of patients, although we have to admit that in most patients the diagnosis will be made late, when there is no longer a chance to make a successful treatment decision:

1. The possibility for a patient to have acute mesenteric ischemia is high if the patient is diabetic, hypertensive, with heart disease or with arrhythmia, with severe abdominal pain, vomiting or diarrhea, in whom the physical examination contributes with very few signs, with a high grade intestinal obstruction syndrome, hemodynamic decompensation, abnormal laboratory findings including leukocytosis, extensive aortic sclerosis, with a previous history of acute mesenteric ischemia and in whom acute mesenteric ischemia is suspected (intestinal sounds may be found in initial, early stages).

2. When the acute mesenteric ischemia is considered to be the cause of the abdominal symptoms, an emergency CT angiography or angiogram should be performed.

3. If an angiogram is performed and the diagnosis is confirmed, a vascular reconstruction should be made. It is recommended to get a vascular surgeon involved.

4. If vascular repair is performed (embolectomy or shunt) surely there will be some dead bowel that must be resected and there will be a need for an ileostomy. The bowel loops whose viability is doubtful must be reevaluated during a second look at 24 hours.

5. If the CTA or angiography reveals venous thrombosis or non-occlusive mesenteric ischemia, anticoagulants or vasodilators must be considered for treatment.

We must always remember that acute mesenteric ischemia is not common and that a late diagnosis is usual; it will always involve comorbidities and a high mortality rate. An accurate and fast diagnosis requires careful attention to the clinical history and physical examination, with a high index of suspicion and an early CTA. The most common clinical finding was acute abdominal pain syndrome in 70%, the most frequently associated history was type 2 diabetes mellitus and systemic hypertension in 26% of patients.

The CTA findings were direct (filling defects in 38%) and indirect (intestinal pneumatosis 29%), venous filling defect 22%, intestinal occlusion syndrome in 22%, and free fluid in 22%. In no case increased vascular density was found, nor intramural hemorrhage. Other nonspecific findings were sites of vascular calcification, and jointly with the risk factors, clinical factors, biochemical and radiological and imaging results, a low, intermediate or high probability for a patient to have acute mesenteric ischemia will be determined.

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