Canadian Association of General Surgeons and American College of Surgeons Evidence Based Reviews in Surgery. 15

Biphasic computed tomography with mesenteric evaluation of acute mesenteric ischemia

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CAGS Evidence Based Reviews in Surgery

In September 2000, the Canadian Association of General Surgeons (CAGS) initiated an Internet-based journal club entitled "CAGS Evidence Based Reviews in Surgery (CAGS-EBRS)" to help practising clinicians improve their critical appraisal skills. Since October 2005, EBRS have been made available to members of the American College of Surgeons (ACS). During the academic year, 8 clinical articles are chosen for review and discussion. Both methodological and clinical reviews of the article are performed by experts in the relevant areas. The *Canadian Journal of Surgery* publishes 4 of these reviews each year, and the remaining 4 are published by the *Journal of the American College of Surgeons*. Each review will consist of an abstract of the selected article and a summary of the methodological and clinical reviews. We hope that readers will find these useful and learn skills that can be used to evaluate other articles. For more information about EBRS or information about participating in the program, send an email to mmckenzie@mtsinai.on.ca or access the CAGS Web site www.cags-accg.ca or the ACS Web site www.facs.org.

Selected article

Kirkpatrick ID, Kroeker MA, Greenberg HM. Biphasic CT with mesenteric CT angiography in the evaluation of acute mesenteric ischemia: initial experience. *Radiology* 2003;229:91-8.

Abstract

Question: Is biphasic computed tomography (CT) with mesenteric CT angiography effective in diagnosing acute mesenteric ischemia (AMI)? **Design:** Prospective cohort study. **Setting**: Two tertiary care centres in Canada. **Patients:** Sixty-two patients had clinically suspected AMI, with a finding of abdominal pain and at least 1 of the following symptoms: pain out of proportion to clinical findings; biochemical evidence of ischemia, namely, elevated lactate levels or unexpected metabolic acidosis; or patients' risk factors for ischemia, such as previous ischemia or symptoms of chronic ischemia, severe vascular disease, atrial fibrillation without therapeutic anticoagulation, low flow (history of hypotension or vasopressor therapy) or hypercoagulable states. The patients consisted of 21 men (age range 32–87 [mean 60] yr) and 41 women (age range 32–87 [mean 65] yr). All patients were examined before CT angiography by a specialist (either a general or vascular surgeon or an internist). **Description**

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of test and diagnostic standard: All patients were examined with 4-row multidetector row CT. Mesenteric angiography was performed with 1.25-mm collimation, starting 25 seconds after intravenous (IV) administration of contrast material, which was delivered at a rapid rate of injection (4 mL/s) for maximum enhancement of the arteries during the arterial phase. Water was given as an oral contrast agent so that 3-dimensional CT angiograms could be reconstructed from high-density oral contrast material. The results were compared with findings from surgery, autopsy, serial CT, laboratory tests or by following patients until they recovered spontaneously. **Main results:** AMI was diagnosed in 26 patients, 11 of whom died of bowel ischemia while in hospital. The initial interpretation of the radiologist had 100% sensitivity and 89% specificity. The likelihood ratio of a positive test was 9. A finding of any one of pneumatosis intestinalis, venous gas, superior mesenteric artery (SMA) occlusion, celiac and inferior mesenteric artery occlusion with distal SMA disease, or arterial embolism was 100% specific but only 73% sensitive. A finding of bowel-wall thickening in addition to a focal lack of bowel enhancement, solid-organ infarction or venous thrombosis was 50% sensitive and 94% specific. By using either of these criteria for a diagnosis, a sensitivity of 96% and specificity of 94% was achieved. **Conclusion:** Biphasic CT with mesenteric CT angiography is effective in diagnosing AMI.

Commentary

AMI is an emergency condition, with a high mortality rate. Diagnosis is often delayed until there is irreversible ischemia and treatment is impossible or is unlikely to improve outcome. Catheter angiography and CT have been the main diagnostic tests for AMI. Although considered the gold standard for decades, catheter angiography is not universally available, may take time to arrange and perform, and can only provide assessment of the mesenteric vessels. On the other hand, CT is more widely available, less invasive and can be performed quickly. CT provides information regarding not only the mesenteric vessels but also the bowel, abdominal organs and surrounding structures and, therefore, has become the dominant imaging modality for the investigation of acute abdominal conditions as well as AMI.

This month's article examines the value of biphasic CT in combination with mesenteric CT angiography in the diagnosis of acute mesenteric ischemia. Single-slice helical (or spiral) CT technology is currently being supplanted by multislice CT technology. In the latter, instead of a single row of detectors, there are multiple rows of detectors, allowing for the acquisition of multiple slices per tube rotation. Multislice CT has made CT scanning faster, allowed for the acquisition of thinner slices and provides greater flexibility with regard to the timing of image acquisition related to the delivery of IV contrast material. This technology had led to improvements in a wide range of clinical applications including CT angiography, CT colonography and multiphase organ imaging.

For a diagnostic test to be useful in patients with suspected AMI, it must be readily available and interpreted by an expert radiologist within an hour of the request. Furthermore, the test must identify early signs of ischemia so that treatment is likely to be effective rather than identifying late findings when the outcome is unlikely to be affected by treatment. General and vascular surgeons can often identify the patency of the major vessels and free air on the axial sections. The radiology consultation can add the more subtle findings such as mucosal enhancement, bowel-wall thickening and portal venous gas, which may improve diagnostic accuracy and lead to better treatment. The addition of a reconstructed mesenteric angiogram may also be of benefit, but will be less useful if the diagnosis is unrelated to the arterial or venous system. For vascular surgeons, thin-slice, contrast-enhanced CT with 3-dimensional mesenteric arterial reconstructions will help to differentiate mesenteric arterial thrombosis from embolism and allow preoperative planning for those patients who may require a vascular reconstruction.

This study included 72 patients over an 18-month period at 2 tertiary care hospitals. All had been assessed by a specialist (general or vascular surgeon or internist) who believed that there was clinical suspicion of AMI. Ten patients were excluded (8 had contrast contraindications, 2 failures to give contrast), leaving 62 patients in the study. The findings of AMI on CT are related to the underlying cause and the extent and degree of bowel-wall ischemia. CT findings of AMI evaluated in this study included the following: mesenteric arterial or venous thrombus, mesenteric venous gas, pneumatosis intestinalis, bowel-wall thickening, increased or decreased enhancement of the bowel wall, bowel dilatation, stranding of the mesentery or perienteric fat, ascites, pneumoperitoneum and solid-organ infarction. The authors also assessed the CT angiograms for evidence of arterial stenosis or occlusion. In practice, any one of the CT findings, in isolation, does not usually lead to a diagnosis of AMI. However, in the appropriate clinical setting, 1 or more of these findings can help to establish the diagnosis of AMI.

The positive diagnosis of AMI was confirmed by surgery or autopsy in 25 of 26 patients. One other patient was presumed to have AMI but did not have surgery. Instead, serial CT scans showed resolution of the findings. In the non-AMI group, 8 had other surgical diagnoses confirmed at surgery, 22 had laboratory test results and clinical findings that confirmed another diagnosis and 6 did not have a diagnosis but made an uneventful recovery, and it was assumed they did not have AMI. In this article, the data are presented in several ways and one has to critically assess the results. On the basis of the interpretation of the initial radiologist reading the scan, upon which clinical decisions were made, a 2 × 2 table (Table 1) can be constructed. (This seems to be the most clinically relevant way of analyzing the data although these data are found only in the Discussion.)

Table 1

Summary of diagnostic test results

Test result	Diagnosis +	Diagnosis –	Total no. of patients
+	26	4	30
–	0	32	32
Total no. of patients	26	36	62

Therefore:
Sensitivity = 26/(0 + 26) × 100 = 100%
Specificity = 32/(32 + 4) × 100 = 89%
Positive predictive value = 26/(26 + 4) × 100 = 87%
Negative predictive value = 32/(32 + 0) × 100 = 100%
Likelihood ratio of a positive test = [26/(26 + 0)]/[4/(4 + 32)] = 9
Likelihood ratio of a negative test = [0/26]/[32/36] = 0
Of the many ways to evaluate a diagnostic test, likelihood ratios (negative or positive) seem to make the most sense. The prevalence of the disease is also the pretest likelihood of disease. For instance, if 50 of 100 patients in the sample have the disease, the prevalence is 50 of 100 and the pretest probability of disease is also 50%. The positive and negative predictive values vary depending on the prevalence of the disease, whereas likelihood ratios do not. In addition, the likelihood ratios essentially tell the clinician how much the pretest chance of a specific diagnosis increases or decreases. Thus, a likelihood ratio of greater than 10 or less than 0.1 generally results in large changes in the post-test probability of disease; those between 2 and 5 or between 0.5 and 0.2 generate small, but sometimes important, changes in the probability of disease, and smaller likelihood ratios alter the post-test chance of the diagnosis by only a small degree. In this study, the likelihood ratio of a positive test was 9 so it would seem that the test was very useful.

There are, of course, some limitations to the study. The sample was relatively small. The investigators used state of the art technology that was available in 2000 but may be obsolete now. Some might question the "gold standard," but in reality it was a pragmatic approach that makes the most sense in clinical medicine. One could argue that some of those patients who did not have surgery and were considered not to have had AMI, in fact, did have AMI, but one could argue that if they got better without intervention, the diagnosis was not clinically relevant. Finally, there are no data on the total number of patients with AMI who were seen during the study period. If this is a highly selected group, it may decrease the generalizability of the results. From the report, the reader can tell that 26 of 62 (42%) individuals suspected of AMI had AMI requiring surgery. Furthermore, 11 of 26 (42%) with AMI died.

In summary, thin-slice, contrast-enhanced biphasic abdominal CT appears to be a very useful examination in the setting of abdominal pain without a clear diagnosis and a suspicion of AMI. However, it is important to emphasize that the CT scanning protocol used in this study should be used primarily when AMI is the leading clinical consideration. Compared with a standard CT protocol of the abdomen and pelvis performed for nonspecific abdominal pain, the protocol used for AMI would take longer for the technologists to set up, would create a larger number of images to be filmed or stored electronically, and would take a longer time for the radiologist to interpret. If 3-dimensional images were reconstructed, this would also add to the workload for the radiologist. These are important points to consider for radiologists and surgeons who may be considering adopting such a CT protocol at their institution for patients with a high clinical suspicion of AMI.

Competing interests: None declared.