Interobserver agreement on the diagnosis of bowel ischemia: assessment using dynamic computed tomography of small bowel obstruction

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Abstract

Purpose. The aim of this study was to evaluate the accuracy and interobserver variability of dynamic computed tomography (CT) for diagnosis of small bowel obstruction.

Method and materials. A total of 115 patients with a CT diagnosis of small bowel obstruction were included. Two radiologists and two residents performed blinded, independent, retrospective reviews of CT studies. Attention was focused on the presence of reduced early enhancement of the bowel wall and closed loop obstruction. Results were correlated with surgical findings in 15 cases and clinical follow-up in 100 cases. Sensitivity and specificity were calculated, and kappa statistics were used to analyze interobserver agreement.

Results. In all, 13 cases were surgically confirmed small bowel ischemia. Sensitivity, specificity, positive predictive value, and negative predictive value for the diagnosis of ischemia were 85%, 96%–97%, 73%–79%, and 97%–98%, respectively, for radiologists and 69%–93%, 93%–95%, 63%–64%, and 96%–99%, respectively, for residents. For agreement in the interpretations of reduced early enhancement of bowel wall, closed loop obstruction, and presence of bowel ischemia, the values were 0.62, 0.71, and 0.80, respectively, between radiologists and 0.57–0.70, 0.63–0.74, and 0.56–0.68, respectively, between radiologists and residents.

Conclusion. There was moderate or substantial agreement for the diagnosis of small bowel ischemia between radiologists and residents. However, there was substantial agreement for the presence of closed loop obstruction.

Key words Small bowel obstruction · Computed tomography · Interobserver agreement · Bowel ischemia

Introduction

Bowel obstruction is a relatively common condition on emergent computed tomography (CT). The diagnosis of small bowel ischemia has important implications for patient care because morbidity and mortality increase with delay in diagnosis.1,2 Bowel obstructions associated with small bowel ischemia have a mortality rate of 20%–37%, compared with a rate of 5%–8% for simple obstruction.3–5 This high mortality rate is mainly attributed to a delay in establishing the correct diagnosis.

In the previous literature, CT diagnosis of bowel obstruction was reported to have a sensitivity of 75%–100% and a specificity of 61%–93%.1,2,6–8 In addition, accurate detection of strangulation on CT remains controversial, although several studies have reported a detection rate of 63%–100%.6,7,9–11 On the other hand, one study reported that the prospective sensitivity of CT for identifying small bowel ischemia in patients in the
emergency department was much lower than that of previously published reports.\textsuperscript{12}

To ensure a reliable diagnosis of small bowel ischemia in patients with bowel obstruction, dynamic CT must be reproducible among observers. To the best of our knowledge, no report in the literature has described an assessment regarding the level of agreement. Thus, our study was performed to evaluate agreement among radiologists on the interpretation of the presence of small bowel ischemia and closed loop obstruction in those with bowel obstruction.

Materials and methods

Between September 2005 and September 2007, a total 115 patients with clinically confirmed bowel obstruction underwent abdominal CT examinations. The initial CT findings were correlated with the surgical findings in 15 patients and with clinical follow-up findings after nasogastric suction in 100 patients. The 55 women and 60 men ranged in age from 16 to 96 years (median 73 years).

The CT examinations of the abdomen and pelvis were performed with 64-row, multidetector (MD) CT (Sensation Cardiac; Siemens, Erlangen, Germany) using 3-mm reconstruction thickness and 3-mm intervals through the abdomen and pelvis, or with 6-row MDCT (Somatom Emotion 6; Siemens) using 4-mm reconstruction thickness and 4-mm intervals. In 74 cases, further transverse section data were reconstructed with 1 mm thick sections at 1-mm intervals; and the second data set was reformatted coronal scans, with 5 mm thick sections at 5-mm intervals. Transverse scans reconstructed with 1 mm thick sections at 1-mm intervals were not sent to the picture archiving and communication system because of the excessive number of slices.

Bowel opacification was not accomplished before scanning. After unenhanced CT scans were obtained, 100 ml of nonionic contrast material (300 mg I/ml) was administered intravenously with a power injector at a rate of 3 ml/s. Dynamic CT (0.6-mm collimation × 64, a pitch of 5, table speed of 12.5 mm/rotation, and 0.5-s gantry rotation period: Sensation Cardiac; or 3-mm collimation × 6, pitch of 1, table speed of 18 mm/rotation: Somatom Emotion 6) was initiated 40 s (early phase) and 150 s (late phase) after starting the contrast material injection.

Image interpretation

Two radiologists and two radiology residents independently reviewed the images using the scroll mode display, in which multiple original sections can be viewed by scrolling through the images. Observers were blinded to patient identification and all clinical information, including the surgical or pathological diagnosis. Each reader evaluated causes of obstruction and ischemia. The following findings were considered signs of closed loop obstruction: (1) the presence of a C- or U-shaped loop of dilated small bowel; (2) a transitional area consisting of dilatation of the bowel loops above and of a collapse below.

Bowel ischemia was diagnosed based on the following findings: reduced early enhancement of the small bowel wall compared with other small bowel wall segments during the early phase on dynamic CT or the same bowel wall segments on unenhanced CT under appropriate conditions.

Statistical analysis

Results were correlated with surgical findings in 15 cases and clinical follow-up in 100 cases. Sensitivity and specificity were calculated, and kappa statistics were used to analyze interobserver agreement. The kappa statistics for interobserver agreement for binary CT signs were interpreted using the following scale: fair agreement, 0.21–0.40; moderate agreement, 0.41–0.60; substantial agreement, 0.61–0.80; and almost perfect agreement, 0.81–1.0.\textsuperscript{13} \( P < 0.05 \) was considered a significant difference for all analyses.

Results

Clinical outcomes are presented in Table 1. In all, 100 patients’ symptoms were alleviated with conservative treatment, including long tube decompression. In 2 of 100 cases, adhesiolysis was needed because small bowel obstruction recurred after oral intake was resumed. We considered these 100 patients to have simple small bowel obstruction based on the following criteria reported by Ha et al.\textsuperscript{10}: abdominal tenderness, tachycardia (heart rate >100 bpm), fever (temperature >38.5°C), and leukocytosis [white blood cell count >10 000/mm\(^3\) (10.0 × 10\(^9\) l)].

| Table 1. Characteristics of 115 patients who underwent computed tomography |
|---------------------------------|------|
| Characteristic                  | No.  |
| No bowel ischemia (open loop)   | 100  |
| Closed loop obstruction         | 2    |
| Bowel ischemia                  | 13*  |
| Total                           | 115  |

\*Of the 13 patients with bowel ischemia, 9 had closed loop obstruction.