Diagnostic Value of Plain and Contrast Radiography, and Multi-slice Computed Tomography in Diagnosing Intestinal Obstruction in Different Locations

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Abstract Early intestinal obstruction is easily misdiagnosed. Many physicians consider terminal bouton if computed tomography (CT) scan is done. However, different examinations provide diverse information and significance. This retrospective, randomized, clinical study investigated the diagnostic value of three imaging modalities for intestinal obstruction, supine and upright (or decubitus) plain abdominal radiography, contrast radiography using Gastrografin, and 64 multi-slice spiral CT (MSCT). A total 142 patients with intestinal obstruction were examined. The diagnostic accuracy of plain radiography, contrast radiography, and MSCT for detecting small bowel obstruction was 62.5, 85, and 77.5 %, for localizing the obstruction was 0, 90, and 78.75 %, and for determining the cause of obstruction was 0, 71, and 65 %, respectively. The diagnostic accuracy for detecting large bowel obstruction was 53.23, 73.17, and 92 %, and for localizing the obstruction was 38.17, 60.98, and 98 %, respectively. The diagnostic accuracy of MSCT in determining the cause of obstruction was 91 %. None of the patients administered Gastrografin experienced any adverse effects. In conclusion, MSCT has great diagnostic value in identifying the site and cause of intestinal obstruction, especially in cases of large bowel obstruction. Contrast radiography using Gastrografin was effective in diagnosing and treating small bowel obstruction, making it a beneficial adjunct to MSCT.

Keywords Small intestine obstruction · Large intestine obstruction · Radiography · Gastrografin · Computed tomography · Diagnosis

Introduction

Intestinal obstruction is one of the most common emergencies in general surgery and is a major cause of morbidity and financial expenditure worldwide [1]. Early diagnosis of intestinal obstruction is comparatively difficult. The misdiagnosis rate of supine and erect plain abdominal radiographs, which are typically employed diagnostically, is high, and it is difficult to discern the location and cause of obstructions [2]. Computed tomography (CT) is a considerably more sensitive method of detecting intestinal obstruction, and increased numbers of physicians have become overly dependent on it [3]. Therefore, the present retrospective study examined the diagnostic value of plain radiography and CT examination for intestinal obstruction at various locations.

Patients and Methods

This randomized clinical study included patients admitted to Xuanwu Hospital, Capital University of Medical Sciences, Beijing, China. The medical records of 142 patients (80 small intestine obstruction and 62 large intestine obstruction) admitted between September 2012 and September 2013 were retrospectively reviewed. Supine and erect abdominal radiographs were obtained in all patients on admission, and the maximal intestinal diameter was measured. Radiological signs of intestinal obstruction included the existence of multiple gas lesions in the small intestine more than 2.5 cm in diameter, the absence of gas in the colon, the presence of multiple gas lesions

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in the large intestine more than 6 cm in diameter, or the absence of gas in the distal colon [4]. Patients were randomized using a random number table and allocated into two groups. All patients met the inclusion and exclusion criteria before study enrolment. This study was approved by the ethics committee of Xuanwu Hospital. All enrolled patients provided informed written consent and patients were free to withdraw from the study at anytime. Three different imaging examinations (plain radiography, contrast radiography, and multi-slice CT [MSCT]) were performed in the patients with small intestinal obstruction. Among the patients with large intestinal obstruction, 41 patients (41/62) underwent contrast radiography, and 21 patients underwent MSCT in addition to plain radiography.

Inclusion Criteria

Patients meeting the following criteria were included: over 18 years of age, supine and erect abdominal radiographs, and a diagnosis of intestinal obstruction based on clinical and radiological evidence.

Exclusion Criteria

Patients meeting the following criteria were excluded: aged less than 18 years, diagnosed with early postoperative obstruction (within 4 weeks postoperatively), ileus, inflammatory bowel disease, previous abdominal irradiation, hyperthyroidism, iodine sensitivity, or a final diagnosis other than intestinal obstruction. The cutoff age in similar studies was also 18 years as these studies were conducted in adult patients. Patients under 18 years of age who were already under the care of a pediatric surgeon were excluded from the study because these patients sometimes had congenital problems, which are more complex. It was considered better to refer pediatric patients to a pediatric surgeon for examination.

Imaging Examination

Oral feeding was discontinued in all patients, and nasogastric tube decompression and intravenous fluid resuscitation were initiated. Supine and erect plain abdominal radiography was performed initially. Contrast radiography was performed by administering 100 ml of Gastrografin (meglumin amidotrizoate, Shanxi Jingxi Pharmaceutical Manufacturing Co., Xian, China) through the nasogastric tube and radiographing the abdomen 30 min and 1–2 h later. Patients in the CT group ($n=125$) underwent 64 MSCT using routine parameters. Contrast CT was performed by administering Ultravist Solution intravenously. All radiographs and CT images were reviewed by two experienced radiologists. The obstruction sites were localized to specific segments of the small or large intestine.

Patients who did not show any clinical and radiological improvement after 6–12 h underwent surgery. Concerning signs included the failure of the contrast agent to pass the obstruction site, scant contrast material passing the obstruction, worsened intestinal dilation proximal to the obstruction, and deteriorating physical signs.

Statistical Analysis

Patients were divided into three groups according to the imaging procedure performed (plain radiography, contrast radiography, and MSCT), and the diagnostic value of each technique for intestinal obstruction at different locations was evaluated. The diagnostic accuracy, obstruction site, and obstruction etiology were presented as the number (percentage) of patients and analyzed. Differences between the groups were detected using the chi-square (χ^2) test. P values less than 0.05 were considered statistically significant, and P values less than 0.01 were considered highly significant.

Results

The small and large intestinal obstruction groups did not differ significantly in sex and age but did differ in the number of previous surgeries ($P=0.00$), as shown in Table 1. None of the patients experienced any adverse effects, and none of those administered Gastrografin exhibited iodine sensitivity.

Small Intestinal Obstruction

The diagnostic accuracy of contrast radiography and MSCT both significantly surpassed that of plain radiography. The obstruction sites and etiologies could not be determined on plain radiography but were discernable using the other two methods. The diagnostic accuracy of contrast radiography was significantly greater than that of MSCT in diagnosing the obstruction site (Table 2). The small intestinal obstruction group ($n=80$) included 55 cases of ileum obstruction and 25 jejunum obstruction cases. Sixty cases were caused by adhesive small intestinal obstruction, 14 cases by chyme obstruction, 3 cases by tumor obstruction, 2 cases by internal hernia, and 1 case by intussusception.

Large Intestinal Obstruction

In cases of large intestinal obstruction, the diagnostic accuracy in determining the obstruction site and cause was significantly higher for MSCT compared with the other modalities. The diagnostic accuracy for detecting the obstruction site was significantly higher for contrast radiography compared with plain radiography, but neither modality was able to ascertain the cause of obstruction (Table 3). Among the 62 cases of large

Table 1 Patient characteristics

	Small bowel obstruction	large bowel obstruction	<i>P</i>
Male	44 (55 %)	39 (63 %)	0.439
Age (years) ^a	50.64±16.28	52.17±17.13	0.43
Number of previous surgeries	2.16	0.32	0.00

^a Data are presented as the mean±standard deviation or number (percentage) of patients

intestinal obstruction, 42 cases were diagnosed as left hemicolon obstruction, 9 cases were right hemicolon obstruction, 4 cases were transverse colon obstruction, and 7 cases were rectum obstruction. Forty-three cases were caused by tumor obstruction, 17 cases by bezoar obstruction, and 2 cases by acute sigmoid volvulus.

Discussion

Intestinal obstruction usually occurs acutely and progresses rapidly; therefore, it is critical to devise a treatment plan as early as possible. However, early intestinal obstruction is difficult to diagnose owing to its complexity and variable presentation. Plain abdominal radiography is the first diagnostic choice because it is inexpensive and widely available, but it is unable to determine the location and cause of obstruction and shows a low diagnostic accuracy because of the superimposition of abdominal contents [5]. The present findings confirm that clinicians should not rely solely on plain abdominal radiography owing to its low diagnostic accuracy (58 %, 83/142).

Intestinal adhesion and tumor were the most common causes of intestinal obstruction in this study. The incidence of abdominal adhesion had been estimated to be as high as 94–95 % after laparotomy [6, 7]. Abdominal adhesions can begin forming within several hours postoperatively and are responsible for 60 to 70 % of all small intestinal obstructions

Table 2 Imaging findings in patients with small intestinal obstruction

Examination methods (cases)	Diagnostic accuracy	Obstructive locations ascertained	Obstructive reasons ascertained
Plain film (80)	62.5 %	—	—
Oral Gastrografin (80)	85 %*	90 %	71 %
	77.5 %**	78.75 %***	65 %
64 MSCT scan (80)			

MSCT multi-slice computed tomography

*P<0.01 and **P<0.05 compared with plain radiography. ***P<0.05 compared with contrast radiography

Table 3 Imaging findings in patients with large intestinal obstruction

Examination methods (cases)	Diagnostic accuracy	Obstructive locations ascertained	Obstructive reasons ascertained
Plain film (62)	53.23 %	38.17 %	—
Oral Gastrografin (41)	73.17 %**	60.98 %**	—
	92 %*.,##	98 %*.,#	91 %
64 MSCT scan (62)			

MSCT multi-slice computed tomography

*P<0.01 and **P<0.05 compared with plain radiography. # *P*<0.01 and ## *P*<0.05 compared with contrast radiography

[8, 9]. This is especially evident in patients with a history of previous abdominal surgery [10], while other causes of adhesion account for few cases [11]. The presence of adhesions adds a mean 24 min to the surgical duration, increases the risk of iatrogenic intestinal injury, and makes future laparoscopic surgery more difficult or even impossible [12, 13]. Therefore, emergency surgery is mandatory only in cases of strangulation or complete obstruction to avoid generating new adhesions needlessly [14].

The early clinical manifestation of adhesive small bowel obstruction is atypical, making it easy to misdiagnose. The chief complaint is typically nonspecific, plain abdominal radiography is often negative, and obstructions are difficult to confirm on MSCT. Contrast radiography exhibited excellent diagnostic accuracy compared with MSCT and was especially superior in ascertaining the obstruction location. This is because the diagnosis of intestinal obstruction using MSCT is based primarily on identifying the transitional zone between the distended proximal intestinal segment and segment distal to the obstruction. The early transitional zone is indistinct in small intestinal obstruction [2]. Gastrografin, the most widely used nonionic, water-soluble contrast medium for intestinal obstruction, images the intestine safely and intuitively, facilitates dynamic observation, and can identify complete obstruction. Conservative treatment is recommended if the contrast medium passes the suspect obstruction, while laparotomy is typically performed if the medium fails to pass the obstruction [15]. With an osmolarity approximately six times that of extracellular fluid (1900 mOsm/L), it has been postulated that the contrast agent draws fluid from the bowel wall into the lumen, thereby decreasing edema and increasing the pressure gradient across the obstruction site [16–19]. In the present study, 56 patients with small intestinal obstruction (56/80) who received Gastrografin had a good clinical outcome, which included 45 cases of adhesive obstruction. Similar findings have been reported in recent studies [20, 21].

The most common cause of large intestinal obstruction is colorectal cancer [22]. MSCT can display the anatomic structure surrounding the space-occupying lesion in exacting detail

and offers the advantage of being noninvasive and fast. MSCT can provide a large volume of information and is superior to traditional plain radiography. In this study, MSCT had a diagnostic accuracy for large bowel obstruction of 92 % and accurately identified the site and cause of large bowel obstruction. It was superior to both traditional plain radiography and contrast radiography. Therefore, MSCT can be considered the first choice for diagnosing large bowel obstruction. The diagnostic rate for the obstruction site was only 60.98 % using contrast radiography; we suspect that this reflects excessive dilution of the Gastrografin when it reached the obstruction in the large intestine.

With the recent increased popularity of CT, it has become the first choice for diagnosing intestinal obstruction [23]. However, clinicians should not rely solely on CT. Because the ascending and descending colon is located in a relatively fixed position within the retroperitoneum, it is relatively easy to identify the transitional zone using CT, which helps in staging colorectal carcinoma. Therefore, CT is preferred when large intestinal obstruction is suspected, especially when combined with intravenous contrast enhancement, which provides even more information. For small bowel obstruction, owing to the anatomical characteristics of the small intestine and the indistinct transitional zone in the cases of early, mild, or incomplete obstruction, reliable diagnosis is difficult to achieve using CT. During contrast radiography using Gastrografin, the contrast agent can travel through the narrowed bowel, allowing the obstruction and its location to be visualized, making it a beneficial adjunct to CT examination. In addition, the contrast agent promotes intestinal peristalsis, which has a positive effect on treatment. Therefore, contrast radiography should be applied in cases of suspected small bowel obstruction.

Compliance with Ethical Standards The authors declare that they have no conflicts of interest. This study was approved by the ethics committee of Xuanwu Hospital, Capital University of Medicine Sciences. All patients provided informed, written consent prior to study enrolment.

Conflict of interest We declare that we have no conflict of interests. We have no financial and personal relationships with other people or organizations that can inappropriately influence our work.

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